PANIMALAR ENGINEERING COLLEGE

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai

B.E - MECHANICAL ENGINEERING

REGULATION 2021

CURRICULUM & SYLLABUS

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1: Technical Competence and Problem-Solving: Achieve success in careers that deal with the design, simulation and analysis of engineering systems, experimentation and testing, manufacturing, technical services, and research to implement effective solutions for real-world engineering challenges.

PEO2: Career Growth and Leadership: To actively embrace impactful leadership roles in the practice of Mechanical Engineering in industry and government organizations (including both traditional and emerging technical areas) as well as in public service organizations.

PEO3: Innovation, Research and Ethical Excellence: Conduct multi-disciplinary research and development (via graduate study or industry) resulting in tangible applications that advance technology and foster innovation in order to compete successfully in the global economy.

PEO4: Lifelong Learning and Societal Contribution: Commit to continuous learning, adapting core knowledge, and competing in the ever-changing multicultural global enterprise to ethically contribute to society.

PROGRAM OUTCOMES (PO)

PO1 (Engineering knowledge): Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 (Problem Analysis): Identify, formulate, research literature, and analyze complex engineering problem reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3(Design/development of solutions): Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 (Conduct investigations of complex problems): Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5(Modern tool usage): Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6(The engineer and society): Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Professional engineering practice.

PO7 (Environment and sustainability): Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the 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, and 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 (Life-long learning): Recognize the need for, and have the preparation and abilitytoengageinindependentandlife-longlearninginthebroadestcontextof technological change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO 1: Fundamental Domain Knowledge: Design mechanical systems in various fields of machine elements, thermal, manufacturing, industrial and inter disciplinary fields using engineering/technological tools

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PSO 2: Usage of software programs: Resolve new challenges in Mechanical Engineering using modern computer tools and software programs.

PSO 3:**Continual learning and Research:** Develop intellectual and technical solution to complex mechanical problems through continual learning and research.

PANIMALAR ENGINEERING COLLEGE
(An Autonomous Institution, Affiliated to Anna University, Chennai)
Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600 123

Department of Mechanical Engineering
B.E- Mechanical Engineering

CURRICULUM AND SYLLABUS
REGULATION-2021

B.E- Mechanical Engineering
CHOICE BASED CREDIT SYSTEM
I - VIII SEMESTERS CURRICULA AND SYLLABI- R 2021

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21HS1101	Communicative English and Language SkillsLab I Integrated	HS	5	3	0	2	4
2.	21MA1101	Engineering Mathematics-I	BS	4	3	1	0	4
3.	21PH1101	Engineering Physics	BS	3	3	0	0	3
4.	21CY1101	Engineering Chemistry	BS	3	3	0	0	3
5.	21ES1101	Problem Solving and Python Programming	ES	3	3	0	0	3
6.	21ES1102	Engineering Graphics	ES	5	3	0	2	4
PRACTICALS								
7.	21ES1111	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8.	21BS1111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	31	18	1	12	25

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21HS1201	Communicative English and Language Skills Lab II Integrated	HS	5	3	0	2	4
2.	21MA1201	Engineering Mathematics- II	BS	4	3	1	0	4
3.	21PH1203	Material Science	BS	3	3	0	0	3
4.	21ES1203	Basic Electrical and Electronics Engineering	ES	3	3	0	0	3
5.	21ME1201	Engineering Mechanics	PC	4	3	1	0	4
6.		Mandatory course	MC	2	2	0	0	0
Practical								
7.	21ME1211	Computer Aided Drafting and Modelling Laboratory	PC	4	0	0	4	2
8.	21ES1211	Engineering Practices Laboratory	ES	4	0	0	4	2
			TOTAL	29	17	2	10	22

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21MA1303	Transforms and Partial Differential Equations	BS	4	3	1	0	4
2.	21ME1301	Engineering Thermodynamics	PC	3	3	0	0	3
3.	21ME1302	Strength of Materials for Mechanical Engineers	PC	3	3	0	0	3
4.	21ME1303	Engineering Materials and Metallurgy	PC	3	3	0	0	3
5.	21ME1304	Manufacturing Processes	PC	3	3	0	0	3
6.	21ES1301	Electrical Drives and Controls	ES	3	3	0	0	3
PRACTICALS								
7.	21ES1311	Electrical Engineering Laboratory	ES	4	0	0	4	2
8.	21ME1311	Manufacturing Processes Laboratory	PC	4	0	0	4	2
9.	21ME1312	Computer Aided Design Laboratory	PC	4	0	0	4	2
			TOTAL	31	18	1	12	25

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21MA1405	Statistics and Numerical Methods	BS	4	3	1	0	4
2.	21ME1401	Kinematics of Machinery	PC	3	3	0	0	3
3.	21ME1402	Thermal Engineering-I	PC	3	3	0	0	3
4.	21ME1403	Fluid Mechanics and Machinery	PC	3	3	0	0	3
5.	21ME1404	Metal Cutting and Machine Tools	PC	3	3	0	0	3
6.		Mandatory Course	MC	2	2	0	0	0
PRACTICALS								
7.	21ME1411	Metal Cutting and Machine Tools Laboratory	PC	4	0	0	4	2
8.	21ME1412	Strength of Materials and Fluid Mechanics and Machinery Laboratory	PC	4	0	0	4	2
			TOTAL	26	17	1	8	20

SEMESTER V

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21ME1501	Thermal Engineering - II	PC	3	3	0	0	3
2.	21ME1502	Design of Machine Elements Applications	PC	3	3	0	0	3
3.	21ME1503	Metrology and Measurements	PC	3	3	0	0	3
4.	21ME1504	Computer Aided Design and Manufacturing	PC	3	3	0	0	3
5.	21ME1505	Dynamics of Machines	PC	3	3	0	0	3
6.		Professional Elective -I	PE	3	3	0	0	3
PRACTICALS								
7.	21ME1511	Thermal Engineering Laboratory	PC	4	0	0	4	2
8.	21ME1512	Metrology and Mechanics of Machines Laboratory	PC	4	0	0	4	2
9.	21ME1513	Technical presentation and Comprehension Laboratory	EEC	2	0	0	2	1
			TOTAL	28	18	0	10	23

SEMESTER VI

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21ME1601	Design of Transmission Systems	PC	3	3	0	0	3
2.	21ME1602	Finite Element Analysis	PC	3	3	0	0	3
3.	21ME1603	Heat and Mass Transfer	PC	3	3	0	0	3
4.		Professional Elective -II	PE	3	3	0	0	3
5.		Professional Elective -III	PE	3	3	0	0	3
PRACTICALS								
6.	21ME1611	Heat Transfer and RAC Laboratory	PC	4	0	0	4	2
7.	21ME1612	Computer Aided Manufacturing Laboratory	PC	4	0	0	4	2
8.	21ME1613	Design and Fabrication Project	EEC	4	0	0	4	2
			TOTAL	27	15	0	12	21

SEMESTER VII

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21ME1701	Mechatronics	PC	3	3	0	0	3
2.	21ME1702	Power Plant Engineering	PC	3	3	0	0	3
3.		Open Elective -I	OE	3	3	0	0	3
4.		Professional Elective –IV	PE	3	3	0	0	3
5.		Professional Elective -V	PE	3	3	0	0	3
PRACTICALS								
6.	21ME1711	Simulation and Analysis Laboratory	PC	4	0	0	4	2
7.	21ME1712	Mechatronics Laboratory	PC	4	0	0	4	2
TOTAL				23	15	0	8	19

SEMESTER VIII

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Open Elective -II	OE	3	3	0	0	3
2.		Professional Elective -VI	PE	3	3	0	0	3
PRACTICAL								
3.	21ME1811	Project Work	EEC	16	0	0	16	8
TOTAL				22	6	0	16	14

TOTAL NO. OF CREDITS: 169

Professional Elective courses-Vertical

Vertical 1	Vertical 2	Vertical 3	Vertical 4	Vertical 5	Vertical 6	Vertical 7
Design	**Robotics And Automation**	**Thermal Sciences**	**Modern Mobility Systems**	**Industrial Management**	**Logistics And Supply Chain Management**	**Diversified Group**
Surface Engineering and Tribology	Welding Technology	Renewable Energy Resources	Advanced IC Engines	Engineering Ethics	Operations Research	Thermal Power Engineering
Optimization Techniques in Engineering	Modern Machining Processes	Energy Conservation and Waste Heat Recovery	Automotive Technology	Industrial Engineering	Automation in Manufacturing	Selection of Materials
Design of Jigs and Fixtures	Hydraulics and Pneumatics	Nuclear Engineering	Automotive Electrical and Electronics	Total Quality Management	Warehousing Automation	Internet of Things for Mechanical Engineers
Composite Materials and Mechanics	Additive Manufacturing	Turbo Machinery Systems	Vehicle Body Engineering	Process Planning and Cost Estimation	Material Handling Equipment, Repair and Maintenance	Machine Vision
Testing of Materials	Automation in Manufacturing	Gas Dynamics and Jet Propulsion	Vehicle Dynamics	Industrial safety and Maintenance	Plant Layout Design and Ergonomics	Advanced Vehicle Engineering
Design concepts in Engineering	Digital Manufacturing	Solar Energy Engineering	Vehicle Maintenance and Safety	Entrepreneurship Development	Logistics in Manufacturing, Supply Chain and Distribution	Non Destructive Testing and Evaluation
Noise vibration and Harshness	Industrial Robotics	Refrigeration and Air Conditioning	Hybrid and Electrical Vehicles	Quality and Reliability Engineering	Data Science	
New Product Development	Nano Technology	Computational Fluid Dynamics	Thermal Management of Batteries and Fuel Cells			

Professional Elective Courses will be registered in Semesters V to VIII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group.

1. Only one Professional Elective course shall be chosen in a semester horizontally (row-wise).
2. Also, more courses are permitted from the same row, in different semester.
3. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

PROFESSIONAL ELECTIVES

Vertical 1 **Area of Specialization: Design**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1901	Surface Engineering and Tribology	PE	3	3	0	0	3
2.	21ME1902	Optimization Techniques in Engineering	PE	3	3	0	0	3
3.	21ME1903	Design of Jigs and Fixtures	PE	3	3	0	0	3
4.	21ME1904	Composite Materials and Mechanics	PE	3	3	0	0	3
5.	21ME1905	Testing of Materials	PE	3	3	0	0	3
6.	21ME1906	Design concepts in Engineering	PE	3	3	0	0	3
7.	21ME1907	Noise vibration and Harshness	PE	3	3	0	0	3
8.	21ME1908	New Product Development	PE	3	3	0	0	3

Vertical 2 **Area of Specialization: Robotics and Automation**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1909	Welding Technology	PE	3	3	0	0	3
2.	21ME1910	Modern Machining Processes	PE	3	3	0	0	3
3.	21ME1911	Hydraulics and Pneumatics	PE	3	3	0	0	3
4.	21ME1912	Additive Manufacturing	PE	3	3	0	0	3
5.	21ME1913	Automation in Manufacturing	PE	3	3	0	0	3
6.	21ME1914	Digital Manufacturing	PE	3	3	0	0	3
7.	21ME1915	Industrial Robotics	PE	3	3	0	0	3
8.	21ME1916	Nano Technology	PE	3	3	0	0	3

Vertical 3 **Area of Specialization: Thermal Sciences**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1917	Renewable Energy Resources	PE	3	3	0	0	3
2.	21ME1918	Energy conservation and waste heat recovery	PE	3	3	0	0	3
3.	21ME1919	Nuclear Engineering	PE	3	3	0	0	3
4.	21ME1920	Turbo Machinery Systems	PE	3	3	0	0	3
5.	21ME1921	Gas Dynamics and Jet Propulsion	PE	3	3	0	0	3
6.	21ME1922	Solar Energy Engineering	PE	3	3	0	0	3
7.	21ME1923	Refrigeration and Air Conditioning	PE	3	3	0	0	3
8.	21ME1924	Computational Fluid Dynamics	PE	3	3	0	0	3

Vertical 4 **Area of Specialization: Modern Mobility Systems**

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1925	Advanced IC Engines	PE	3	3	0	0	3
2.	21ME1926	Automotive Technology	PE	3	3	0	0	3
3.	21ME1927	Automotive Electrical and Electronics	PE	3	3	0	0	3
4.	21ME1928	Vehicle Body Engineering	PE	3	3	0	0	3
5.	21ME1929	Vehicle Dynamics	PE	3	3	0	0	3
6.	21ME1930	Vehicle Maintenance and Safety	PE	3	3	0	0	3
7.	21ME1931	Hybrid and Electrical Vehicles	PE	3	3	0	0	3
8.	21ME1932	Thermal Management of Batteries and Fuel Cells	PE	3	3	0	0	3

Vertical 5 Area of Specialization: Industrial Management

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1933	Engineering Ethics	PE	3	3	0	0	3
2.	21ME1934	Industrial Engineering	PE	3	3	0	0	3
3.	21ME1935	Total Quality Management	PE	3	3	0	0	3
4.	21ME1936	Process Planning and Cost Estimation	PE	3	3	0	0	3
5.	21ME1937	Industrial safety andMaintenance	PE	3	3	0	0	3
6.	21ME1938	Entrepreneurship Development	PE	3	3	0	0	3
7.	21ME1939	Quality and Reliability Engineering	PE	3	3	0	0	3

Vertical 6 Area of Specialization: Logistics and Supply Chain Management

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1940	Operations Research	PE	3	3	0	0	3
2.	21ME1913	Automation in Manufacturing	PE	3	3	0	0	3
3.	21ME1941	Warehousing Automation	PE	3	3	0	0	3
4.	21ME1942	Material Handling Equipment, Repair and Maintenance	PE	3	3	0	0	3
5.	21ME1943	Plant Layout Design and Ergonomics	PE	3	3	0	0	3
6.	21ME1944	Logistics in Manufacturing, Supply Chain and Distribution	PE	3	3	0	0	3
7.	21ME1945	Data Science	PE	3	3	0	0	3

Vertical 7 **Area of Specialization: Diversified Group**

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21ME1946	Thermal Power Engineering	PE	3	3	0	0	3
2.	21ME1947	Selection of Materials	PE	3	3	0	0	3
3.	21ME1948	Internet of Things for Mechanical Engineers	PE	3	3	0	0	3
4.	21ME1949	Machine Vision	PE	3	3	0	0	3
5.	21ME1950	Advanced Vehicle Engineering	PE	3	3	0	0	3
6.	21ME1951	Non Destructive Testing and Evaluation	PE	3	3	0	0	3

MANDATORY COURSES

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21MC1001	Environmental Science	MC	2	2	0	0	0
2.	21MC1002	Constitution of India	MC	2	2	0	0	0
3.	21MC1003	Human Values	MC	2	2	0	0	0
4.	21MC1004	Energy Studies	MC	2	2	0	0	0
5.	21MC1005	Essence of Indian Traditional Knowledge	MC	2	2	0	0	0
6.	21MC1006	Soft Skills and Personality Development	MC	2	2	0	0	0
7.	21MC1007	Value Education, Human Rights &Legislative Procedures	MC	2	2	0	0	0

OPEN ELECTIVES

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21GE1001	Disaster Management	OE	3	3	0	0	3
2.	21GE1006	Intellectual Property Rights	OE	3	3	0	0	3
3.	21ME1001	Energy Auditing	OE	3	3	0	0	3
4.	21ME1002	Lean Six Sigma	OE	3	3	0	0	3
5.	21ME1003	Sensors for Automation	OE	3	3	0	0	3
6.	21ME1004	Industrial Pollution and Prevention	OE	3	3	0	0	3
7.	21ME1005	Hospital Management	OE	3	3	0	0	3
8.	21ME1006	Systems Engineering	OE	3	3	0	0	3
9.	21ME1007	Marketing Management	OE	3	3	0	0	3
10.	21AD1001	Fundamentals of Artificial Intelligence	OE	3	3	0	0	3
11.	21AD1002	Principle of Machine Learning	OE	3	3	0	0	3
12.	21CS1003	Cloud computing	OE	3	3	0	0	3
13.	21EE1008	Micro Electro Mechanical Systems	OE	3	3	0	0	3

EMPLOYMENT ENHANCEMENT COURSES (EEC)

S. No	Course Code	Course Title	Credits	Category	Semester
1.	21ME1513	Technical presentation & Comprehension Laboratory	1	EEC	V
2.	21ME1613	Design and Fabrication Project	2	EEC	VI
3.	21ME1811	Project Work	8	EEC	VIII

CREDIT DISTRIBUTION

S.No.	Subject Area	Credits Per Semester								Credits Total	Percentage
	Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1.	Humanities and Social Studies (HS)	4	4							8	4.73
2.	Basic Sciences (BS)	12	7	4	4					27	15.98
3.	Engineering Sciences(ES)	9	5	5						19	11.24
4.	Professional Core (PC)		6	16	16	19	13	10		80	47.33
5.	Professional Electives (PE)					3	3	6	6	18	10.65
6.	Open Electives (OE)					-	-	3	3	6	3.55
7.	Project Work (PR/EEC)					1	2	-	8	11	6.51
8.	Non-Credit/ (Mandatory)		0		0	0				0	0
	Total	**25**	**22**	**25**	**20**	**23**	**18**	**19**	**14**	**169**	**100**

SEMESTER – I

21HS1101	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS LAB I INTEGRATED	L	T	P	C
		3	0	1	4

COURSE OBJECTIVE:

- To induce the basic reading and writing skills among the firstyear engineering and technology students
- To assist the learners to develop their listening skills, which will enable them listening to lectures and comprehend themby asking questions and seeking clarifications
- To secure the learners to develop their speaking skills andspeak fluently in real contexts
- To motivate the learners to develop vocabulary of a general kind by developing their reading skills for meeting the
- competitive exams like GATE, TOFEL, GRE, IELTS, and other exams conducted by Central andState governments

UNIT I INTRODUCING ONESELF 9

Listening: Listening and filling details, Listening to Speeches by Specialists and Completing Activities suchas Answering Questions, Identifying the Main Ideas, Style, etc. Speaking: Introducing Oneself – Introducing Friend/ Family. Reading: Descriptive Passages (From Newspapers / Magazines).Writing:

Writing a Paragraph (Native Place, School Life), Developing Hints. Grammar: Noun, Pronoun & Adjective. Vocabulary Development: One Word Substitution

UNIT II DIALOGUE WRITING 9

Listening: Listening to Conversations (Asking for and Giving Directions).Speaking: Making Conversation Using (Asking for Directions, Making an Enquiry), Role Plays, and Dialogues. Reading: Reading a Print Interview and Answering Comprehension Questions. Writing: Writing a Checklist, Dialogue Writing Grammar: Tenses and Voices. Vocabulary Development: Prefix &Suffix, Wordformation.

UNIT III DRAFTING OFFICIAL COMMUNICATIONS 9

Listening: Listening for specific information. Speaking: Giving Short Talks on a given Topic. Reading: Reading Motivational Essays on Famous Engineers and Technologists (Answering Open – Ended and Closed Questions).Writing: Writing Formal Letters / Emails. Grammar: Adverb, Prepositions &

Conjunctions. Vocabulary Development: Collocations – Fixed Expressions.

UNIT IV WRITTEN COMMUNICATION 9

Listening: Listening to Short Talks (5 Minutes Duration and Fill a Table, Gap-Filling Exercise) Note Taking/Note Making .Speaking: Small Group Discussion, Giving Recommendations .Reading: Reading Problem – Solution Articles/Essays Drawn From Various Sources .Writing: Making Recommendations Note Making – Complaint Letters.Grammar: Subject- Verb Agreement, FramingQuestions.Vocabulary Development: Connectives, Reference Words, Technical Vocabulary.

UNIT V WRITING DEFINITIONS AND PRODUCT DESCRIPTION 9

Listening: Listening to a Product Description (Labeling and Gap Filling) Exercises. Speaking: Describing a Product and Comparing and Contrasting it with Other Products. Reading: Reading Graphical Material for Comparison (Advertisements).Writing: Writing Definitions (Short and Long) – Compare and Contrast Paragraphs, Essay writing.Grammar:– Phrasal Verbs – Cause and Effect Sentences –Compound NounsVocabulary Development: Use of Discourse Markers

TOTAL :45 PERIODS

COURSE OUTCOME

CO1 Comprehend conversations and short talks delivered in English.
CO2 Participate effectively in informal conversations; introduce themselves and their friends and express opinions English.
CO3 Read articles of a general kind in magazines and newspapers.
CO4 Write short essays of a general kind and personal letters and emails in English.
CO5 Recognize the use of grammar in speech and writing.

TEXT BOOKS

1. N P Sudharshana & C Savitha, English for Technical Communication Delhi: CUP, 2019.
2. Board of Editors. English for Engineers and Technologists Volume 1 Orient Black Swan Limited, 2020.

REFERENCE BOOKS

1. Board of Editors. Using English-A course book for Undergraduate engineers and Technologists Orient Black SwanLimited, 2017
2. Bailey, Stephen. Academic Writing: A Practical Guide for Students. New York:Rutledge,2011.
3. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. CambridgeUniversity Press, Cambridge: Reprint 2011
4. Means,L. Thomas and Elaine Langlois. English & Communication For Colleges. Cengage Learning ,USA:2007
5. Redston, Chris & Gillies Cunningham Face2Face (Pre-intermediate Student's Book& Workbook)Cambridge University Press, New Delhi: 2005

WEB REFERENCES:

1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabulary-exams/word- formation
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20180316 21.pdf
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.htm
4. https://www.edudose.com/english/grammar-degree-of-comparison-rules/

ONLINE COURSES / RESOURCES:

1. https://basicenglishspeaking.com/wh-questions/
2. https://agendaweb.org/verbs/modals-exercises.html
3. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20180316 21.pdf
4. https://www.ego4u.com/en/cram-up/grammar/prepositions

LANGUAGE SKILLS LAB

MINIMUM OF EXERCISES TO BE CONDUCTED 15 Periods

List of exercises

Reading: Different text type
Reading: Predicting content using pictures and title.
Reading: Use of graphic organizers to review
Reading: Aid comprehension.
Reading: Understanding reference words
Reading: Use of connectors in a passage-
Reading: Speed reading Techniques.
Reading and Comprehending the passages in the competitive exams like GATE, TOFEL,GRE,IELTS, and other exams conducted by Central and State governments.

Reading: Sentence Completion: Exercises used in competitive exams.
Writing- Error Detection:
Writing-Spotting and reasoning the errors found from the passages in competitiveexams.

Writing-Email writing-
Writing: Job Application: Resume
Writing- Elements of a good essay-
Writing: Types of essays- Descriptive-Narrative- issue based.
Writing: Statement of Purpose-
Writing: Letter of recommendation-
Writing: Vision statement
Writing- Verbal Analogy,
Writing- Phrases and Idioms associated with competitive exams.

SOFTWARE REQUIRED:

Globarena

REFERENCS

1. SureshKumar.E and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
2. Davis, Jason and Rhonda Liss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006
3. Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writingskills. Cambridge University Press: Cambridge, 2004
4. Goatly, Andrew. Critical Reading and Writing. Routledge: United States of America, 2000

21MA1101	ENGINEERING MATHEMATICS- I	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To apply the structural properties of graphs from an algebraic point of view.
- To get depth knowledge about calculus.
- To familiarize the functions of two variables and finding its extreme points.
- To make the students understand various techniques of integration.
- To apply multiple integral ideas in solving areas, volumes and other practical problems.

UNIT I MATRICES 12

Eigen values and Eigenvectors of a real matrix —Rank of the matrix - Characteristic equation — Properties of Eigen values and Eigenvectors — Cayley Hamilton theorem — Diagonalization of matrices— Reduction of aquadratic form to canonical form by orthogonal transformation and similarity transformation —Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (Sum, Product & Quotient rule, Chain rule, logarithmic and implicit differentiation) – Maxima and Minima of functions of one variable-Rolle's theorem- Mean value theorem.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables –Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts -Bernoulli's formula- Trigonometric integrals - Trigonometric substitutions - Integration of rational functions by partial fraction - Integration of irrational functions - Improper integrals.

UNIT V MULTIPLE INTEGRALS 12

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

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1 Determine the Eigen values and eigenvectors, diagonalization of a matrix, symmetric matrices, positive definite matrices and similar matrices.

CO2 Apply limit definition and rules of differentiation to differentiate functions

CO3 Apply the knowledge of Maxima and Minima, Jacobian, Taylor series and apply the problems involving Science and Engineering.

CO4 Apply the knowledge of Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction.

CO5 Apply the knowledge of Area enclosed byplane curves, Change of variables in double integrals, Triple integrals, Volume of Solids.

TEXT BOOKS:

1. Grewal B.S., —Higher Engineering Mathematics‖, Khanna Publishers, NewDelhi,43rdEdition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning,7thEdition, NewDelhi, 2015.
3. Bali N., Goyal M. and Walkins C., —Advanced Engineering Mathematics‖, Firewall Media (An imprint of Lakshmi Publications Pvt. Ltd.,), New Delhi, 7th Edition, 2009.

REFERENCE BOOKS

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., —Advanced Engineering Mathematics‖, Narosa Publications,NewDelhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., —Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016.
6. B.V. Ramana, — Higher Engineering Mathematics‖, McGraw Hill Education, India. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley sons,10thedition,2015

ONLINE COURSES / RESOURCES:

7. https://onlinecourses.nptel.ac.in/noc21_ma60/preview
8. https://onlinecourses.nptel.ac.in/noc21_ma58/preview

21PH1101	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of thermal conductivity of the materials.
- To motivate the students to know the concepts of oscillations, optics and laser.
- Equipping the students to be successfully understand the importance of quantum physics.

UNIT - I MECHANICS 9

System of particles: centre of mass in one and two dimensions - rotational motion of continues system - torque - moment of inertia - conservation of angular momentum – Newton's laws for rotation -equations of rotational motion - work energy theorem for rotational motion.Stress, strain, Hooke's law and elastic moduli – twisting couple per unit twist for solid and hollow cylinders – torsional pendulum theory – bending moment of beam – cantilever and non-uniform bending theory - uniform bendingtheory - I shape girder.

UNIT - II ELECTROMAGNETIC THEORY 9

Divergence – curl – integral calculus – Gauss divergence theorem – Stoke's theorem – equation of continuity – displacement current - Maxwell's equations – Gauss's laws – Faraday's law –Ampere- Maxwell law – mechanism of electromagnetic wave propagation – Hertz observation – production and detection of electromagnetic wave - electromagnetic waves in free space and matter – energy carried byelectromagnetic wave – momentum and radiation pressure – properties of electromagnetic waves.

UNIT - III THERMAL PHYSICS 9

Mode of heat transfer: conduction, convection and radiation – thermal expansion of solids – bimetallic strips – thermal conductivity - heat conduction through compound media (series & parallel) - Forbe's and Lee's disc method; theory and experiment - thermal insulation – applications - heat exchangers –refrigerators, solar water heater.

UNIT - IV OSCILLATORY MOTION, LASERS AND FIBER OPTICS 9

Spring mass system – differential equation-simple harmonic motion-damped oscillation-forced oscillation –analogy with LCR circuits and mechanical oscillation – plane wave equation – equations of wave motion in a rope and velocity of wave. Population of energy levels, Einstein's A and B coefficients derivation – optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction –components and principle of fiber optics – numerical aperture and acceptance angle derivation - types of optical fibers (material, refractive index, mode) – losses associated with optical fibers – fiberas pressure and displacement sensors.

UNIT - V QUANTUM MECHANICS 9

Blackbody radiation – Planck's hypothesis and derivation – wave particle duality of light: concepts of photon - Compton effect: theory and experiment – de Broglie hypotheses - concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional box –

tunnelling (qualitative) - scanning tunneling microscope.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Understand and apply the basics of mechanics and especially elastic properties of materials.

CO2: Have adequate knowledge on the conceptsof electromagnetic waves and its properties.

CO3: Comprehend the concepts of thermal properties of materials and their applications in heat exchangers.

CO4: Acquire the knowledge on oscillations, lasers and fiber optics and their technological applications.

CO5: Gain knowledge on advanced physics concepts of quantum theory

CO6: Apply the concept of quantum physics –Tunneling electron microscope.

TEXT BOOKS

1. Gaur, R.K. & Gupta, S.L. —Engineering Physics‖. Dhanpat Rai Publishers, 2012.
2. Santhosam, K. Russel Raj, K. & Maheswaran, A. —Engineering Physics, KRAM Publications, 2021.
3. Pandey, B.K. & Chaturvedi, S. —Engineering Physics‖. Cengage Learning India, 2012.

REFERENCE BOOKS

1. Halliday, D., Resnick, R. & Walker, J. —Principles of Physics‖. Wiley, 2015.
2. Tipler, P.A. & Mosca, G. —Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.
3. Arthur Beiser, —Concepts of Modern Physics‖, Mc Graw Hill, Sixth edition, 1994.
4. Douglas. C., Giancoli. —Physics: Principles with applications‖, Pearson, 2014.

WEB REFERENCES

1. https://kluniversity.in/physics/pdfs/crypdf.pdf
2. https://mrcet.com/downloads/digital_notes/ECE/III%20Year/FIBER%20OPTICAL%20COM MUNICATIONS.pdf
3. https://nptel.ac.in/content/storage2/courses/117101002/downloads/Lec01.pdf
4. https://nptel.ac.in/content/storage2/courses/117101002/downloads/Lec19.pdf
5. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecture-notes/MIT8_04S16_LecNotes3.pdf
6. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecture-notes/MIT8_04S16_LecNotes5.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/115/102/115102023/
2. https://nptel.ac.in/courses/115/106/115106066/

21CY1101	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the importance of Chemistry in engineering domain.
- To understand the Chemistry background ofindustrial process.
- To apply Chemistry knowledge for Engineering disciplines.

UNIT - I WATER TECHNOLOGY 9

Hardness -Types of hardness - Estimation by EDTA method - Boiler troubles- scale, sludge, priming, foaming, caustic embrittlement, Boiler corrosion - Internal Conditioning – Carbonate, phosphate, Calgon conditioning - External Conditioning - Zeolite and Demineralization process -Desalination,Reverse Osmosis Method – Domestic water treatment.

UNIT - II HIGH POLYMERS AND NANOCHEMISTRY 9

Polymers - Introduction - Classification of Polymers (Origin/Source, Structure, Monomers, Inter- molecular Forces, Synthesis) - Commercial Polymers (Poly Vinyl Chloride (PVC), Polytetrafluoroethylene (PTFE), Nylon-6 6, Nylon-6, Polyethylene Terephthalate (PET) - Conducting Polymers - Polyaniline, Polythiophene, Trans-Polyacetylene - Basic definition – FRP - General Engineering applications of FRP (Civil Engineering Structures).Nanomaterials - Introduction, size dependent properties (Surface area, Electrical, Optical, Catalytic and Thermal properties). Synthesis of nanomaterials: Top- down and bottom-up approaches, Chemical Synthesis – Co precipitation, Sol-Gel process and Chemical vapour deposition, Nanoscale materials: Fullerenes, Carbon nanotubesand graphene – Characterization, properties and applications. Green synthesis of Nanoparticles.

UNIT - III INSTRUMENTAL METHODS AND ANALYSIS 9

Introduction to Spectroscopy – Types of spectroscopy - Absorption spectra - Emission spectra - Wave length and Wave number- Electromagnetic radiation – Flame Photometry, Atomic Absorption Spectroscopy, UV-Visible spectrum. Introduction - basic principles - Instrumentation& Applications – Infrared Spectroscopy. Chromatographic methods - Types (column, Thin layer, paper, Gas, High Performance Liquid Chromatographic methods) – principle- Separation and quantification of Organic compounds by GC and HPLC. Conductometric Titrations: Instrumentation – Advantages – Applications Potentiometric Titrations: Instrumentation –Advantages-Applications. Measurement ofpH: pH metry - Instrumentation – Applications.

UNIT - IV ELECTROCHEMISTRY AND CORROSION 9

Introduction- Electrode potentials-Electrochemical series-Electrochemical cell-redox reaction –measurement and applications – Nernst Equation Derivation- Electrochemical extraction of metals - Electrolytic refining of metals –Nano electrochemical Sensors. Corrosion – causes, factors, types, Chemical and Electrochemical Corrosion (Galvanic, Differential aeration) – Corrosion Control, Electrochemical protection – Sacrificial Anodic method – Impressed Current Cathodic Protection – Corrosion Inhibitors – Biocorrosion. Protective Coatings – Paints, Constituents, Functions- Surface preparation for metallic coatings, Electroplating and Electroless Plating.

UNIT - V ENERGY SOURCES AND STORAGE DEVICES 9

Introduction – Nuclear energy – Nuclear fission – Controlled Nuclear fission – Nuclear Fusion – Differences – Nuclear chain reactions –Nuclear Reactor -- Classification of Nuclear Reactor - Light WaterNuclear Reactor, Breeder Reactor – Solar Energy, Conversion, Solar Cells – Wind Energy.Batteries and Fuel Cells – Types of batteries –– Zinc - carbon dry cell -Lead Storage battery– Nickel- Cadmium Battery – Lithium battery – Battery Engineering – Battery hazards - Biological Batteries.Fuel Cells – Hydrogen-Oxygen Fuel Cell – Hondas cell- Supercapacitors. (elementary idea)

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the water quality parameters in purification and significance in industries, daily life.

CO2: Explain the types, fabrication and engineering applications of polymers. Develop economic methods of synthesizing nanomaterials and their applications.

CO3: Demonstrate the knowledge of analytical techniques using spectroscopy.

CO4: Relate the electrode potential for its feasibility in electrochemical reaction. Illustrate the causes, co corrosion and to achieve itsprotection.

CO5: Compare the economic and efficient usage ofnon-conventional and conventional energy sources.

TEXT BOOKS

1. P.C.Jain and Monika Jain, ―Engineering Chemistry‖, Dhanpat Rai Publishing Company (P) LTD., New Delhi.
2. S. S. Dara and S.S. Umare, ―A Textbook of Engineering Chemistry‖ S. Chand and CompanyLtd, New Delhi.
3. V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar, ―Polymer Science‖, New Age International P (Ltd.,), Chennai, 2006.
4. P. Kannan and A. Ravikrishnan, ―Engineering Chemistry‖, Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2009.
5. S. Vairam, P. Kalyani and Suba Ramesh, ―Engineering Chemistry‖, Wiley India, 2011.

REFERENCE BOOKS

1. Friedrich Emich, ―Engineering Chemistry‖, Scientific International Pvt.Ltd., NewDelhi.
2. PrasanthaRath, ―Engineering Chemistry‖, Cengage Learning India Pvt., Ltd., Delhi.
3. P.W. Atkins and de Paula Julio, ―Physical Chemistry‖, Oxford University Press, 8th Ed., (Indian Student Edition) (2009).
4. K. K. Rohatgi-Mukherjee, ―Fundamental of Photochemistry‖ New Age International (P) Ltd.,New Delhi, 1986.
5. G.A. Ozin and A.C. Arsenault, ―Nanochemistry: A Chemical Approach to Nanomaterials‖, RSC Publishing, 2005 Nanomaterials, B.Viswanathan, Alpha Science , ISBN: 9781842654941

WEB REFERENCES

1. http://www.mhhe.com/engcs/compsci/forouzan/dcn/student/olc

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/103/108/103108100
2. https://nptel.ac.in/courses/121/106/121106014
3. https://nptel.ac.in/courses/104/105/104105039

21ES1101	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the basic programming constructs –data types, decision structures, and control structures in python.
- To know how to use libraries for string manipulation
- To Use python data structures – Lists, Tuples and Dictionary
- To know the basic concepts of Object-Oriented Programming
- To learn about input/output with files in Python.

UNIT - I ALGORITHMIC PROBLEM SOLVING 9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language); Python: Data types, variables, expressions, precedence of operators, algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sortedcards, and guess an integer number in a range, Towers of Hanoi.

SUGGESTED ACTIVITIES:

- Developing Pseudo codes and flowcharts for real life activities such as railway ticketbooking using IRCTC, admission process to undergraduate course, academic schedules during a semester etc.
- Developing algorithms for basic mathematical expressions using arithmetic Operations
- Installing Python.
- Simple programs on print statements, arithmetic operations.

SUGGESTED EVALUATION METHODS:

- Quizzes on algorithm and basic python.
- Assignments on illustrative problems.
- Quizzes on simple python programs.

UNIT - II CONTROL FLOW, STRINGS & FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; functions, function definition and use; Fruitful functions: return values, parameters and arguments, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module. Illustrative programs: exchange the values of two variables, circulate the values of nvariables, distance between two points.

SUGGESTED ACTIVITIES:

- Simple Python program implementation using Operators, Conditionals, Iterative Constructs and Functions.
- Developing simple applications like calculator, calendar, phone directory, to-do lists etc.
- Flow charts for GCD, Exponent Functions, Fibonacci Series using conditionals and
- Recursion vs. Iteration.

SUGGESTED EVALUATION METHODS:

- Quizzes on strings.
- Assignments on illustrative problems.

- Quizzes on control flow and functions.

UNIT - III LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods;advanced list processing - list comprehension; Lists as arrays. Illustrative programs: selection sort, insertion sort, merge sort, histogram.

SUGGESTED ACTIVITIES:

Implementing python program using lists, tuples, sets for the following scenario:

- Simple sorting techniques.
- Student Examination Report.
- Billing Scheme during shopping.
- Implementing any application using List and Tuple data structures.

SUGGESTED EVALUATION METHODS:

- Quizzes on list slices.
- Assignments on illustrative problems.
- Quizzes on tuples and dictionaries.

UNIT - IV OBJECT ORIENTED PROGRAMMING WITH PYTHON 9

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects - inheritance, polymorphism, operator overloading; abstract classes; exception handling, try block. Illustrative programs: demonstrate the concept of class andobjects.

SUGGESTED ACTIVITIES:

- Features of OOP.
- Persistent storage of objects.
- Operators and its usage.
- Simple programs using OOP concepts.

SUGGESTED EVALUATION METHODS:

- Quizzes on basic OOP concepts.
- Assignments on illustrative problems.
- Quizzes on inheritance and exception handling.

UNIT - V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments,errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

SUGGESTED ACTIVITIES:

- Developing modules using Python to handle files and apply various operations on files
- Usage of exceptions, multiple except blocks - for applications that use delimiters likeage, range of numerals etc.
- Implementing Python program to open a non-existent file using exceptions.

SUGGESTED EVALUATION METHODS:

- Quizzes on basic file operations.
- Assignments on illustrative problems.
- Quizzes on packages and modules.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Write and execute simple Python programs.
CO3: Familiarize with python string handling techniques and user defined functions.
CO4: Represent compound data using Python lists, tuples and dictionaries.
CO5: Understand the concept of object oriented programming techniques.
CO6: Read and write data from/to files in Python Programs.

TEXT BOOKS

1. Reema Thareja, ``Problem Solving and Programming with Python'', 2nd edition, OXFORD University Press, New Delhi, 2019.(UNIT 1,2,3,4(Exception Handling) and 5).
2. Bill Lubanovic, —Introducing Python-Modern Computing in Simple Packagell, 2nd edition, O'REILLY, 2019.(UNIT 4(Object Oriented Programming).

REFERENCE BOOKS

1. Steven F. Lott, —Modern Python Cookbook'', 2nd Edition, O'REILLY, 2020.
2. Ryan Marvin, Mark Ng'ang'a, Amos Omondi, —Python Fundamentals, Packt Publishing., 2018.
3. Paul J. Deitel, Python for Programmers, Pearson India Education Services Pvt. Ltd,2020.
4. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education; Forth edition, 2018.

WEB REFERENCES

1. https://greenteapress.com/thinkpython2/thinkpython2.pdf
2. https://freecomputerbooks.com/An-Introduction-to-Python-Guido-van-Rossum.html#downloadLinks
3. http://marvin.cs.uidaho.edu/Teaching/CS515/pythonTutorial.pdf

ONLINE COURSES / RESOURCES:

1. https://docs.python.org/3/tutorial/
2. https://www.w3schools.com/python/
3. https://www.tutorialspoint.com/python/index.htm
4. https://www.javatpoint.com/python-tutorial
5. https://nptel.ac.in/courses/

21ES1102	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To understand and draw free hand sketches of basic geometrical shapes and multiple views of objects.
- To understand and draw orthographic projections of lines and planes.
- To apply and draw orthographic projections of solids.
- To apply and sketch development of the surfaces of objects.
- To analyze and sketch isometric and perspective views of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination): 2

Importance of graphics in engineering applications – Use of drafting instruments.BIS conventions and specifications. Size, layout and folding of drawing sheets – Lettering and dimensioning. Introduction to drafting packages like CAD and demonstration of their use in engineering fields.

UNIT - I PLANE CURVES AND FREEHAND SKETCHING 14

Basic Geometrical constructions, Curves used in engineering practices-Conics: Construction of Ellipse, Parabola and Hyperbola by eccentricity method – Construction of cycloid, Involutes of square, pentagon and circle – Drawing of tangents and normal to the above curves. Free Hand sketching-Orthographic projection – Orthographic views of simple three-Dimensional objects.

UNIT - II PROJECTION OF POINTS, LINES AND PLANE SURFACES 15

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

UNIT - III PROJECTION OF SOLIDS 15

Projection of simple solids like prisms, pyramids, cylinder, and cone when the axis is inclined to one principle planes by rotating object method and auxiliary plane method.

UNIT - IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 15

Sectioning of 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 and frustum and truncated solids – Prisms, pyramids cylinders and cones.

UNIT - V ISOMETRIC AND PERSPECTIVE PROJECTIONS 14

Principles of isometric projection – isometric scale –Isometric projections of simple solids and frustum and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method.

TOTAL : 75 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyse and sketch free hand sketching of basic geometrical shapes, multiple views of objects.

CO2: Draw the engineering curves, draw orthographic projections of lines and planes.

CO3: Draw orthographic projections of solids.

CO4: Apply and draw the sections and development of the surfaces of objects.

CO5: Apply and sketch isometric and perspective projections and intersection of curves of simple solids.

TEXT BOOKS

1. Natarajan, K. V., ―A text book of Engineering Graphics‖, 28th Ed., Dhanalakshmi Publishers, Chennai, 2015.
2. Venugopal, K. and Prabhu Raja, V., ―Engineering Graphics‖, New Age, 2008.

REFERENCE BOOKS

1. Bhatt, N.D.,Panchal V M and Pramod R. Ingle, ―Engineering Drawing‖, Charotar Publishing House, 53rd Edition, 2014.
2. Parthasarathy, N. S. and Vela Murali, ―Engineering Drawing‖, Oxford University Press, 2015
3. Agrawal, B. and Agrawal C.M., ―Engineering Drawing‖, Tata McGraw, N.Delhi, 2008.

WEB REFERENCES

1. https://nptel.ac.in/courses/105/104/105104148/
2. https://www.youtube.com/channel/UCkCk0nvNyWhEOLge9JtDLDg

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112/103/112103019/

21ES1111	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditions and loops.
- To use functions for structuring Python programs.
- To represent compound data using Python lists, tuples, dictionaries.
- To use OOPS concepts in Python.
- To read and write data from/to files in Python

LIST OF EXPERIMENTS

1. Basic Python Programs.
2. Write programs to demonstrate different number data types in python.
3. Develop python programs to demonstrate various conditional statements.
4. Implement user defined functions using python.
5. Develop python scripts to demonstrate functions.
6. Develop python programs to perform various string operations like slicing, indexing & formatting.
7. Develop python programs to perform operations on List & Tuple.
8. Demonstrate the concept of Dictionary with python programs.
9. Develop python codes to demonstrate concept of class and objects.
10. Demonstrate OOPS concepts like inheritance and polymorphism with pythonprograms.
11. Demonstrate python codes to print try, except and finally block statements.
12. Implement python programs to perform file operations.
13. Implement python programs using modules and packages.
14. Simulate bouncing ball using Pygame.

Mini Project :Suggested Topics(but not limited to)

1. Dice roll simulator.
2. Guess the number game.
3. Sending emails using python.
4. Random password generator.
5. Alarm clock.
6. URL shortener.

TOTAL:60 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Write, test, and debug simple Python programs.
CO2: Implement Python programs with conditions and loops.
CO3: Use functions for structuring Python programs.
CO4: Represent compound data using Python lists, tuples, dictionaries.
CO5: Use OOPS concepts in Python.
CO6: Read and write data from/to files in Python

ONLINE COURSES / RESOURCES:

1. https://www.programiz.com/python-programming/examples
2. https://www.geeksforgeeks.org/python-programming-examples/
3. https://beginnersbook.com/2018/02/python-programs/
4. https://www.javatpoint.com/python-programs
5. https://www.w3schools.com/python/python_examples.asp
6. https://www.sanfoundry.com/python-problems-solutions/

21BS1111	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

PHYSICS LABORATORY

OBJECTIVES:

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

PHYSICS LAB : LIST OF EXPERIMENTS(Minimum of experiments to be conducted: 5 Experiments)

1) Determination of rigidity modulus – Torsion pendulum.
2) Determination of Young's modulus by non-uniform bending method.
3) (a)Determination of wavelength, and particle size using Laser.
   (b) Determination of acceptance angle in an optical fiber.
4) Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5) Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
6) Determination of wavelength of mercury spectrum – spectrometer grating.
7) Determination of band gap of a semiconductor.
8) Determination of thickness of a thin wire – Air wedge method.

TOTAL:30 PERIODS

TEXT BOOK:

1. Ruby Das, C.S. Robinson, Rajesh Kumar, Prashant Kumar Sahu, A Textbook of Engineering Physics Practical, University Science Press, Delhi, II Edition (2016), ISBN 978-93-80386-86-7.
2. Harnam Singh, Dr.P.S. Hemne, B.Sc., Practical Physics, S.Chand & Company Ltd, New Delhi, Edition 2011, ISBN 81-219-0469-2.

WEB REFERENCES:

1. https://www.vlab.co.in/broad-area-physical-sciences
2. https://vlab.amrita.edu/?sub=1

CHEMISTRY LABORATORY

OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters such as, alkalinity, hardness, DO and chloride.
- To induce the students to familiarize with electro analytical techniques such as, pHmetry, potentiometry and conductometry in the determination of aqueous solutions.

CHEMISTRY LAB: LIST OF EXPERIMENTS(Minimum of experiments to be conducted: 5 Experiments)

1. Estimation of HCl using Na2CO3 as primary standard and Determination of alkalinity in Water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.

5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Determination of total, temporary & permanent hardness of water by EDTA method.
10. Estimation of iron content of the water sample using spectrophotometer (1, 10-26,Phenanthroline / thiocyanate method).
11. Estimation of sodium and potassium present in water using flame photometer.
12. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
13. Pseudo first order kinetics-ester hydrolysis.
14. Corrosion experiment-weight loss method.
15. Phase change in a solid.

TOTAL:30 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Experiment the basic light and optical fiber parameters like wavelength, particle size, numerical aperture and mercury spectrum wavelength determination using grating.

CO2: Experiment the basic light and optical fiber parameters like wavelength, particle size, numerical aperture and mercury spectrum wavelength determination using grating.

CO3: Determine the thermal conductivity by demonstrating the Lee's disc method.

CO4: Determine the strength and amount of given acid by conductometric method.

CO5: Estimate the amount of DO, Chloride in the given water sample by volumetric method.

CO6: Classify the hardness, alkalinity in the sample water by volumetric method.

TEXT BOOK:

1. Laboratory Manual- Department of Chemistry, CEGC, Anna University (2014).
2. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

SEMESTER – II

21HS1201	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS LAB II INTEGRATED	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To develop linguistic and strategic competence in workplace context and to enhance language proficiency and thereby the employability of budding engineers and technologists.
- To improve the relevant language skills necessary for professional communication.
- To help learners to develop their listening skills, which will, enable them to listen to lectures and comprehend them by asking questions; seeking clarification and developing their speaking skills and to speak fluently in real contexts.
- To Introduce them to life skills, their importance in leading Personal & professional life, key concepts of business communication and Communicative skills.

UNIT - I INTERPERSONAL COMMUNICATION 9

Listening: Listening to Telephone Conversations. Speaking: Role Play Exercises Based on Workplace Contexts, Introducing Oneself - PEP Talks. Reading: Reading the Interview of an Achiever and Completing Exercises (Skimming, Scanning andPredicting). Writing: Writing a Short Biography of an Achiever Based on Given Hints, Grammar: Adjective, Sentence pattern. Vocabulary Development: Idioms and Phrases.

UNIT - II TECHNICAL COMMUNICATION 9

Listening: Listening to Talks/Lectures Both General and Technical and Summarizing the Main Points. Speaking: Participating in Debates ,TED Talks Reading: Reading Technical Essays/ Articles and Answering Comprehension Questions Writing: Summary Writing ,Minutes of the meeting Grammar: Participle Forms, Relative Clauses Vocabulary Development: Compound Words, Abbreviations and Acronyms.

UNIT - III PROCESS DESCRIPTION 9

Listening: Listening to a Process Description and Drawing a Flowchart Speaking: Participating in Group Discussions, Giving Instructions, Presentation Reading: Reading Instruction Manuals Writing: Process Descriptions – Writing Instructions Grammar: Use of Imperatives, Active and Passive Voice, Sequence Words Vocabulary Development: Misspelt words, Homophones and Homonyms.

UNIT - IV REPORT WRITING 9

Listening: Listening to a Presentation and Completing Gap-Filling Exercises Speaking: Making Formal Presentations Reading: Reading and Interpreting Charts/Tables and diagrams Writing: Interpreting Charts/Tables and Diagrams, Writing a Report Grammar: Direct into Indirect Speech, Use of Phrases Vocabulary Development: Reporting Words, Technical Jargon.

UNIT - V APPLYING FOR JOBS 9

Listening: Listening to a Job Interview and Completing Gap-Filling Exercises Speaking: Mock Interview, Telephone Interviews, GD Reading: Reading a Job Interview, SOP, Company Profile and Completing Comprehension Exercises Writing: Job Applications and Resumes Grammar: Conditional Clauses, Modal verbs Vocabulary Development: Technical Vocabulary, Purpose Statement.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Read and comprehend technical texts effortlessly.
CO2: Write thoughts and insights of their own.
CO3: Recognize the need for life skills, apply them to different situations, the basic communication practices in different types of communication.
CO4: Gain confidence to communicate effectively in various situations to acquire employability skills.
CO5: Become an active listener of professional contexts.

TEXT BOOKS

1. Richards, C. Jack. Interchange, New Delhi: CUP, 2017
2. Board of Editors. English for Engineers and Technologists Volume 2 Orient Black Swan Limited, 2020.

REFERENCE BOOKS

1. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015.
2. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice.Oxford University Press: New Delhi, 2014.
3. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007.
4. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. CengageLearning, USA: 2007.
5. Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

WEB REFERENCES

1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabulary-exams/word- formation
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20 1803 1621.pdf
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.htm
4. https://www.edudose.com/english/grammar-degree-of-comparison-rules/

ONLINE COURSES / RESOURCES:

1. https://basicenglishspeaking.com/wh-questions/
2. https://agendaweb.org/verbs/modals-exercises.html
3. https://www.ego4u.com/en/cram-up/grammar/prepositions

List of exercises minimum of exercises to be conducted: Total Periods: 15

1. Listen to lectures - articulate a complete idea as opposed to producing fragmented utterances – Tedtalks, Science Fiction – My fair lady
2. Listening to a process information – General Competitive Examinations, GRE
3. Listening for specific information: accuracy and fluency – BEC
4. Listening - following, responding to explanations, giving directions and instructions in academic andbusiness contexts – IELTS, TOEFL.
5. Listening to transcripts and answer to the questions.
6. Listening: Read aloud in class and gap - filling.
7. Listening: Recognizing and interpreting non - verbal cues.
8. Listen first, speak second - Having the mind-set of a listener.
9. Speaking – sharing personal information - Self introduction.

10. Speaking – Small talk or Pep Talk.
11. Speaking – Group discussion, Visume –visual presentation of resume.
12. Speaking – Presentation – Formal and Informal.
13. Speaking – Mock interview.
14. Speaking – FAQ"S on Job interview.
15. Speaking : Simulations - (show and tell).
16. Speaking: News brief - Ripped from today's headlines.
17. Speaking: Who's telling the truth?
18. Speaking: JAM.
19. Speaking: Debate.
20. Speaking: Story Narration.

SOFTWARE REQUIRED:

1. Globarena.

TEXT BOOKS:

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford:2011.
2. Richards, C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010.

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
2. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014.
3. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.
4. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.
5. E. Suresh Kumar et al. Communication for Professional Success, Orient Blackswan: Hyderabad, 2015.
6. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014.

21MA1201	ENGINEERING MATHEMATICS - II	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To trace along the different types of curves.
- To develop an understanding of the standard technique ofa complex variable theory in particular of analytics functions and its mapping property.
- To develop complex integration is an intuitive extension of real integration.
- To solve the linear differential equations with constant coefficients.
- To solve Laplace Transform problems in electronic circuits.

UNIT I VECTOR CALCULUS 12

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields –Vector integration – Green's theorem in a plane - Gauss divergence theorem and Stokes" theorem (excluding proofs) – Simple applications involving cubes, rectangular parallelopiped, sphere and cylinder.

UNIT II ANALYTIC FUNCTIONS 12

Functions of a complex variable – Analytic functions - Cauchy-Riemann equations - Necessary and sufficient conditions– Harmonic and orthogonal properties of analytic function – Harmonic conjugate– Construction of analytic functions by Milne Thomson method– Conformal mapping: w =z+c, cz, 1/z, z^2 and bilinear transformation

UNIT III COMPLEX INTEGRATIONS 12

Line integrals- Cauchy"s integral theorem-Cauchy's integral formula - Singularities – Residues– Cauchy"s residue theorem - Taylor's and Laurent's series expansions —– Application of residue theorem for evaluation of real definite integrals – Use of circular contour and semi- circular contour (excluding poleson the real axis).

UNIT IV ORDINARY DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients -Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

UNIT V LAPLACE TRANSFORMS 12

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

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1 Analyze the Gradient, divergence and curl of a vector point function and related identities. Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.

CO2 Apply the analytic functions, harmonic functions, conformal mapping in engineering applications.

CO3 Determine the types of singularities, residues, contour integration..

CO4 Apply various techniques in solving differential equations.

CO5 Solve differential equations using Laplace transforms.

TEXT BOOKS

1. Grewel. B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, Delhi, 2014.
2. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill Education, India.
3. Bali N., Goyal M. and Walkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt. Ltd.,), New Delhi, 7th Edition, 2009.

REFERENCE BOOKS

1. Kreyszig Erwin, Advanced Engineering Mathematics", John wiley and Sons, 10th Edition, New Delhi.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. O"Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt. Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol.I & II, PHI Learnig Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wyile, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt Ltd, 6th Edition, New Delhi, 2012.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ma69
2. https://onlinecourses.nptel.ac.in/noc21_ma57

21PH1203	MATERIALS SCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To inculcate the knowledge of phase relationships for the understanding of material properties.
- To understand the various invariant reaction and microstructure exist in ferrous alloys.
- To understand the mechanical properties such as deformation, tensile strength and hardness.
- To impart knowledge on physics of magnetic, dielectric and superconducting materials.
- Acquire the knowledge on the types and applications of engineering materials such as ceramics, composites, SMA and nanomaterials.

UNIT - I PHASE DIAGRAMS 9

Solid solutions - Hume Rothery's rules – intermediate phases - the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the tie-line rule - the lever rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram – Eutectoid and Peritectoid reactions - microstructural change during cooling

UNIT - II FERROUS ALLOYS 9

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructure of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - diffusion in solids - Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations - tempering of martensite – steels – stainless steels – cast irons.

UNIT - III CRYSTAL PHYSICS AND MECHANICAL PROPERTIES 9

Crystal physics: Classification of solids: single crystal, polycrystal and amorphous – crystal terminologies: unit cell, lattice, basis, lattice parameters – crystal system – Bravais lattices – crystal imperfections: point defects, line defects and stacking faults – Burger vector.Mechanical properties: Tensile test - plastic deformation mechanisms - slip and twinning - role of dislocations in slip - creep resistance - creep curves - mechanisms of creep - creep-resistant materials - fracture - the Griffith criterion - critical stress intensity factor and its determination – fatigue failure - fatigue tests - methods of increasing fatigue life - hardness - Rockwell and Brinell hardness - Knoop and Vickers microhardness.

UNIT - IV MAGNETIC, DIELECTRIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetism - Ferromagnetism – domain theory – hysteresis – hard and soft magnetic materials – ferrites - dielectric materials – polar and non-polar dielectrics - types of polarization –Langevin-Debye equation – frequency effects on polarization - dielectric breakdown – insulating materials – superconducting materials and their properties – Applications: Cryotron – Maglev train.

UNIT - V MODERN ENGINEERING MATERIALS 9

Ceramics – types and applications – composites: classification, role of matrix and reinforcement, processing of fiber reinforced plastics – metallic glasses: types - melt spinning process, applications - NLO materials and Biomaterials – types and applications -

nanomaterials: preparation (bottom up and top down approaches), mechanical properties – applications – carbon nanotubes: types.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Evaluate the various phase diagrams and their applications.
CO2: Analyze the Fe-Fe3C phase diagram, various microstructures and alloys.
CO3: Apply the knowledge of crystalline materials and their mechanical properties and measurements.
CO4: Evaluate the magnetic, dielectric and superconducting properties of materials.
CO5: Anlayze the basics of ceramics, composites and nano materials.

TEXT BOOKS

1. Balasubramaniam, R. “Callister's Materials Science and Engineering”. Wiley India Pvt. Ltd., 2019.
2. Raghavan, V. “Physical Metallurgy: Principles and Practice”. PHI Learning, 2015.
3. Raghavan, V. “Materials Science and Engineering: A First course”. PHI Learning, 2015.

REFERENCE BOOKS

1. Askeland, D. “Materials Science and Engineering”. Brooks/Cole, 2010.
2. Smith, W.F., Hashemi, J. & Prakash, R. “Materials Science and Engineering”. Tata McGraw Hill Education Pvt. Ltd., 2014.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Narosa Publishing House, 2009.

WEB REFERENCES

1. https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_07_m.pdf
2. http://nifft.ac.in/WriteReadData/topic%201.pdf
3. https://physics.iitm.ac.in/~manianvs/PH102-3.pdf
4. https://nanobiotec.iqm.unicamp.br/download/preparation%20nanoparticles-chapter%205.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/113/104/113104068/
2. https://nptel.ac.in/courses/115/101/115101012/

21ES1203	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of electric circuits.
- To study about the three phase system and magnetic circuits.
- To understand the operation of AC machines.
- To understand the basic concepts of domestic wiring and instruments.
- To understand the working principle of electronic devices.

UNIT - I BASIC CIRCUITS 9

Current- Voltage- Power- Voltage Source – Current Source- Ohm‟s Law – KCL – KVL (Analysis with only independent source) – Resistors in series and parallel – Current Division – Voltage Division-Phasors- RMS value of current and voltage – Active power- Apparent Power- Complex Power – Power Factor.

UNIT - II THREE PHASE CIRCUITS & MAGNETIC CIRCUITS 9

Three Phase Supply – Advantages of three phase system- Star Connection – Delta Connection – Power in three phase system- Measurement of Three phase power.

Magnetic circuits- MMF, Flux, Reluctance, Magnetic field intensity, Flux density, Self and Mutual inductances-Simple problems.

UNIT - III ELECTRICAL MACHINES 9

Construction of DC Machine- Working Principle of DC machine- EMF equation – Torque Equation- Types of Motor- Shunt – Series – Compound – Application – Single phase induction motor - Stepper Motor.

UNIT - IV DOMESTIC WIRING AND INTRUMENTS 9

Types of wiring- Domestic wiring - Specification of Wires – Energy Auditing -Earthing methods- Protective devices, Classification of instruments – Operating Principles of indicating Instruments – Moving iron, Moving coil and wattmeter.

UNIT - V BASICS OF ELECTRONICS 9

P-N junction, V-I Characteristics of PN junction diode and Zener diode, Half Wave Rectifier- Full Wave Rectifier – Principle and Characteristics of BJT, SCR, JFET, MOSFET.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the concepts related with electrical circuits.

CO2: Analyze the different three phase connections and the concepts of magnetic circuits

CO3: Analyze the operating principle of AC machines

CO4: Analyze the concepts of domestic wiring and instruments

CO5: Analyze the working principle of electronic devices such as diode and Zener diode and BJT.

TEXT BOOKS

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, McGraw Hill Education, 2014.
2. Del Toro, “Electrical Engineering Fundamentals”, Second edition, Pearson Education, Delhi, 1989.
3. V N Mittle and Aravind Mital, “Basic Electrical Engineering”, Second edition, TataMcGraw Hill Publication, 2006.

REFERENCE BOOKS

1. C L Wadhwa, “Basic Electrical Engineering”, Fourth edition, New Age International Publication, 2007.
2. V K Metha, Rohith Metha, Basic Electrical Engineering”, Sixth edition, S Chand & Company Ltd, 2012.
3. R K Rajput, “Basic Electrical and Electronics Engineering”, Second edition, University Science Press, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/105/108105053/
2. https://www.electrical4u.com/electrical-engineering-articles/basic-electrical/
3. https://library.automationdirect.com/basic-electrical-theory/
4. https://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering

ONLINE COURSES / RESOURCES:

1. https://learnengineering.org - Resources
2. https://www.youtube.com/channel/UCqZQJ4600a9wIfMPbYc60OQ - Resources
3. https://en.wikipedia.org/wiki/Electrical_engineering - Resources
4. https://www.edx.org/learn/electrical-engineering - Online courses
5. https://www.khanacademy.org/science/electrical-engineering/introduction-to-ee-Online courses

21ME1201	ENGINEERING MECHANICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the principles of resultant force and moment for particles and rigid bodies.
- To apply the concepts of equilibrium to particles and rigid bodies in both 2D and 3D contexts.
- To apply the principles of centroid, moment of inertia, and mass moment of inertia in mechanical analysis.
- To Evaluate and apply the concepts of friction and the dynamics of rigid bodies.
- To analyse and comprehend the fundamentals of particle kinetics.

UNIT - I STATICS OF PARTICLES 12

Introduction - Units and dimensions – Fundamental laws of Mechanics - Principle of transmissibility - Parallelogram and triangular Law of forces - Vectorial representation of forces - Vector operations of forces - 2D Force system - Rectangular components of force - Equilibrium of a particle in 2D -Lami"s theorem - 3D Force system - Equilibrium of a particle in 3D.

UNIT - II STATICS OF RIGID BODIES 12

Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon"s theorem – Single equivalent force - Free body diagram – Types of supports and their reactions - Equilibrium of Rigid bodies in 2D– Equilibrium of Rigid bodies in 3D – Case studies.

UNIT - III PROPERTIES OF SURFACES AND SOLIDS 12

Centroid of areas – simple and composite areas - Theorems of Pappus and Guldinus – Centre of mass– simple and composite volumes - Moment of inertia - simple and composite areas - Parallel axis theorem and perpendicular axis theorem - Polar moment of inertia - Radius of gyration – Product of inertia - Principal moment of inertia of plane areas - Mass moment of inertia of simple solids.

UNIT - IV FRICTION AND DYNAMICS OF RIGIDBODIES 12

Friction -Laws of dry friction - Angle of friction - Coefficient of static and kinetic friction – Slidingfriction - Rolling resistance. Kinematics - Translation and Rotation of Rigid Bodies – Velocity and acceleration -General Plane motion of simple rigid bodies such as cylinder and sphere.Kinetics – Work done on a rigid body - Kinetic energy of a rigid Body – Conservation of energy and momentum principle for a rigid body.

UNIT - V DYNAMICS OF PARTICLES 12

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles - Equations of Motions - Projectile Motion.Kinetics - Newton's Second Law of Motion – D"Alembert's Principle – Work and Energy Principle - Impulse and Momentum Principle – Principle of Virtual work - Impact of elastic bodies.

TOTAL : 60 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the resultant force and moment in 2D and 3D force systems.
CO2: Apply equilibrium principles to solve engineering problems involving particles and rigid bodies.
CO3: Analyze the centroid, moment of inertia, and mass moment of inertia for composite areas and volumes.
CO4: Evaluate the concepts of frictional force in practical engineering applications.
CO5: Apply the principles of particle kinetics to address real-world physical problems.

TEXT BOOKS

1. Beer F.P and Johnston Jr. E.R, "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8thEdition, Tata McGraw-Hill Publishing Company, New Delhi, 2004.
2. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
3. Balasubramaniam T.V and Murugan R, “Engineering Mechanics”, 1st Edition, Vijay Nicole Imprints, 2015.

REFERENCE BOOKS

1. Irving H. Shames and Krishna Mohana Rao G., "Engineering Mechanics - Statics and Dynamics", 4thEdition, Pearson Education, 2006.
2. Hibbeller R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics",
3. 11thEdition, Pearson Education, 2010.
4. Meriam J.L and Kraige L.G, "Engineering Mechanics - Statics - Volume 1, Dynamics Volume 2", 3rdEdition, John Wiley & Sons,1993.
5. Bhavikatti S.S and Rajashekarappa, K.G, "Engineering Mechanics", New Age International (P) Limited Publishers, 2005.
6. Vela Murali, "Engineering Mechanics", Oxford University Press, 2010.

WEB REFERENCES

1. http://www.iitg.ac.in/rkbc/me101/me101.htm
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-engineering-mechanics-i-fall-2007/index.htm
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112/106/112106286/
2. https://nptel.ac.in/courses/122/104/122104015/
3. https://www.coursera.org/learn/engineering-mechanics-statics
4. https://www.edx.org/course/engineering-mechanics-2

21ME1211	COMPUTER AIDED DRAFTING AND MODELLING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To impart knowledge and skills in drafting and modelling.
- To introduce the basics and standards of drawing related to machine components.
- To use the CAD package for the creation of 2D and 3D models.
- To improve communications through documentation.

UNIT - I INTRODUCTION TO COMPUTER AIDED DRAFTING 9

Introduction to computer aided drafting hardware - Overview of drafting packages - Coordinate systems (absolute, relative, polar, etc.)

UNIT - II CONVENTIONS, ABBREVIATIONS AND SYMBOLS 12

BIS codes for Engineering Drawing - Abbreviations - Conventional representation of standard components - Systems of dimensioning - surface finish, symbols and representing surface finish on drawing - Sectioning conventions - Representation of welded joints - Riveted joints - Screw threads.

UNIT - III CREATION OF SIMPLE OBJECTS 15

Creating 2D Drawings - Simple figures like polygon, general multi-line figures and curves. Front view, top view and side view of objects from the given pictorial views for simple objects - Objects with hole and curves - Dimensioning of common components Principles of Isometric Projection - Simple objects.

UNIT - IV SOLID MODELING 12

Solid Primitives – Viewpoint – Creation of Solids - Protrusion/ Extrusion – Holes - Revolve – Sweep – Loft –Blend – Fillet - Pattern – Chamfer - Round – Mirror – Composite Solids.Creation of 3D models of simple objects.

UNIT - V PRODUCTION DRAWING 12

Obtaining 2D multi-view drawings from 3D model - Dimensional Tolerances – Fits – Types - General Tolerances for Linear and Angular Dimensions. Creating text style – Color – Line type – Line weights - Layering concepts – Editing Dimensions.

TOTAL : 60PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Acquire foundational knowledge of computer-aided drafting hardware, drafting software packages, and coordinate systems for creating precise and efficient technical drawings.

CO2: Understand basics of standards of drawing related to machine components

CO3: Create accurate 2D drawings, including pictorial view projections and isometric projections.

CO4: Create and manipulate 3D models using solid primitives and advanced modeling techniques.

CO5: Apply dimensional tolerances and fits, and utilize text styles, colors, line types, and layering concepts to create and edit detailed technical drawings

TEXT BOOKS

1. K.L. Narayana, P. Kannaiah, K. Venkata Reddy, “Machine Drawing”, New Age International (P) Ltd, 6thEdition, 2018.
2. Goutam Pohit, Goutam Ghosh, “Machine Drawing with AutoCAD”, Pearson, 2007.

REFERENCE BOOKS

1. K R Gopala Krishna, A S Ravindra, “Computer Aided Machine Drawing”,Subhas Stores, 2015
2. Bhatt N.D. and Panchal V.M, “Machine Drawing”, Charotar Publishing House, 46thEdition, 2011.

WEB REFERENCES

1. http://nptel.ac.in/courses/112102101/

ONLINE COURSES / RESOURCES:

1. https://www.autodesk.com/education/home.
2. https://www.coursera.org/learn/autodesk-autocad-design-drafting
3. https://www.coursera.org/specializations/autodesk-cad-cam-cae-mechanical-engineering

21ES1211	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To illustrate and demonstrate on Lathe
- To discover the usage of Sheet Material
- To apply the techniques of Welding in metal
- To discover the techniques used for carpentry and to connect the pipe fittings using Plumbing components
- To discover exposure to the students with hands on experience in Electrical and Electronics Engineering.

GROUP – ACIVIL & ELECTRICAL

ICIVIL ENGINEERING PRACTICES15

Plumbing Work:

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows andother components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump.
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

Wood Work:

a) Introduction to Tools and Equipments.
b) Simple Planning and sawing practice.
c) Making Half Lap, Dovetail, Mortise and Tenon joints.

Wood Work Study:

a) Studying joints in door panels and wooden furniture.
b) Studying common industrial trusses using models.

IIIELECTRICAL ENGINEERING PRACTICES: 15

a) Residential house wiring using switches, fuse, indicator, lamp and energy meter.
b)Fluorescent lamp wiring.
c) Stair case wiring.
d) Measurement of electrical quantities – voltage, current, power & power factor in RLC Circuit.
e) Measurement of energy using single phase energy meter.
f)Measurement of resistance to earth of an electrical equipment.

GROUP – BMECHANICAL AND ELECTRONICS

III MECHANICAL ENGINEERING PRACTICES 15

Basic Machining Work:

a) Introduction to Lathe machine, Tools and Equipments.
b) Simple Turning and facing.
c) Step turning.
d) Simple Drilling and Tapping of flat plate.

Welding Work:

a) Introduction to Arc welding, Tools and Equipments.
b) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.

Assembly Work:

a) Assembling a centrifugal pump.
b) Assembling an air conditioner.

Sheet Metal Work:

a) Demonstrating basic sheet metal operations.

Foundry Work:

a) Demonstrating basic foundry operations.

IV ELECTRONICS ENGINEERING PRACTICES 15

a) Study of Electronic components and equipments – Resistor, colour coding.
b) Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
c) Study of logic gates AND, OR, EX-OR and NOT.
d)Generation of Clock Signal.
e) Soldering practice – Components Devices and Circuits – Using general purpose PCB.
f)Measurement of ripple factor of HWR and FWR.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Understand tools and equipment's with making different joints.

CO2: Analyze Sheet Metal Tools and its mechanism to make objects for day to day usages.

CO3: Understand Welding process and implement it to join two objects.

CO4: Making wood into a useful household objects with help of carpentry tools and Connecting various basic pipe fittings and other components.

CO5: Connect out basic home electrical works and appliances and measure the electricalQuantities.

TEXT BOOKS

1. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”, Vikas Publishing House Pvt.Ltd, (2006)
2. Kannaiah P. & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, (1999).
3. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, (2007).
4. S. Gowri & T. Jeyapoovan, “Enginering Practices Lab Manual 5/E”, S. Chand Publishing, 2019.

REFERENCE BOOKS

1. K.C. John, "Mechanical workshop practice", Second edition, PHI learning Pvt Ltd, New Delhi
2. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, (2007)

WEB REFERNENCE:

1. https://nptel.ac.in/courses/112/107/112107090/
2. https://nptel.ac.in/courses/112/107/112107084/

SEMESTER III

21MA1303	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To introduce the basic concepts of PDE for solving standard Partial differential equations.
- To introduce Fourier series analysis which is core to many applications in engineering field apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in various situations.
- To introduce the effective Mathematical tools in solutions of partial differential equations, that helps besides several physical processes and to develop Z transform techniques in discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations - Solutions to standard types of first order partial differential equations - Lagrange's linear equation - Second and higher order with constant coefficients of homogeneous linear partial differential equations.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series - Odd and even functions - Change of interval- Half range sine series – Half range cosine series – RMS values- Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction in Cartesian coordinates.

UNIT IV FOURIER TRANSFORMS 12

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

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z-transforms - Elementary properties –Initial and final value theorems- Inverse Z-transform (Using partial fraction method and Residue method) - Convolution theorem– Formation of difference equation-Solution of difference equations using Z – transform.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1 Apply the basic Knowledge to identify and deal with partial differential equations and their solutions.
CO2 Analyze the principles of Fourier series in solving engineering problems.
CO3 Solve two dimensional equations using Fourier series techniques.

CO4 Analyze the mathematical principles on Fourier transforms.
CO5 Utilise the basic knowledge in solving difference equations using Z-transforms.

TEXT BOOKS

1. Grewal B.S., “Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
3. Veerarajan T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
4. Nagarajan G. and Sundar Raj M., "Transforms and Partial Differential Equations", Sree kamalamani Publications , 6th edition , Chennai , 2021.

REFERENCE BOOKS

1. Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
3. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
4. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Wylie, R.C. and Barrett, L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

21ME 1301	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental concepts of thermodynamics.
- To understand the basics of flow processes.
- To understand the application of second law of thermodynamics.
- To understand the performance of vapour power cycle and properties of pure substances.
- Analyzethe thermodynamic behaviour of real gases, gas mixtures, and moist air systems.

UNIT - I BASIC CONCEPTS AND FIRST LAW 9

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

UNIT - II SECOND LAW AND AVAILABILITY ANALYSIS 9

Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Available and non-available energy of a source and finite body. Energy and irreversibility. Irreversibility. I and II law Efficiency.

UNIT - III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

UNIT - IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS 9

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

UNIT - V GAS MIXTURES AND PSYCHROMETRY 9

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

saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fundamentals of thermodynamics in various areas.
CO2: Apply the first law of thermodynamics for steady and unsteady flow process.
CO3: Apply second law of thermodynamics to heat engine, heat pump and refrigerator.
CO4: Analyze the properties of pure substance, performance of vapour power cycle.
CO5: Analyze thermodynamic relations for real gases, properties of gas mixtures and moist air.

TEXT BOOKS

1. Nag.P.K.,“Engineering Thermodynamics”, 6thEdition, Tata McGraw-Hill, New Delhi, 2017.
2. R.K. Rajput, "Thermal Engineering", 10th Edition, Laxmi Publications (P) LTD, 2020.
3. Domkundwar, Kothandaraman, "A Course in Thermal Engineering", Dhanpat Rai & Co, 2016.

REFERENCE BOOKS

1. Cengel. Y and M.Boles, "Thermodynamics - An Engineering Approach", 7th Edition, TataMcGraw Hill, 2010.
2. Holman.J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 1995.\
3. Rathakrishnan. E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall ofIndia Pvt. Ltd, 2006
4. Natarajan E., "Engineering Thermodynamics: Fundamentals and Applications", AnuragamPublications, 2012.
5. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2010.
6. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
7. Van Wylen and Sonntag, “Classical Thermodynamics”, Wiley Eastern, 1987
8. Venkatesh. A, “Basic Engineering Thermodynamics”, Universities Press (India) Limited, 2007.
9. Kau-Fui Vincent Wong, "Thermodynamics for Engineers", CRC Press, 2010 Indian Reprint.
10. Prasanna Kumar: Thermodynamics "Engineering Thermodynamics" Pearson Education, 2013

WEB REFERENCES

1. https://www.youtube.com/watch?v=1_InUUX5-LE
2. https://nptel.ac.in/courses/127106135

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105220
2. https://www.youtube.com/watch?v=0jXeNaSM5Xc
3. https://www.youtube.com/watch?v=xQwi9fveGTQ

21ME1302	STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

- To understand the concepts of stress, strain, principal stresses and principal planes
- To understand the concepts of stresses on circular shafts and springs due to torsion and on cylinders due to internal pressures.
- To understand the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To analyse the deflections and slope of beam under variable load conditions and theory of columns and perfect frames

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types, transverse loading on beams – Shear force and bending moment in beams – Cantilevers, Simply supported beams and overhanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shearing Stress at a Section in a Loaded Beam, Distribution of Shearing Stress over various cross section

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses and Deflection in helical and leaf springs.

UNIT IV DEFLECTION OF BEAMS AND ANLYSIS FOR FRAMES 9

Deflection of beams - Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam method, Analysis of Perfect Frames - Method of Joints, Method of Sections.

UNIT V THEORY OF COLUMNS, THIN AND THICK CYLINDERS&SPHERES 9

Euler's column theory – Euler's formula for various end conditions - Rankine's Formulae for Columns, Stresses in thin cylindrical and thick cylindrical shell due to internal pressure - circumferential and longitudinal stresses and deformation – Spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

TOTAL : 45 PERIODS

COURSE OUTCOME

CO1: Apply the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
CO2: Apply the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
CO3: Apply the basic equation of simple torsion, stresses in shafts and helical spring.
CO4: Apply different methods to find the slope and deflection in beams.
CO5: Analyse the buckling and crippling load of columns and design thin and thick shells for the applied internal and external pressures.

TEXT BOOKS

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. R. Narayan and S. Ramamrutham," Strength of Materials", Dhanpat Rai Publishing Co., New Delhi, 19th editon, 2017

REFERENCE BOOKS

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.
5. Gere & Timoshenko, "Mechanics of materials" Macmillan company, 2004

WEB REFERENCES

1. https://mechanicalc.com/reference/strength-of-materials
2. https://www.springer.com/journal/11223
3. https://www.engineersedge.com/strength_of_materials.htm
4. https://mechanicalbasics.com/strength-of-materials/
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/strength-of-materials

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/105105108
2. https://www.digimat.in/nptel/courses/video/112107147/L01.html
3. https://www.youtube.com/watch?v=GkFgysZC4Vc
4. https://nptel.ac.in/courses/112107146
5. https://www.nptelvideos.com/mechanical/strength_of_materials.php

21ME1303	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the classification of materials and its various mechanical properties.
- To understand the concepts of CCT Diagrams and the principles of various heat treatment process.
- To understand the effects of alloying elements on the steel and various steel types.
- To understand the properties and applications of the non-ferrous metal and non-metallic materials..
- To understand the concept of various strengthening mechanisms.

UNIT I MATERIALS AND MECHANICAL PROPERTIES 9

Classification of Materials - alloys types - Intermediate Alloy Phase/Compound , Solid Solutions - Mechanical Properties - Strength , Homogeneity, Isotropy, Anisotropy, Elasticity, Plasticity, Ductility, Malleability, Machinability, Brittleness, Embrittlement, Hardness, Toughness, Stiffness, Impact strength, Resilience, Proof Resilience, Modulus of Resilience, Damping, Creep, Fatigue, Cohesion , Rupture - Iron carbon equilibrium diagram - Classification of steel and cast Iron and its microstructure, properties and applications.

UNIT II HEAT TREATMENT 9

Definition – Full annealing, stress relief, recrystallization and spheroidising – normalising, hardening and Tempering of steel- Austempering, martempering – Hardenability, Jominy end quench test - cooling curves superimposed on I.T. diagram CCR - case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening.

UNIT III STEEL AND ITS CLASSIFICATIONS 9

Specification of steel - Effect of alloying additions on steel- α and β stabilizers – Alloy Steels- Ni Steel, Cr Steels, Nickel -Chromium Steels, Mn Steels, Mo Steels, W Steel, V Steels, and Si Steels - Stainless Steel - Tool steels - Dual Phase Steel – TRIP - HSLA - Maraging steels - properties and applications.

UNIT IV NON FERROUS METALS AND NON METALLIC MATERIALS 10

Copper and copper alloys – Aluminium and Aluminium Alloys and Al-Cu – precipitation strengthening treatment – Bearing alloys - Magnesium alloys - Super alloys and its types - Titanium alloys. Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers - Engineering Ceramics – Properties and applications - Composites and its types - Applications of Composite.

UNIT V STRENGTHENING MECHANISMS 8

Basic concepts: Dislocations and plastic deformations - Solid solution strengthening - strengthening by grain size reduction - Precipitation hardening - Particle and fiber dispersion strengthening- Strain hardening – Recovery - Recrystallisation and grain growth.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the various material classifications and its properties, Iron-Iron carbon diagram and its microstructures.

CO2: Analyze key heat treatment processes for steel as well as the concepts of hardenability and related testing techniques.

CO3: Apply the basic concepts of material specifications and properties of various alloy steels, including the effects of various alloying elements.

CO4 : Analyse the properties, types, and applications of various non ferrous materials, polymers, ceramics, and composites.

CO5: Analyse key material strengthening methods, including dislocations, grain size reduction, and processes like precipitation hardening and recrystallization.

TEXT BOOKS

1. Avner, S.H., “Introduction to Physical Metallurgy”, McGraw Hill Book Company,1997.
2. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian Edition 2014
3. Bolton, W., Engineering Materials Technology: Butterworth-Heinemann.
4. Jacobs, J. A., & Kilduff, T. F. “Engineering materials technology: structures, processing, properties, and selection”, Pearson/Prentice Hall.

REFERENCE BOOKS

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 2010.
2. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2015.
3. U.C.Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012
4. Upadhyay. G.S. and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi, 2006.

WEB REFERENCES

1. https://www.theengineerspost.com/heat-treatment-of-steel/
2. https://unacademy.com/lesson/iron-carbon-equilibrium-diagram/KP6BFSGT
3. https://www.iqsdirectory.com/articles/powder-metal-parts/powder-metallurgy.html

ONLINE COURSES / RESOURCES:

1. NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112: related web and video resources under Mechanical Engineering &Metallurgy and Material Science categories**.**

21ME 1304	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concept in various metal casting processes.
- To understand the various types of metal joining techniques used for different materials.
- To understand the principles and processes of hot and cold working of metals, including forging, drawing, extrusion, and rolling, along with the common defects in rolled parts.
- To understand the various sheet metal characteristics and forming processes.
- To understand the types and characteristics of plastics, various molding techniques, and the manufacture of composite materials and powder metallurgy.

UNIT I METAL CASTING PROCESSES 9

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Mouldings and Properties and testing – Cores –Types and applications – Melting furnaces : Blast and Cupola Furnaces; Moulding machines– Types and applications; Principle of special casting processes : Shell - Investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO_2process – Stir casting - Defects in Sand casting

UNIT II JOINING PROCESSES 9

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding- Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types,causes and cure.Case studies on welding in marine

UNIT III METAL FORMING PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed dieforging – forging operations. Principle of rod and wire drawing – Tube drawing – Principles ofExtrusion – Types – Hot and Cold extrusion. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes- Working principle and applications – construction, working and applications of Hydro forming and Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Superplastic forming – Micro forming

UNIT V MANUFACTURE OF POLYMERS AND COMPOSITES 9

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding –applications – introduction to blow moulding – Rotational moulding –Film blowing – Extrusion – Thermoforming – Bonding of

Thermoplastics; Manufacture of Composite materials -Powder metallurgy - Process, Compacting, Sintering, Vacuum processing- high energy compaction.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze different metal casting processes, associated defects, merits and demerits

CO2: Analyze the different metal joining processes for various applications.

CO3: Analyze various hot working and cold working methods of metals.

CO4: Apply the concepts of various sheet metal making processes.

CO5: Analyse the concepts for manufacturing various polymer and composite components.

TEXT BOOKS

1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008
2. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013

REFERENCE BOOKS

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition,2013

WEB REFERENCES

1. http://www.iitg.ac.in
2. https://ocw.mit.edu/courses
3. http://hyperphysics.phy-astr.gsu.edu/hbase

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105306
2. https://nptel.ac.in/courses/112105233
3. https://nptel.ac.in/courses/112104189https://www.coursera.org/learn/manufacturing-process-fusion-360?
4. https://www.edx.org/course/introduction-to-computer-numerical-control?index=product&queryID=27fc411936a1e77b4e2b7b1a013873ff&position=1

21ES1301	ELECTRICAL DRIVES AND CONTROLS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of different types of electrical machines and their performance.
- To understand the characteristics of various drive motors.
- To understand the different methods of starting D.C motors and induction motors
- To understand the conventional and solid-state DC and AC drives

UNIT I INTRODUCTION 9

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

UNIT II DRIVE MOTOR CHARACTERISTICS 9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.

UNIT III STARTING METHODS 9

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.

UNIT IV CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES 9

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

UNIT V CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES 9

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic elements of electric drives, factors influencing drive selection.

CO2: Analyze the characteristics of various types of DC Motor.

CO3: Analyze the performance of various starters for AC and DC Motors.

CO4: Apply the basic concepts of conventional and solid state speed control of D C drives.

CO5 Analyse the concepts of conventional and solid state speed control of A C drives.

TEXT BOOKS

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2006
2. Vedam Subrahmaniam, “Electric Drives (Concepts and Applications)”, Tata McGraw-Hill, 2010

REFERENCE BOOKS

1. Partab. H., “Art and Science and Utilisation of Electrical Energy”, Dhanpat Rai and Sons, 2017
2. Pillai.S.K “A First Course on Electric Drives”, Wiley Eastern Limited, 2012
3. Singh. M.D., K.B.Khanchandani, “Power Electronics”, Tata McGraw

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc19_ee65/preview
2. https://nptel.ac.in/courses/108104011

21ES1311	ELECTRICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To Understand and perform load tests on various DC motors (shunt, series, and compound) and analyze their performance characteristics.
- To understand the open-circuit and load characteristics of DC shunt and series generators and conduct related tests to study their behaviour under different loads.
- To understand speed control techniques for DC shunt motors (armature and field control) and three-phase slip-ring induction motors, including their practical applications.
- To Perform load tests on single-phase and three-phase induction motors, along with tests on transformers, and understand the use of DC and AC starters for motor control.

LIST OF EXPERIMENTS

1. Load test on DC Shunt motor.
2. Load test on DC Series motor.
3. Load test on DC Compound motor.
4. O.C.C & Load characteristics of DC Shunt generator.
5. Load characteristics of DC Series generator.
6. Speed control of DC shunt motor (Armature, Field control).
7. Load test on single phase transformer.
8. O.C & S.C Test on a single phase transformer.
9. Load test on three phase squirrel cage Induction motor.
10. Load test on Single phase Induction motor.
11. Speed control of three phase slip ring Induction Motor.
12. Study of DC & AC Starters.

TOTAL:60 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the performance characteristics of various DC motors (shunt, series, and compound) through load testing, and explain how different load conditions affect their operation.

CO2: Analyze the open-circuit and load characteristics of DC shunt and series generators, and describe their behavior under varying load conditions.

CO3: Apply speed control techniques for DC shunt motors (armature and field control) and three-phase slip-ring induction motors.

CO4: Apply the methods for performing load tests on single-phase and three-phase induction motors, transformers, and the operation of DC and AC starters.

CO5: Evaluate the effectiveness of different load testing techniques and motor control methods by comparing the results and determining the most suitable approach for specific applications.

TEXT BOOKS

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2006
2. Vedam Subrahmaniam, “Electric Drives (Concepts and Applications)”, Tata McGraw-Hill, 2010

ONLINE COURSES / RESOURCES:

1. http://www.empa.ftn.kg.ac.rs/en/links.php
2. https://kener.elektr.polsl.pl/epedlab/project.php?lang=en
3. https://ied-nitk.vlabs.ac.in/

21ME1311	MANUFACTURING PROCESSES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

1. To understand the process of preparing green sand molds with solid, split, and loose-piece patterns for casting applications.
2. To understand the sheet metal fabrication techniques, including shearing and bending operations, for creating components like trays and funnels.
3. To understand the principles and techniques of Gas Metal Arc Welding (GMAW) to fabricate lap, butt, and T-joints.
4. To understand the process of taper turning and thread cutting on a center lathe, including the use of the compound rest and tailstock set-over for precise operations.
5. To understand the process of knurling and external and internal thread cutting, including the creation of square head shapes through shaping operations.

LIST OF EXPERIMENTS

1. Preparation of green sand mould with Solid Pattern
2. Preparation of green sand mould with Split and Loose-piece Pattern
3. Fabrication of sheet metal tray using shearing and bending operations.
4. Fabrication of a funnel using shearing and bending operations.
5. Fabrication of Lap Joint using Gas Metal Arc Welding
6. Fabrication of Butt Joint using Gas Metal Arc Welding
7. Fabrication of T-Joint using Gas Metal Arc Welding
8. Taper turning using Center Lathe - compound rest, Tailstock set over
9. Single and Multi start thread cutting - External and Internal, Knurling
10. Square Head Shaping

DEMONSTRATION

1. Preparation of green sand mould with core.
2. Brazing.
3. Gas Welding.
4. Manufacturing of sheet metal components using metal spinning on a lathe.

TOTAL : 60PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the techniques for preparing green sand molds with solid, split, and loose-piece patterns and their application in casting processes.
CO2: Analyze the various sheet metal fabrication methods, including shearing and bending operations.
CO3: Apply the principles of Gas Metal Arc Welding (GMAW) to fabricate lap, butt, and T-joints.
CO4: Apply turning, thread cutting, knurling operations and shaping operations on a center lathe for precision manufacturing.
CO5: Evaluate the effectiveness of different fabrication technique to use most suitable approach for specific industrial applications.

21ME1312	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To understand the basics and standards used in 3D drawing.
- To understand the Assembly of the machine components.
- To understand the rendering module, layouts and printing.
- To apply the concepts of Topology optimization and Generative design.

UNIT I GEOMETRY CREATION AND MODIFICATION 10

Introduction to Computer Aided Design**,** Sketch Geometry - Create: Circle, Arc, Line, Rectangle, Ellipse, Spline, Text by using different option, Geometric construction option, Geometric selection method - Set working directory - Sketch Modification: Fillet, Chamfer, Offset - Datum plane Construction.

UNIT II 3D SOLID GEOMETRY CREATION 10

Introduction about working window of Solid Creation, 3D solid geometry command: Extrude, Revolve, Sweep, Variable sweep, Helical sweep, Swept blend and 3D Geometric modification - Creation of components in part Module : Support Brackets, Wall Brackets, Bearing Brackets, Flanges, etc.

UNIT III ASSEMBLY MODELLING 20

Assemble Part With Constrains - Creation of 3D assembly model using 3D Modelling software: Flange Coupling, Plummer Block, Screw Jack, Universal Joint, Machine Vice, Stuffing box, Safety Valves, Connecting rod, Piston - Create Animation for Assemble and Disassemble - Drawing Creation from 3D models.

UNIT IV RENDERING MODULE, LAYOUTS, PRINTING AND OUTPUTS 10

Rendering in Drawing Layouts - Creation of main view and projection view - Model scale and sheet size - View style, View display and Visible area - Section view creation and view states - Different view and add new model in sheet - Creation of Dimension in Drawing View - Generating bill of material.

UNIT V TOPOLOGY OPTIMIZATION AND GENERATIVE DESIGN 10

Objective function, Optimization variables, Constraints, Methods to quantify and compute objective function and constraints, Structural optimization - Topology optimization of components.

TOTAL : 60 PERIODS

Note: Plotting of drawings must be made and attached to the records written by students.

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the basics of CAD, including creating and modifying simple geometry like circles, lines, and text.

CO2: Evaluate how to create 3D solid shapes using commands like extrude, revolve, and sweep.

CO3: Apply assembly modeling techniques to create and animate 3D assemblies with constraints.

CO4: Apply rendering and drawing techniques to create views, dimensions, and bills of materials in CAD.

CO5: Evaluate the use of topology optimization and generative design to find the best design solutions.

TEXT BOOKS

1. Sandeep Dogra, "Creo Parametric 8.0: A Power Guide for Beginners and Intermediate Users", CADArtifex, 2021.
2. Michael Rider, "Designing with Creo Parametric 7.0", Taylor & Francis Group, August 2020.
3. Goutam Pohit, Goutam Ghosh, “Machine Drawing with AutoCAD”, Pearson, 2007.
4. Jasbir S. Arora, " Introduction to Optimum Design", 3rd Edition, Elsevier Academic Press, 2012.

REFERENCE BOOKS

1. Matt Lombard, "Mastering SolidWorks", Wiley, 2018.
2. Bhatt N.D. and Panchal V.M, “Machine Drawing”, Charotar Publishing House, 46th Edition, 2011.
3. Bendsoe, M. P. and Sigmund, O., "Topology Optimization: Theory, Methods, and Applications," Springer, 2003.

WEB REFERENCES

1. http://support.ptc.com/help/creo/creo_pma/usascii/index.html#page/tutorials_pma%2Ftutorials_overview.html%23
2. https://mecheng.iisc.ac.in/suresh/me260/notes.html - Topology optimization

ONLINE COURSES / RESOURCES:

1. https://www.classcentral.com/subject/creo

SEMESTER IV

21MA1405	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

Course Objective

- To understand how to solve various engineering problems using numerical methods.
- To understand the process of testing hypotheses for both small and large samples in real-life applications.
- To understand the basic concepts involved in solving algebraic and transcendental equations.
- To understand the numerical techniques for interpolation and differentiation, and their applications in engineering and technology.
- To understand the methods used to solve ordinary differential equations and their significance in various engineering fields.

UNIT I TESTING OF HYPOTHESIS 12

Statistical hypothesis - Large sample test based on Normal distribution for Proportion , single mean and difference of two means - Student's t test for single mean and difference of two means, F test for Variance. Chi-square tests for independence of attributes and goodness of fit

UNIT II DESIGN OF EXPERIMENTS 12

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

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 12

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

UNIT IV INTERPOLATION AND NUMERICAL DIFFERENTIATION 12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Single Step Methods: Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order ordinary differential equations. Multi step methods : Milne's predictor corrector methods for solving first order ordinary differential equations.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2: Apply the basic concepts of classifications of design of experiments in the field of agriculture.
CO3: Understand the numerical techniques to solve algebraic and transcendental equations in engineering problems.
CO4: Apply interpolation and differentiation methods to analyze and solve engineering problems in technology and design.
CO5: Analyse the interpolation and differentiation methods to solve engineering problems and make design decisions in technology.

TEXT BOOKS

1. Johnson. R.A., and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers",11th Edition, Pearson Education, , Asia, 2011.
2. Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007. 41

REFERENCE BOOKS

1. Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
2. Spiegel. M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.
3. Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 5th Edition, Tata McGraw Hill, New Delhi, 2007.
4. Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis" Pearson EducationAsia, New Delhi, 2006.
5. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
6. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", CengageLearning, New Delhi, 8th Edition, 2014.
7. Kandasamy, P., Thilagavathy ,K.,andGunavathy,S., 'Numerical Methods', S. Chand and Co.,2007

21ME1401	KINEMATICS OF MACHINERY	L	T	P	C
		3	0	0	3

Course Objective

- To understand basic mechanisms, kinematic concepts, and how to analyze mobility and degrees of freedom.
- To understand how to calculate displacement, velocity, and acceleration in linkage mechanisms using basic methods.
- To understand the types of cam mechanisms, their motion profiles, and how to design cam layouts.
- To understand the basics of gears, gear action, and how gear trains work.

UNIT I BASICS OF MECHANISMS 9

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Grubler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.

UNIT II KINEMATICS OF LINKAGE MECHANISMS 9

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration –Introduction to linkage synthesis problem.

UNIT III CAM MECHANISMS 9

Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams –Pressure angle and undercutting – sizing of cams.

UNIT IV GEARS AND GEAR TRAINS 9

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains.

UNIT V FRICTION IN MACHINE ELEMENTS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOME:

CO1: Analyze the mechanisms, basic kinematic concepts, and degrees of freedom.
CO2: Evaluate the displacement, velocity, and acceleration in linkage mechanisms and their application.
CO3: Apply the principles of cam mechanisms to design displacement diagrams and cam profiles for different motion types.
CO4: Apply the knowledge of gears and gear trains to analyze gear actions, contact ratios, and solve related engineering problems.
CO5: Evaluate the Friction in clutch, bearings, brakes and belt drives.

TEXT BOOKS

1. S. S. Rattan, “Theory of Machines”, McGraw Hill Publication, 5th edition, 2019
2. Uicker. J. J, Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2017.

REFERENCE BOOKS

1. Amitabha Ghosh and Ashok Kumar Mallik, “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., 2006.
2. Rao.J.S. and Dukkipati. R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2006.
3. F.B. Sayyad, “Kinematics of Machinery”, MacMillan Publishers Pvt Ltd., Tech-max Educational resources, 2011.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, 1999.
5. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
6. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014

WEB REFERENCES

1. https://ekeeda.com/degree-courses/mechanical-engineering/kinematics-of-machinery
2. https://freevideolectures.com/course/2359/kinematics-of-machines
3. https://www.cloudkampus.com/course-details.php?course_id=232&c=Kinematics+of+Mechanisms+and+Machines+online-training-course

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_me25/preview
2. https://www.coursera.org/courses?query=kinematics

21ME1402	THERMAL ENGINEERING - I	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the principles and analysis of air standard cycles such as Otto, Diesel, Dual, and Brayton, and compare their performance.
- To understand the classification and working principles of reciprocating air compressors, and explain the efficiency calculations including volumetric, isothermal, and isentropic efficiencies.
- To understand the working, components, and classification of internal combustion engines, and differentiate between two-stroke and four-stroke engines, as well as SI and CI engines.
- To understand the performance parameters of internal combustion engines and explain the functioning of ignition, fuel injection, lubrication, and cooling systems.
- To understand the principles of gas turbine cycles, including open and closed cycles, and describe methods for performance improvement, such as regenerative and reheated cycles.

UNIT I GAS AND STEAM POWER CYCLES 9

Air Standard Cycles - Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison

UNIT II RECIPROCATING AIR COMPRESSOR 9

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors.

UNIT III INTERNAL COMBUSTION ENGINES AND COMBUSTION 9

IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control

UNIT IV INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS 9

Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common Rail Direct Injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms and Low temperature Combustion Engines (HCCI, PCCI, RCCI)

UNIT V GAS TURBINES 9

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Materials for Turbines.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the different air standard cycles and solve problems.
CO2: Analyze the working principle of single and multistage compressors.
CO3: Analyze the functioning and features of IC engines, components and auxiliaries
CO4: Apply the combustion, performance and emission characteristics of IC engine.
CO5: Analyze different Gas turbines cycles and its efficiency improvement.

TEXT BOOKS

1. R.K. Rajput, "Thermal Engineering", 10th Edition, Laxmi Publications (P) LTD, 2020.
2. Domkundwar, Kothandaraman, "A Course in Thermal Engineering", Dhanpat Rai & Co, 2016.

REFERENCE BOOKS

1. Arora.C.P, ”Refrigeration and Air Conditioning ,” Tata McGraw-Hill Publishers 2008.
2. Ganesan V..” Internal Combustion Engines” , Third Edition, Tata Mcgraw-Hill 2012.
3. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.
4. Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2003.
5. Sarkar, B.K,”Thermal Engineering” Tata McGraw-Hill Publishers, 2007.
6. Rakesh Kumar Maurya, "Characteristics and Control of Low Temperature Combustion Engines: Employing Gasoline, Ethanol and Methanol"(Mechanical Engineering Series)-Springer 2017.

WEB REFERENCES

1. https://www.youtube.com/watch?v=NakOoD-G0IY
2. https://www.youtube.com/watch?v=cT9UN1XENNk
3. https://www.youtube.com/watch?v=Hdy0il9nvI8

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112103275
2. https://nptel.ac.in/courses/112106133

21ME1403	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the properties of fluids such as mass density, viscosity, surface tension, and compressibility, and explain their significance in fluid mechanics.
- To understand the principles of fluid statics, including Pascal's Law, pressure variations in a fluid at rest, and the concepts of absolute, gauge, and atmospheric pressures.
- To understand the concepts of laminar flow, boundary layers, and the Darcy-Weisbach equation, and describe the flow characteristics.
- To understand the need for dimensional analysis and its methods and their application in model analysis.
- To understand the working principles of hydraulic pumps and turbines, including centrifugal and reciprocating pumps, as well as Pelton, Francis, and Kaplan turbines.

UNIT I FLUID PROPERTIES AND STATICS 9

Units and dimensions- Properties of fluids - mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity.

Fluid Statics: Pascal's Law – Pressure Variation in a Fluid at Rest– Absolute Pressure – Gauge Pressure – Atmospheric Pressure - Vacuum Pressures. Flow characteristics - application of continuity equation, energy equation and momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 9

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundarylayerconcepts–Typesofboundarylayerthickness–Darcy-Weisbachequation– friction factor- Moody diagram-Commercial pipes-Minor losses– Flow through pipes in series and parallel.

UNIT III DIMENSIONALANALYSIS 9

Need for dimensional analysis – Methods of Dimensional Analysis – Similitude –Types of similitude – Dimensionless parameters- Application of dimensionless parameters– Model analysis.

UNIT IV HYDRAULIC PUMPS 9

Impactofjets-Euler'sequation-TheoryofRoto-dynamicmachines–variousefficiencies– velocity components at entry and exit of the rotor-velocity triangles.

Centrifugal pumps–working principle - work done by the impeller - performance curves - Reciprocating pump- working principle – Rotary pumps –classification.

UNIT V HYDRAULIC TURBINES 9

Classification of turbines - Axial, radial and mixed flow turbines –Heads and efficiencies– Velocity triangles. Pelton wheel, Francis turbine and Kaplan turbines- Working principles - Work done by water on the runner–Draft tube. Specific speed- unit quantities– Performance curves for turbines – Governing of turbines.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fundamental properties of fluids and their importance in fluid mechanics applications.
CO2: Analyze flow through circular conduits and pipelines.
CO3: Analyze the need for dimensional analysis to solve engineering problems.
CO4: Analyze the performance of hydraulic pumps.
CO5: Analyze the performance of turbines.

TEXT BOOKS

1. Bansal R.K., “Fluid Mechanics and Hydraulic Machines”, 10th Edition, Lakshmi Publications, New Delhi, 2018.
2. Modi P.N .and Seth, S.M ."Hydraulics and Fluid Mechanics", Standard Book House ,New Delhi2013.

REFERENCE BOOKS

1. Hibbeler R.C., “Fluid Mechanics in SI units”, 1st Edition, Pearson India Education Services Pvt. Ltd., Noida, 2017.
2. Graebel.W.P,"Engineering Fluid Mechanics",Taylor & Francis, Indian Reprint,2011.
3. KumarK.L.,"EngineeringFluidMechanics",EurasiaPublishingHouse(p)Ltd.,NewDelhi2016.
4. RobertW.Fox, AlanT.McDonald,PhilipJ. Pritchard ,“Fluid Mechanics and Machinery”, 2011.
5. Streeter,V.L.and WylieE.B.,"Fluid Mechanics",McGrawHill Publishing Co.2010.
6. YunusA.Cengel, and John M.Cimbala, FluidMechanics, Thirdedition, McGrawHill Education(India)Pvt Ltd,2014.

WEB REFERENCES

1. https://energyeducation.ca/encyclopedia/Pelton_turbine
2. https://www.sciencedirect.com/topics/engineering/fluid-mechanics
3. https://www.annualreviews.org/journal/fluid
4. https://madhavuniversity.edu.in/fluid-mechanics-and-its-use.html
5. https://theconstructor.org/practical-guide/centrifugal-pump-working-types/2917/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105183/.
2. https://nptel.ac.in/courses/112104118
3. https://nptel.ac.in/courses/105103192
4. https://nptel.ac.in/courses/112105171
5. https://onlinecourses.nptel.ac.in/noc21_ce56/preview

21ME1404	METAL CUTTING AND MACHINE TOOLS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the mechanics of chip formation, cutting tool materials, tool wear, and the effects of cutting fluids on machinability in metal cutting processes.
- To understand the construction, operations, and specifications of turning machines, including taper turning and thread cutting methods.
- To understand the types of operations and construction methods for shapers, milling machines, and gear cutting processes, including gear milling and hobbing.
- To understand the types of abrasive processes, such as grinding and broaching, and their applications in machining, including cylindrical and surface grinding.
- To understand the basic principles of CNC machining, including the types of CNC machines, part programming fundamentals, and their applications in micromachining.

UNIT I THEORY OF METAL CUTTING 9

Mechanics of chip formation, single point cutting tool, forces in machining, cutting tool materials, tool wear, tool life, Types of chips, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, surface finish, cutting fluids and Machinability

UNIT II TURNING MACHINES 9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation.

Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle.

UNIT III SHAPER, MILLING AND GEAR CUTTING 9

Shaper - Types of operations. Drilling, reaming, boring, Tapping. Gear cutting – forming and generation principle and construction of gear milling, Hobbing and gear shaping processes – finishing of gears. Milling operations-types of milling cutter. Case studies about machining centers used in car manufacturing companies

UNIT IV ABRASIVE PROCESS AND BROACHING 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process, construction and application – 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 - Generation of Codes for simple components .

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the mechanism of material removal processes.

CO2: Apply the principles of lathes / special purpose machines for various applications.

CO3: Analyze the constructional and operational features of shaper, planner, milling, drilling, sawing and broaching machines.

CO4: Apply the concepts about the types of grinding and other super finishing processes.

C05: Analyse the basic principles of numerical control/CNC machine tools in part programming.

TEXT BOOKS

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2014.
2. Rao. P.N “Manufacturing Technology - Metal Cutting and Machine Tools", 3rd edition, Tata McGraw-Hill, New Delhi, 2013.

REFERENCE BOOKS

1. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J. White “Machine Tool Practices”, Prentice Hall of India, 1998
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984

WEB REFERENCES

1. http://www.iitg.ac.in/rkbc/me101/me101.htm
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-engineering-mechanics-i-fall-2007/index.htm
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112104195
2. https://nptel.ac.in/courses/112104301
3. https://nptel.ac.in/courses/112107219
4. https://www.coursera.org/learn/manufacturing-process-fusion-360?
5. https://www.edx.org/course/fundamentals-of-manufacturing-processes

21ME1411	METAL CUTTING AND MACHINE TOOLS LABARATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To understand the process and techniques of eccentric turning, drilling operations, and contour milling using various machines such as center lathe, radial drilling machine, and vertical milling machine.
- To understand the principles of spur gear cutting, key way cutting, and the basics of surface grinding, cylindrical grinding, and centerless grinding operations.
- To understand the methods for measuring cutting forces in lathe and milling machines and their impact on machining performance.
- To understand the basics of CNC machining, including part programming and operations like turning, facing, and contour milling using CNC lathe and CNC mill.

LIST OF EXPERIMENTS

1. Eccentric Turning using Center Lathe.
2. Various drilling operations using Radial drilling machine.
3. Contour milling using Vertical milling machine.
4. Spur gear cutting in Milling machine.
5. Measurement of cutting forces in Lathe and Milling machine.
6. Key way cutting using Slotting machine.
7. Plain Surface grinding.
8. Cylindrical grinding and Centerless grinding.
9. Grinding of Single point cutting tool.
10. Introduction to CNC Part Programming.
11. Simple turning and facing using CNC Lathe.
12. Contour milling using CNC Mill.

DEMONSTRATION

1. Turret and Capstan Lathe.
2. Helical Gear Cutting in Hobbing machine.
3. Spur Gear generation in Gear shaping machine.

TOTAL : 60 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply basic machining operations like turning, drilling, milling, and gear cutting on conventional machines.
CO2: Apply grinding techniques for plain surface, cylindrical, and centerless grinding.
CO3: Analyze cutting forces in lathe and milling machines and their effects on machining.
CO4: Analyze keyway cutting and slotting methods, and compare different grinding processes.
CO5: Evaluate CNC programming for turning, facing, and milling operations on CNC machines.

21ME1412	STRENGTH OF MATERIALS AND FLUID MECHANICS AND MACHINERY LABARATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- Understand the mechanical properties of materials through tests like tension, shear, torsion, and impact tests.
- Understand the effects of hardening and tempering on the mechanical properties of steels through hardness and impact resistance testing.
- Understand the concept of beam deflection and strain measurement using a rosette strain gauge.
- Understand the principles of fluid flow and determine the coefficient of discharge for orifice meters, venturimeters, and the rate of flow using a rotameter.
- Understand the working principles of different pumps and turbines by studying and analyzing their characteristic curves in experiments.

STRENGTH OF MATERIALS **30**

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod.
2. Double shear test on Mild steel and Aluminium rods.
3. Torsion test on mild steel rod.
4. Impact test on metal specimen.
5. Hardness test on metals - Brinnell and Rockwell Hardness Number.
6. Deflection test on beams.
7. Compression test on helical springs.
8. Strain Measurement using Rosette strain gauge.
9. Effect of hardening- Improvement in hardness and impact resistance of steels.
10. Tempering- Improvement Mechanical properties Comparison
    (i) Unhardened specimen.
    (ii) Quenched Specimen and
    (iii) Quenched and tempered specimen.
11. Microscopic Examination of
    (i) Hardened samples and
    (ii) Hardened and tempered samples**.**

FLUID MECHANICS AND MACHINERY LABORATORY **30**

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturimeter.
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

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Analyze the basic material tests and their role in material strength.
CO2: Apply fluid mechanics principles to test pumps and turbines.
CO3: Analyze hardening and tempering affect the strength and toughness of steels.
CO4: Analyze the deflection and strain in materials using beam tests and strain gauges.
CO5: Evaluate the performance of fluid to determine flow rate and discharge.

TEXT BOOKS

1. R. K. Rajput, “A text book of Strength of Materials’, S. Chand & Co. Ltd., 2018
2. R. K. Rajput, “A Textbook of Fluid Mechanics and Hydraulic Machines’, S. Chand & Co. Ltd., 2015.

SEMESTER V

21ME1501	THERMAL ENGINEERING - II	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the thermodynamic concepts for Nozzles, pressure ratio and mass flow rate.
- To explain the different types of boilers, their accessories, and the performance of various fuels.
- To Study the turbines, Velocity diagrams and Ref. & Air conditioning systems.
- To understand the concept of utilizing residual heat in thermal systems.

UNIT I STEAM NOZZLE 9

Types and Shapes of nozzles Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.

UNIT II BOILERS 9

Types and comparison. Mountings and Accessories. Fuels — Solid, Liquid and Gas. Performance calculations, Boiler trial, Indian Boiler Regulations (IBR)

UNIT III STEAM TURBINES 9

Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency — optimal operating conditions. Multi-staging, compounding and governing.

UNIT IV COGENERATION AND RESIDUAL HEAT RECOVERY 9

Cogeneration Principles, Cycle Analysis, Applications, Source and utilisation of residual heat. Heat pipes, Heat pumps, Recuperative and Regenerative heat exchangers. Economic Aspects.

UNIT V REFRIGERATION AND AIR — CONDITIONING 9

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Solar driven Refrigeration system and Use of Nanoparticles in Refrigeration systems. Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the various types of nozzles and the concept of different velocity flow through a nozzle.

CO2: Evaluate the functioning and features of various types of boilers and auxiliaries and calculate performance parameters.

CO3: Calculate the work done and efficiency and steam governing systems.

CO4: Analyze cogeneration, heat pump, heat pipes, recuperators, regenerative heat

exchangers and their economic aspects.

CO5: Evaluate the types of Refrigeration cycles and calculate the refrigeration system performance.

TEXT BOOKS

1. R.K. Rajput, "Thermal Engineering", 10th Edition, Laxmi Publications (P) LTD, 2020.
2. Domkundwar, Kothandaraman, "A Course in Thermal Engineering", DhanpatRai& Co, 2016.

REFERENCE BOOKS

1. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.
2. Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2003
3. Sarkar, B.K,”Thermal Engineering” Tata McGraw-Hill Publishers, 2007
4. Arora.C.P, ”Refrigeration and Air Conditioning ,” Tata McGraw-Hill Publishers 2008
5. Mahesh. M. Rathore, “Thermal Engineering”, 1 st Edition, Tata McGraw Hill Publications, 2010.
6. Sydney Reiter “Industrial and Commercial Heat Recovery Systems” Van NostrandReinhols, 1985.
7. Charles H Butler: Cogeneration” McGraw Hill, 1984.

WEB REFERENCES

1. https://www.youtube.com/results?search_query=NPTEL+Thermal+engineering

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105129
2. https://nptel.ac.in/courses/112106133

21ME1502	DESIGN OF MACHINE ELEMENTS APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use catalogues and standard machine components.
- To examine the shape and dimensions of a component to verify they fulfill functional and strength requirements.

UNIT I DEISGN FOR STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Design process - Factors influencing Machine Design - Selection of materials based on Mechanical properties - Preferred numbers – Direct, Bending and torsional stresses in Machine members – Impact and shock loading – Modes of failure - Calculation of Principle stresses for various load Combinations - Eccentric loading – Curved beams – Crane hook and 'C' frame - Factor of safety - Theories of failure – Stress Concentration –Variable Stresses - Endurance limit –Design for finite and infinite life under variable loading.

UNIT II DESIGN OF SHAFTS, KEYS AND COUPLINGS 9

Design of solid and hollow shafts -Based on strength, rigidity and critical speed – Design of various Keys and splines – Design of Rigid and flexible couplings – Selection of Flexible coupling.

UNIT III DESIGN Of TEMPORARY AND PERMANENT JOINTS 9

Design of Knuckle joints - Cotter joints – Design of Screwed joints for commercial and leak proof joints including eccentric loading - Design of Welded joints - Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads – Design of Riveted joints and bonded joints (Elementary treatment only)

UNIT IV DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Design of Compression and Tension Helical springs – Leaf Springs – Belleville springs - Rubber springs (Elementary Treatment only) – Design of Flywheels considering stresses in rims and arms for engines and Punching machines- Design of Connecting Rods and Crank shafts.

UNIT V DESIGN OF BEARINGS 9

Design of Sliding contact bearings - Hydrodynamic Journal bearings - Sommerfeld Number, Raimondi and Boyd graphs -- Selection of Rolling Contact bearings.– Design of Seals and Gaskets (Elementary treatment only).

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze 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: Analyze the concepts of design of journal bearings.

TEXT BOOKS

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, 2008.
2. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2010.

REFERENCE BOOKS

1. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co.(Schaum’s Outline), 2010
2. AnselUgural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3. P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
5. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley, 2005.
6. Sundararajamoorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2015.

WEB REFERENCES

1. Slideshare.net

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105129
2. https://nptel.ac.in/courses/112106133

21ME1503	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on various Metrological equipment's 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.
- To provide a suitability of measuring instruments, their calibration, and the quality control of manufactured components.
- To describe application of principle of metrology and measurements in industries.

UNIT I BASICS OF METROLOGY 9

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards. Static and dynamic characteristic of an instruments

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly .Electronic comparator and pneumatic comparator– Angular measuring instruments – Types – Bevel protractor . – Angle alignment telescope – Autocollimator – Applications.

UNIT III ADVANCES IN METROLOGY 9

Laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM– Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications .computer aided inspection.

UNIT IV FORM MEASUREMENT 9

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE 9

Force, torque, power - mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the concepts of measurements various metrological instruments.

CO2: Analyze the principles of linear and angular measurement tools used for industrial applications.

CO3: Analyze the procedure for conducting computer aided inspection.

CO4: Distinguish the various techniques of form measurement used for industrial components.

CO5: Analyze and compare various techniques for measuring mechanical properties in industrial applications.

TEXT BOOKS

1. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
2. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2009.
3. K. Duraivelu, “Engineering Metrology & Measurements” university press India pvt Ltd, 2018.

REFERENCE BOOKS

1. Alan S. Morris, “The essence of Measurement”, Prentice Hall of India 1996.
2. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.
3. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition,Cengage LearningEMEA,1990.
4. Donald Peckman, “Industrial Instrumentation”, Wiley Eastern, 2004.
5. Raghavendra,Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013.
6. A course in Electrical and Electronic Measurements and Instrumentation, AK Sawhney, DhanpatRai& Co. (P) LimitedYear: 1985.

WEB REFERENCES

1. http://www.infocobuild.com/education/audio-video-courses/mechanical-engineering/MechanicalMeasurements-IIT-Madras/lecture-26.html
2. https://archive.nptel.ac.in/courses/112/104/112104250/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112106179

21ME1504	COMPUTER AIDED DESIGN AND MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Design and Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
- To study about the different CAD standards and CNC part programming.
- To explore Group Technology, coding systems, and FMS.

UNIT I INTRODUCTION 9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems - homogeneous coordinates - 2D and 3D transformations - Line drawing -Clipping- viewing transformation-Brief introduction to CAD and CAM – CAD/CAM concepts - Manufacturing Planning, Manufacturing control –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance.

UNIT II GEOMETRIC MODELING AND INTRODUCTION TO VISUAL REALISM 9

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep, Introduction to visual realism.

UNIT III CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Data exchange standards - IGES, STEP, CALS etc. - communication standards - Open Graphics Library (OpenGL)

UNIT IV FUNDAMENTAL OF CNC AND PART PROGRAMING 9

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- 2D and 3D machining on CNC ,Introduction of CAM package. Various Cutting tools in CNC machines.

UNIT V CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS) 9

Group Technology(GT),Part Families–Parts Classification and coding–OPITZ, DCLASS, MICLASS coding systems with examples–Production flow Analysis–Cellular Manufacturing–Composite part concept–Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Execute the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics.

CO2: Apply the fundamentals of parametric curves, surfaces and Solids used in CAD.

CO3: Apply the different types of Standard systems used in CAD.

CO4: Develop part programs for Lathe and Milling Machines by applying NC and CNC programming concepts.

CO5: Evaluate various techniques used in Cellular Manufacturing and Flexible Manufacturing Systems. (FMS)

TEXT BOOKS

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007
2. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.
3. Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi,2000.
4. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc,1992.

REFERENCE BOOKS

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.
2. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
3. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

WEB REFERENCES

1. https://en.wikipedia.org/wiki/Computer-aided_design
2. http://edutechwiki.unige.ch/en/Computer-aided_design_and_manufacturing

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/112/102/112102101/
2. https://nptel.ac.in/courses/112102102
3. https://onlinecourses.nptel.ac.in/noc22_me10/preview

21ME1505	DYNAMICS OF MACHINES	L	T	P	C
		3	0	0	3

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 apply the effect of Dynamics of undesirable vibrations.
- To evaluate the mechanisms used for speed control and stability control.

UNIT I FORCE ANALYSIS 9

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle – Dynamic 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.

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.

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. Introduction to multi degree of freedom system vibration. Discrete and continuous 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.

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 : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Determine the torque on the crankshaft, maximum fluctuation of energy of flywheel in internal combustion engines and machines.

CO2: Determine the required balancing masses in rotating and reciprocating masses.

CO3: Analyze the natural frequency of different free vibration.
CO4: Analyze the amplitude of forced vibration caused by unbalance, support motion and vibration isolation.
CO5: Evaluate the range of speed governor and gyroscopic effect on automobile, ship & aeroplane.

TEXT BOOKS

1. Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw-Hill, 2014.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”,4th Edition, Oxford University Press, 2014.
3. Khurmi, R.S.,”Theory of Machines”, 14th Edition, S Chand Publications, 2005.

REFERENCE BOOKS

1. V. Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.
2. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
3. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
5. F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
6. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014

WEB REFERENCES

1. https://openlibrary.org/search?q=DYNAMICS+OF+MACHINES&mode=everything
2. https://openlibrary.org/search?q=THEORY+OF+MACHINES&mode=everything
3. https://1lib.in/s/Dynamics%20of%20Machines

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112104114
2. NPTEL :: Mechanical Engineering - NOC:Engineering Mechanics Statics and Dynamics
3. https://archive.nptel.ac.in/corses/112/106/112106180/
4. NPTEL :: Mechanical Engineering - Dynamics of Machines
5. https://archive.nptel.ac.in/courses/112/101/112101096/
6. Dynamics of Machinery Lecture 1|Inertia Force| Newton's second law| D'Alembert's principle - YouTube
7. https://youtube.com/user/sadasivan1988

21ME1511	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To impart knowledge on working of petrol and diesel engines.
- To understand valve timing and port timing of petrol and diesel engines.
- To improve the knowledge of understanding the heat balance test and performance test.
- To evaluate the performance of multi cylinder engine.
- To evaluate the performance and heat balance of Steam boiler and turbine.

LIST OF EXPERIMENTS

a. I.C. Engines Lab

1. Valve timing and port timing diagrams
2. Actual p-v diagrams of IC engines using Data Acquisition system
3. Performance test on 4-stroke diesel engine
4. Heat balance test on 4-stroke diesel engine
5. Morse test on Multi-cylinder petrol engine
6. Retardation test on a diesel engine
7. Determination of Flash point and Fire point of various fuels/lubricants

b. Steam Lab

1. Study on steam generators and turbines
2. Performance and energy balance test on a steam generator
3. Performance and energy balance on steam turbine.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Analyze the working of SI and CI engines.
CO2: Apply the performance characteristics of an IC engine.
CO3: Analyze the heat balance and retardation test on Diesel engine.
CO4: Determine the properties of fuels and lubricating oils.
CO5: Analyze the performance and Energy balance of steam power unit.

TEXT BOOKS

1. R.K. Rajput, "Thermal Engineering", 10th Edition, Laxmi Publications (P) LTD, 2020
2. Domkundwar, Kothandaraman, "A Course in Thermal Engineering", DhanpatRai& Co, 2016

21ME1512	METROLOGY AND MECHANICS OF MACHINES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To study the various measuring instruments and measurement techniques for industrial components.
- To calibrate various measuring instruments and inspect industrial components.
- To familiar the principles learnt in dynamics of machinery.
- To analyse the measuring devices are used for dynamic testing.

METROLOGY AND MEASUREMENTS LAB 30

LIST OF EXPERIMENTS

1. Calibrate the Linear measuring instruments (Vernier height gauge ,Micrometer, Depth Gauge, Inside Micrometer)
2. Calibrate the Angular measuring instruments (Sine bar, Bevel Protractor)
3. Measurement of linear dimensions using Comparators (Mechanical/Electronics)
4. Measurement of screw thread parameters –(floating carriage micrometer/ Tool Makers Microscope)
5. Measurement of Dimensions of Gear tooth (Gear tooth verniercaliper/ Profile Projector)
6. Measurement of Flatness and Straightness using Autocollimator/ Surface Measuring instruments.
7. Measurement of Force, Torque and Temperature.
8. Study the CMM and CNC

DYNAMICS OF MACHINES LABORATORY 30

LIST OF EXPERIMENTS

1. Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
2. Determination of Mass Moment of Inertia using bifilar suspension
3. Determination of MI by oscillation - Connecting rod and flywheel
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Determination of torsional natural frequency of single and Double Rotor systems.
6. Vibration Absorber – Tuned vibration absorber.
7. Vibration of Equivalent Spring mass system – undamped and damped vibration.
8. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
9. Determine the transmissibility ratio using the given universal vibrating table apparatus.
10. Transverse vibration of Free-Free beam – with and without concentrated masses.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Apply knowledge of linear and angular measurements in various applications.
CO2: Determine dimensions of gear tooth, flatness and straightness, force, torque and temperature.
CO3: Evaluate the gyroscopic effect and couple, governor effort and range of sensitivity.
CO4: Apply various measurement techniques to calculate the mass moment of inertia.
CO5: Analyse the natural frequency ,damping coefficient and critical speeds of shaft.

21ME1513	TECHNICAL PRESENTATION AND COMPREHENSION LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To enhance students' skills in analyzing and interpreting advancements in engineering and technology.
- To encourage critical evaluation of innovative technologies and their real-world implications.
- To improve students' communication of technical concepts through structured presentations.
- To foster collaborative learning and interdisciplinary understanding through discussions and feedback.

GUIDELINES FOR REVIEW AND EVALUATION

In this course, a student has to present three Technical papers or recent advances in engineering/technology that will be evaluated by a Committee constituted by the Head of the Department

TOTAL :30 PERIODS

COURSE OUTCOME

CO1: Understand and summarize advancements in engineering and technology through technical literature.

CO2: Identify key concepts and trends in recent technical developments in the mechanical field.

CO3: Apply critical thinking to evaluate the practical implications of innovative technologies.

CO4: Demonstrate effective presentation and collaborative skills in technical discussions.

CO5: Integrate interdisciplinary knowledge to address complex engineering challenges.

SEMESTER VI

21ME1601	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge on the principles and procedures for the design of mechanical power transmission components.
- To understand the standard procedures available for design of transmission elements.
- To apply the various design procedure for gears, clutch and brakes
- To examine the design of gear box and Screws.

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 DESIGN OF SPUR GEARS AND 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 DESIGN OF 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 DESIGN OF GEAR BOX AND POWER SCREWS 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout - Design of multi speed gear box for machine tool applications (6 speed, 9speed, 12speed, 14speed, 18speed) – Constant mesh gear box –Speed reducer unit. - Power Screws - Terminology of Power Screw - Torque Requirement—Lifting Load and Lowering Load - Self-locking Screw - Efficiency of Square Threaded Screw - Coefficient of Friction - Design of Screw Jack.

UNIT V DESIGN OF CLUTCHES AND BRAKES 9

Design of single and multi-plate clutches –axial clutches-cone clutches-Internal expanding rim clutches-Electromagnetic clutches. Design of Brakes. External shoe brakes – Single and Double Shoe, Internal expanding shoe brakes and Band brakes

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the knowledge of Mathematics, Science, and Engineering in deriving governing equations and design of power transmitting systems.

CO2: Select and design flexible power transmission elements for machinery and equipment.

CO3: Design the Spur and Helical gears .

CO4: Design Bevel and Worm gear pair .

CO5: Analyze the Speed Reducers for Machine tools with the given constraints implementing standard design procedure.

TEXT BOOKS

1. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2010.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, 2008

REFERENCE BOOKS

1. Sundararajamoorthy T. V, Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2003.
2. GitinMaitra, L. Prasad “Hand book of Mechanical Design”, 2nd Edition, Tata McGraw-Hill,2001.
3. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
4. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”, 2nd Edition, Tata McGraw-Hill Book Co., 2006.

21ME1602	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To understand the mathematical and physical principles underlying the Finite Element Method (FEM).
- To apply mathematical modelling in one-dimensional and two-dimensional variables..
- To analyse the Quadrilateral elements, Isoparametric elements, solid mechanics, heat transfer and fluid flow problems.

UNIT I INTRODUCTION 9

Historical Background - Discrete and continuous models – Boundary, Initial and Eigen Value problems– Mathematical Modeling of field problems in Engineering - Governing Equations - 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, heat transfer and fluid mechanics. Longitudinal vibration frequencies - Fourth Order Beam Equation – Transverse deflections and Natural frequencies of beams.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

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

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

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

UNIT V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems – Quadrilateral elements - 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 : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basics of finite element formulation.

CO2: Apply finite element formulations to solve one dimensional Problem.

CO3: Apply finite element formulations to solve two dimensional scalar Problems.

CO4: Apply finite element method to solve two dimensional Vector problems.

CO5: Analyse finite element method to solve problems on iso-parametric element and dynamic Problems.

TEXT BOOKS

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

REFERENCE BOOKS

1. BhattiAsghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013).
2. Chandrupatla&Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, 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”, 3rd Edition, Butterworth Heinemann, 2004.
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.
6. Zienkiewicz O.C and Taylor R. L, “The Finite Element Method: Volume 1 The Basics”, Fifth Edition, Butterworth-Heinemann, Oxford. Reprint 2011.

WEB REFERENCES

1. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-ofsolids-and-fluids-i-fall-2009/lecture-notes/
2. https://ocw.mit.edu/courses/2-094-finite-element-analysis-of-solids-and-fluids-ii-spring-2011/pages/lecture-notes/
3. https://ocw.mit.edu/courses/res-2-002-finite-element-procedures-for-solids-and-structures-spring-2010/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112104193
2. https://onlinecourses.nptel.ac.in/noc22_me43/preview
3. https://nptel.ac.in/courses/112104116/

21ME1603	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on the theoretical and analytical concepts to analyze the modes of heat transfer.
- To enable the students to apply various laws of heat transfer in engineering applications.
- To enable the students to analyze heat exchangers using LMTD and NTU methods.
- To interpret the concepts underlying the types of mass transfer.

UNIT I CONDUCTION 9

Fourier Law of Conduction, General Differential equation of Heat Conduction- Cartesian Coordinates, 1-D Steady State Heat Conduction (Plane Wall, Cylinders) Composite Systems, Conduction with Internal Heat Generation, Extended Surfaces (Circular, Rectangular). Cooling of Electronic Components

UNIT II CONVECTION 9

Boundary Layer Concept – Types of Convection – Forced Convection –External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar, Turbulent and Combined flows – Flow over Bank of tubes – Free Convection– Flow over Vertical, Horizontal and Inclined Plates, Cylinders and Spheres.Nano Fluids for Heat Transfer.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt's theory of condensation and Regimes of boiling, Heat Exchangers- Classification of heat exchangers, LMTD & NTU Approach for parallel & Counter flow heat exchangers - Fouling Factors.

UNIT IV RADIATION 9

Black Body Radiation – Grey body radiation –radiation shield - Shape Factor Algebra (Plates, parallel, perpendicular, parallel circular disc) -Electrical Analogy. Data study from Infra-Red Thermography Images.

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 : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the steady state heat conduction for composite systems and fins.

CO2: Determine the heat transfer coefficient in natural and forced convection for internal and external flows.

CO3: Determine the effectiveness of heat exchanger using LMTD and NTU methods.

CO4: Analyze radiative heat transfer mechanisms including black body, grey body radiation, radiation shields, and shape factor.

CO5: Analyze the phenomenon of diffusion and convective mass transfer.

TEXT BOOKS

1. Kothandaraman, C. P. Fundamentals of heat and mass transfer. New Age International, 5th Edition, 2018.
2. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, 5th Edition, 2017.

REFERENCE BOOKS

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", .John Wiley & Sons, 1998.
2. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000.
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002.
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition 2015.

WEB REFERENCES

1. https://hyominsite.files.wordpress.com/2015/03/fundamentals-of-heat-and-mass-transfer-6th-edition.pdf
2. https://edisciplinas.usp.br/pluginfile.php/5464110/mod_book/chapter/23393/Heat%20and%20Mass%20Transfer%20by%20kothadaraman.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/?subjectid=112108149

21ME1611	HEAT TRANSFER AND RAC LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To impart knowledge on thermal conductivity measurement using various apparatus.
- To analyze the heat transfer coefficient under natural convection and forced convection.
- To determine the Stefan boltzmann constant and emission of a grey surface.
- To evaluate the effectiveness heat exchanger and volumetric efficiency of air compressor.
- To determine the COP and performance of a vapour compression refrigeration system.
- To understand the performance of fluidized bed cooling tower.

LIST OF EXPERIMENTS

A. Heat Transfer lab

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. Determination of thermal conductivity of composite wall.
6. Determination of thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan-Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of parallel/counter flow heat exchanger.

B. Refrigeration and Air conditioning lab

1. Determination of COP of a refrigeration system.
2. Performance test on Air conditioning system (Psychrometric processes)
3. Performance test on a reciprocating air compressor.
4. Performance test in HC refrigeration system.
5. Performance test in a Fluidized Bed cooling tower.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Understand knowledge in thermal conductivity of different materials.
CO2: Apply the basics in the measurement of heat transfer coefficient of natural and forced convection.
CO3: Analyze the determination of Stefan Boltzmann constant and emissivity of a grey surface.
CO4: Analyze the effectiveness of Parallel flow and counter flow heat exchangers and performance of air compressor.
CO5: Analyze the performance of a refrigeration system and air conditioning system.

TEXT BOOKS

1. Kothandaraman, C. P. Fundamentals of heat and mass transfer. New Age International, 5th Edition, 2018
2. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, 5th Edition, 2017.

21ME1612	COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To expose the students to the techniques of CNC programming and cutting tool path generation by using G-Codes and M-codes.
- To understand the simulation of CNC Turning part programming.
- To understand the simulation of CNC Milling part programming.
- To study the features of Computer Aided Part Programming.
- To understand the workflow of digital manufacturing from modelling to printing.

INTRODUCTION TO MANUAL PART PROGRAMMING 5

Introduction to CNC technology - CNC machines & controls - CNC programming basics - Introduction tomanual NC programming - Manual NC programming for lathe & milling machines using G codes and M codes - Application of Numerical Control, Advantages, & Disadvantages.

PART PROGRAMMING - CNC TURNING 15

Part Programming - CNC Turning Centre a) Straight, Taper and Radius Turning b) Thread Cutting c) Rough and Finish Turning Cycle d) Drilling and Tapping Cycle.

PART PROGRAMMING - CNC MILLING 15

Part Programming - CNC Machining Centre a) Linear Cutting b) Circular cutting c) Cutter Radius Compensation d) Canned Cycle Operations.

COMPUTER AIDED PART PROGRAMMING 15

CL Data and Post process generation using CAM packages - Application of CAPP in Machining and Turning Centre.

DIGITAL MANUFACTURING (Additive Manufacturing) 10

Fused Deposition Modeling (FDM): Model creation, Import and Export, STL file creation, Machine parameter setting, Printing and Post Processing, Applications.

TOTAL :60 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the techniques of CNC programming and cutting tool path generation by using G-Codes and M-codes.

CO2: Analyze the simulation of CNC Turning part programming.

CO3: Analyze the simulation of CNC Milling part programming.

CO4: Evaluate the features of Computer Aided Part Programming.

CO5: Apply the workflow of digital manufacturing from modelling to printing.

TEXT BOOKS

1. PawanNegi, Mangey Ram, Om PrakashYadav, " Basics of CNC Programming", River Publishers, 2019.

2. Kaushik Kumar, ChikeshRanjan, J. Paulo Davim, " CNC Programming for Machining", Springer International Publishing, 2020.
3. S. K Sinha, "CNC Programming Using Fanuc Custom Macro B", McGraw-Hill Education, 2010.
4. De Gruyter, "Manufacturing in Digital Industries
5. Prospects for Industry 4.0", 2020.

REFERENCE BOOKS

1. Peter Smid, "CNC Programming Handbook - A Comprehensive Guide to Practical CNC Programming", Industrial Press, 2008.
2. DivyaZindani, J. Paulo Davim, Kaushik Kumar, "Digital Manufacturing and Assembly Systems in Industry 4.0, 2019.

21ME1613	DESIGN AND FABRICATION PROJECT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To encourage teamwork and effective collaboration by grouping students to work on a project under the guidance of a supervisor.
- To develop hands-on skills in designing, fabricating, and testing devices, systems, or components in alignment with industry standards.
- To enable students to document their project progress and outcomes through well-structured project reports.
- To prepare students for professional evaluation through oral presentations and interactions with internal and external examiners..

GUIDELINES FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 PERIODS

SEMESTER VII

21ME1701	MECHATRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand electronics, electrical systems, and mechanical systems work together in a Mechatronics application.
- To identify the components of a microprocessor and microcontroller, including pin diagrams and basic addressing modes.
- To configure 8255 for interfacing with different devices (e.g., sensors, actuators).
- To clarify the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronics engineering.
- To apply PLC programming to a simple industrial automation problems and case studies in mechatronic system design.

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 – Pressure sensor-Light sensors-

UNIT II MICROPROCESSOR AND MICROCONTROLLER 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Simple programs using 8085-Addition, Subtraction-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, internal relays, shift register, Jump controls – 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 : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the Electronic controller and sensor technology.

CO2: Apply the basics of 8085 microprocessor and 8051 microcontroller.

CO3: Apply the basics of 8255 PPI and its operational modes.

CO4: Analyze the circuit using PLC Programming.

CO5: Analyze the factors considered for stepper and servo motorfor Mechatronics circuit design.

TEXT BOOKS

1. Bolton, “Mechatronics”, Prentice Hall, 2008
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2008.

REFERENCE BOOKS

1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013
3. DevadasShetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
4. Krishna Kant, “Microprocessors & Microcontrollers”, Prentice Hall of India, 2007.
5. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2007.

WEB REFERENCES

1. https://mechatronics.colostate.edu/resources/
2. https://www.javatpoint.com/programming-in-8085
3. https://circuitdigest.com/microcontroller-projects/keypad-interfacing-with-8051-microcontroller
4. https://circuitdigest.com/microcontroller-projects/interfacing-adc0808-with-8051-microcontroller

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112107298
2. https://www.tutorialspoint.com/microcontroller_interfacing_with_different_elements/index.asp
3. https://www.udemy.com/course/8085-microprocessor/
4. https://www.udemy.com/course/plc-programming-from-scratch/

21ME1702	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand aconceptual overview of coal based Power Plants with their principle components.
- To understand a conceptual overview of diesel, gas turbine and combined cycle Power Plants with their principle components.
- To identify the principle components of Nuclear Power Plants with their safety measures.
- To identify the principle components and the concepts in renewable energy.
- To identify the sustainability issues in environmental and economic aspects.

UNIT I COAL BASED THERMAL POWER PLANTS 9

Rankine cycle — improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants — Fuel and ash handling, Draught system, Feed water treatment and Binary Cycles. Cogeneration systems.

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual &Brayton Cycle — Analysis & Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV POWER FROM RENEWABLE ENERGY 9

Hydro Electric Power Plants — Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Ocean current power generation, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the principle layout, construction and working of thermal power plant.
CO2: Analyze the layout, construction and working of Diesel, Gas and Combined cycle power plants.
CO3: Apply the concepts of safety and disposal of materials in nuclear power plants.
CO4: Analyze the critical factors in selecting and usage of renewable energy sources.
CO5: Analyze the environmental hazards and estimate the costs of electrical energy production.

TEXT BOOKS

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing CompanyLtd., 2008.

REFERENCE BOOKS

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in associationwith the Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second
4. Edition, Standard Handbook of McGraw – Hill, 1998.
5. Domundwar, AroraDomkundwar., “Power Plant Engineering”, DhanpatRai&Co.,2016.

WEB REFERENCES

1. https://www.youtube.com/watch?v=iWWyI8CZhUw

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112107291

21ME1711	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To understand the software tools needed to analyze engineering problems.
- To understand and simulate the concepts of mechanisms using MAT lab.
- To identify the role of stress and vibrations in Mechanical components.
- To identify and understand the concepts of heat transfer for analysis of simple problems.

LIST OF EXPERIMENTS

A. SIMULATION No. of Hours : 20

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables.
2. Simulate the working principle of air conditioning system, hydraulic and pneumatic cylinder and cam follower mechanisms and simple problems in vibration using MATLAB.
3. Mechanism Simulation using Multi-body Dynamic software.

B. ANALYSIS No. of Hours :40

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axisymmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Simulate the working principle of air conditioning system, hydraulic and pneumatic cylinder and cam follower mechanisms using MATLAB.
CO2: Analyze the stresses and strains induced in plates, brackets and beams.
CO3: Analyze the stresses and strains induced in axisymmetric problems.
CO4: Analyze the stresses and strains induced in heat transfer problems.
CO5: Evaluate the natural frequency and mode shape analysis of 2D components and beams.

TEXT BOOKS

1. Rao V Dukkipati, "MatlabFor Mechanical Engineers by Rao V Dukkipati", New Age International (P) Ltd, 2007.
2. SaeedMoaveni, “Finite Element Analysis Theory And Application With ANSYS”, Pearson, 2011.
3. Kent Lawrence , “ANSYS Tutorial Release 2020”, SDC publications, 2020.
4. ErdoganMadenci, Ibrahim Guven. "The Finite Element Method and Applications in Engineering Using ANSYS", 2nd edition, Springer, 2015.

21ME1712	MECHATRONICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To understand the basic hydraulic circuits for actuator systems
- To understand the concepts of programming in microprocessor and its interfacing with other application.
- To identify and understand the concept of PLC for designing of automated systems.
- To understand and analyse the operations carried using 8085 microprocessor for various applications.

LIST OF EXPERIMENTS

1. Design and testing of fluid power circuits using hydraulic linear actuation system
2. Design of fluid power circuits using Electro pneumatic trainer kits.
3. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software.
4. Stepper motor interfacing with 8051 Micro controller
5. Computerized data logging system with control of flow in process
6. Computerized data logging system with control of pressure in process
7. Computerized data logging system with control of temperature in process.
8. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
9. Traffic light interface.
10. Speed control of DC motor using PID controller
11. Study of hydraulic, pneumatic and electro-pneumatic circuits.
12. Study of PLC and its applications.
13. Study of image processing technique.

TOTAL : 60 PERIODS

COURSE OUTCOME

CO1: Apply the concept of mechatronics in designing and modelling of basic electrical Systems.
CO2: Apply the concept of mechatronics in hydraulic Systems
CO3: Apply the concepts of pneumatic Systems to design a mechatronics system.
CO4: Apply the Programming concepts in 8085 microprocessor to perform basic arithmetic and logic functions.
CO5: Apply the functions of PLC with its industrial applications.

SEMESTER VIII

21ME1811	PROJECT WORK	L	T	P	C
		0	0	16	8

COURSE OBJECTIVE:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To provide students with opportunities to apply theoretical concepts in real-world situations.
- To promote teamwork, communication, and collaboration among students.
- To expose students to real-world challenges and situations, allowing them to experience industry-specific issues.
- To encourage students to consider the ethical implications and societal impact of their projects.

GUIDELINES FOR REVIEW AND EVALUATION

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

TOTAL :240 PERIODS

PROFESSIONAL ELECTIVES

21ME1901	SURFACE ENGINEERING AND TRIBOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide students with a comprehensive understanding of the fundamental principles of tribology, including the study of friction, wear, and lubrication mechanisms in engineering materials.
- To analyze different types of wear (abrasive, adhesive, corrosive, etc.) and their mechanisms, and to understand how these wear processes affect material performance in real-world applications.
- To examine the role of lubrication in reducing friction and wear, and to explore the types, properties, and selection criteria of lubricants used in different applications.
- To explore surface engineering techniques, such as coating, hardening, and other treatments, used to improve the wear resistance of materials.
- To investigate how the mechanical, thermal, and chemical properties of materials influence their tribological performance in contact situations.

UNIT - I SURFACES AND FRICTION 9

Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction Laws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and non-metals – Friction in extreme conditions – Thermal considerations in sliding contact.

UNIT - II WEAR 9

Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and non-metals – International standards in friction and wear measurements

UNIT - III CORROSION 9

Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT - IV SURFACE TREATMENTS 9

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy – Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

UNIT - V ENGINEERING MATERIALS 9

Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the principles of tribology, including friction, wear, and lubrication, to solve real-world engineering problems .

CO2: Analyze the different types of wear and their mechanisms, and assess the tribological behaviour of materials in different operational conditions.

CO3: Analyze the effects of corrosion on the mechanical properties and performance of materials.

CO4: Apply the theoretical concepts in designing of surface engineering solutions to improve the wear resistance and tribological performance.

CO5: Analyze the various Engineering materials employed in friction and wear applications

TEXT BOOKS

1. G.W. Stachowiak and A.W. Batchelor, “Engineering Tribology”, Butterworth-Heinemann, 2005.
2. S.K. Basu, S.N. Sengupta and B.B. Ahuja ,”Fundamentals of Tribology”, Prentice Hall of India, 2005.

REFERENCE BOOKS

1. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.
2. Halling, J. (Editor), “Principles of Tribology “, MacMillian, 1984.
3. Rabinowicz.E., “Friction and Wear of materials”, John Willey &Sons,1995.
4. Williams J.A., “Engineering Tribology”, Oxford University Press, 1994.
5. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000.

WEB REFERENCES

1. https://www.wiley.com/en-us/Materials+and+Surface+Engineering+in+Tribology-p-9781848210677
2. https://www.elsevier.com/books-and-journals/book-series/tribology-and-surface-engineering

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/surface-roughness-texture-and-tribology-full-course/
2. https://onlinecourses.nptel.ac.in/noc20_me68/preview
3. https://www.ntnu.edu/studies/courses/TMM4205/#tab=omEmnet

21ME1902	OPTIMIZATION TECHNIQUES IN ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide students with a solid foundation in the basic principles of optimization, including mathematical formulations, problem types, and solution strategies.
- To understand the fundamental principles and mathematical formulations of optimization problems in engineering.
- To teach students to apply classical optimization methods such as linear programming, nonlinear programming, and integer programming to solve engineering optimization problems.
- To provide students with hands-on experience in implementing optimization algorithms using modern computational tools to solve real-world engineering problems.

UNIT - I INTRODUCTION 9

Introduction to optimum design - General concepts of optimization – Problem formulation & their types– Classical optimization techniques - Single variable and multivariable optimization.

UNIT - II UNCONSTRAINED OPTIMIZATION TECHNIQUES 9

Techniques of unconstrained optimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT - III CONSTRAINED OPTIMIZATION TECHNIQUES 9

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions.

UNIT - IV UNCONVENTIONAL OPTIMIZATION TECHNIQUES 9

Genetic algorithms, Simulated Annealing and Ant Colony algorithm. Robust and dynamic optimization application.

UNIT - V MATERIAL AND PROCESSES IN DESIGN 9

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fundamental concepts of optimization and its relativity to the design process.
CO2: Apply the unconstrained methods in improving the solution finding process.
CO3: Apply the role of constrained methods and their various sub-divisions in problem solving.
CO4: Analysis of various unconventional optimization methods as an alternative methodology to traditional optimization methods.
CO5: Analyze the different optimization methods in various engineering applications.

TEXT BOOKS

1. Rao Singaresu.S, “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2009.
2. Kalyanamoy Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall of India Pvt. Ltd.,2006.

REFERENCE BOOKS

1. Johnson Ray C, “Optimum design of mechanical elements”, Wiley, John & Sons, Digitized 2007.
2. Goldberg.D.E, “Genetic algorithms in search, optimization and machine”, Barnen, AddisonWesley, New York, 1989.
3. Rao.C.S, “Optimization Techniques”, Dhanpat Rai & Sons, New Delhi
4. Fox.R.L, “Optimization methods for Engineering Design”, Addison Wesley Pub, Digitized 2007.
5. Garret N. Vanderplaats, “Numerical optimization techniques for engineering design: with applications”, McGraw-Hill Ryerson, Limited, Digitized 2007.

WEB REFERENCES

1. https://www.springer.com/journal/11081
2. https://www.tandfonline.com/journals/geno20
3. https://paperpile.com/s/engineering-optimization-citation-style/

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/optimization-for-engineering-students/
2. https://www.edx.org/course/mathematical-optimization-for-engineers
3. https://in.coursera.org/courses?query=optimization

21ME1903	DESIGN OF JIGS AND FIXTURES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To comprehend the uses and design concepts of jigs, fixtures, and press tools.
- To become proficient in the generation of needed perspectives of the overall design.
- To understand the fundamental principles and applications of jigs and fixtures in manufacturing processes.
- Todesign jigs and fixtures that ensures precision, safety, and efficiency in manufacturing operations.

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 PRESS WORKING TERMINOLOGIES AND 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 AND DRAWING DIES 9

Difference between bending 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 redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT - V FORMING TECHNIQUES AND EVALUATION 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

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fundamental principles and importance of jigs and fixtures in manufacturing processes.

CO2: Apply design principles to create efficient and cost-effective jigs and fixtures for specific machining operations.

CO3: Analyze the factors influencing the selection of materials and components for jigs and fixtures in press applications.

CO4: Analyze the distinction between bending and drawing dies in jig and fixture design.

CO5: Evaluate the performance of jigs and fixtures through forming and other machining process.

TEXT BOOKS

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H “Press tools - Design and Construction”, wheels publishing, 1996

REFERENCE BOOKS

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, 2017.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
5. Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.
6. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.

WEB REFERENCES

1. https://iopscience.iop.org/article/10.1088/1757-899X/551/1/012028/pdf
2. https://www.researchgate.net/publication/281006514_The_Design_and_Need_for_Jigs_and_Fixtures_in_Manufacturing

ONLINE COURSES / RESOURCES:

1. https://virtual-engineering.com/courses/course-on-jigs-fixture-design-theory-practical-design-exercises/
2. https://www.tvsts.com/jigsandfixtures
3. https://www.teacheron.com/online-jigs_and_fixtures_design-tutors

21ME1904	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts, types, and classifications of composite materials, including their properties and applications in engineering.
- To provide the different methods of manufacturing composites.
- To provide the mathematical equations.
- To analyse the various stresses involved in structural applications.

UNIT - I INTRODUCTION TO COMPOSITE MATERIALS 9

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites- Rule of mixtures - problems-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites.

UNIT - II MANUFACTURING OF COMPOSITES 9

Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquidstate,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) –hot pressing-reaction bonding process-infiltration technique, direct oxidation-interfaces

UNIT - III INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS 9

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates

UNIT - IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES 9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

UNIT - V THERMO-STRUCURAL ANALYSIS 9

Fabrication stresses/Residual stresses in FRP laminated composites- Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's -Stress and Moment Resultants due cooling of the laminates during fabrication-Calculations for thermo-mechanical stresses in

FRP laminates. Case studies: Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fundamental concepts of composite materials, including types, properties, and applications in various engineering fields.

CO2: Apply different manufacturing methods for developing the FRP and other composites.

CO3: Analyzing fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.

CO4: Evaluating the stresses in the lamina of the laminate using different failure theories.

CO5: Analyzing thermo-mechanical behavior and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.

TEXT BOOKS

1. Gibson R F, Principles of Composite Material Mechanics, McGraw-Hill, 1994, CRC press, 4th Edition, 2015.
2. Mallick PK, Fiber – Reinforced Composites: Materials, Manufacturing and Design, CRC Press, 3rdEdition, 2007.

REFERENCE BOOKS

1. Agarwal, B. D. and Broutman, L. J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 1990.

2. Halpin, J. C., “Primer on Composite Materials, Analysis”, Technomic Publishing Co., 1984.

3. Hyer M. W., and Scott R White, “Stress Analysis of Fiber – Reinforced Composite Materials”, McGraw-Hill, 1998.

WEB REFERENCES

1. https://onlinelibrary.wiley.com/doi/full/10.1002/9781118985960.meh110
2. https://www.elsevier.com/books/mechanics-of-composite-materials/sendeckyj/978-0-12-136502-8

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/composite-materials/
2. https://onlinecourses.nptel.ac.in/noc19_me67/preview
3. https://onlinecourses.nptel.ac.in/noc22_me40/preview

21ME1905	TESTING OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the codes & standards, and committees.
- To understand the various mechanical testing standards and instruments.
- To provide basic principles of non-destructive testing methods.
- To make the students to understand the characterization concepts in testing of materials.
- To identify the appropriate testing methods for materials.

UNIT I INTRODUCTION TO MATERIALS TESTING 9

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.

UNIT II MECHANICAL TESTING 9

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT III NON DESTRUCTIVE TESTING 9

Visual inspection, Liquid Penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT IV MATERIAL CHARACTERIZATION TESTING 9

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT V OTHER TESTING 9

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo-mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Introduction to mass spectrometry, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze d the principles, codes and standards in material testing.
CO2: Apply the mechanical testing methods for various materials.
CO3: Apply the concepts of non-destructive testing in material testing.

CO4: Analyze the material samples using a characterization technique such as SEM, TEM and spectroscopes

CO5: Analyze the thermal and chemical testing methods to identify the existence of a chemical compound in a material.

TEXT BOOKS

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Cullity, B. D., “Elements of X-ray diffraction”, 3rd Edition, Addison-Wesley Company Inc., New York, 2000.
3. P. Field Foster, “The Mechanical Testing of Metals and Alloys” 7th Edition, Cousens Press, 2007.

REFERENCE BOOKS

1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
2. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA.
3. Brandon D.G., “Modern Techniques in Metallography”, Von Nostrand Inc. NJ, USA, 1986.

WEB REFERENCES

1. https://webstore.ansi.org/industry/material-testing
2. https://nvlpubs.nist.gov/nistpubs/ir/2015/NIST.IR.8059.pdf
3. https://www.thermofisher.com/in/en/home/materials-science/learning-center/applications/sem-tem-difference.html
4. https://www.twi-global.com/technical-knowledge/faqs/what-is-non-destructive-testing#:~:text=Non%2Ddestructive%20testing%20(NDT),damage%20to%20the%20original%20part.
5. https://www.asnt.org/MajorSiteSections/About/Introduction_to_Nondestructive_Testing.aspx

ONLINE COURSES / RESOURCES:

1. https://www.classcentral.com/course/swayam-theory-and-practice-of-non-destructive-testing-
2. https://onlinecourses.nptel.ac.in/noc20_mm07/preview
3. https://www.twi-global.com/locations/india/courses/non-destructive-testing-online-live-courses
4. https://www.asminternational.org/news/industry/-/journal_content/56/10180/42035275/NEWS

21ME1906	DESIGN CONCEPTS IN ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts and terminology.
- To design mechanisms to create an effective product.
- To use scientific methods to provide design solutions.
- To find a solution by attributing human needs and providing a solution.
- To design with material selection, costing, and manufacturing principles in mind.

UNIT - I DESIGN TERMINOLOGY 9

Definition-various methods and forms of design-importance of product design-static and dynamic products-various design projects-morphology of design-requirements of a good design-concurrent engineering-computer aided engineering-codes and standards-product and process cycles-bench marking.

UNIT - II INTRODUCTION TO DESIGN PROCESSES 9

Basic modules in design process-scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem- information gathering - customer requirements- Quality Function Deployment (QFD)- product design specifications-generation of alternative solutions- Analysis and selection-Detail design and drawings

UNIT - III CREATIVITY IN DESIGN 9

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks-Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept mapTheory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts

UNIT - IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT 9

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects

UNIT - V MATERIAL AND PROCESSES IN DESIGN 9

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the various design requirements and get acquainted with the processes involved in product development

CO2: Apply the processes needed to create a product in a competitive market.

CO3: Apply the analytical tools and techniques, such as CAD and simulation, for evaluating design alternatives.

CO4: Analyze the safety, ethics, and sustainability considerations into the engineering design process.

CO5: Analyze the various materials and manufacturing processes in design.

TEXT BOOKS

1. Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.

REFERENCE BOOKS

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, “Integrated Product and Process Design and Development”, CRC Press, 2009.
3. James Garratt, “Design and Technology”, Cambridge University Press, 1996.
4. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, “Mechanical Engineering Design”, McGraw Hill Professional, 2003.
5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016..

WEB REFERENCES

1. https://lo.unisa.edu.au/mod/book/view.php?id=424249&chapterid=69972
2. https://www.d.umn.edu/itss/training/online/webdesign/books.html
3. https://www.sciencedirect.com/topics/materials-science/engineering-design

ONLINE COURSES / RESOURCES:

1. https://www.classcentral.com/course/edx-introduction-to-engineering-and-design-12329
2. https://www.careers360.com/courses-certifications/engineering-design-courses-brpg
3. https://www.edx.org/course/introduction-to-engineering-and-design

21ME1907	NOISE VIBRATION AND HARSHNESS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic principles of noise, vibration, and harshness (NVH) and their significance in engineering design and performance.
- To identify the sources and mechanisms of noise and vibration in mechanical and structural systems, and their effects on product quality.
- To apply NVH analysis techniques, including measurement tools and simulation methods, to evaluate noise and vibration behavior in engineering systems.
- To develop skills in designing and implementing control strategies for noise and vibration reduction in automotive, aerospace, and industrial applications.
- To assess the impact of NVH on comfort, safety, and regulatory compliance, and propose solutions to meet performance and environmental standards.

UNIT - I FUNDAMENTALS OF NOISE, VIBRATION, AND HARSHNESS 9

Theory of sound - Predictions and measurement, Sound sources, Sound propagation in the Atmosphere, Sound radiation from structures and their response to sound, Introduction to vibration, free and forced vibration, undamped and damped vibration, Vibration of simple discrete and continuous systems, Torsional vibration, Determination of natural frequencies., Definition of Harshness, Its effect and acceptable degree of Harshness,

UNIT - II VIBRATIONS MEASUREMENT TECHNIQUES AND CONTROL 9

Vibration measuring Instruments: Vibration pick-up, Types of transducers, Vibrometer for measurement of Frequency of vibrations, Period, Amplitude, Velocity and Acceleration parameters, Vibrations isolation, Different types of vibration absorber.

UNIT - III TRANSPORTATION NOISE AND VIBRATION - SOURCES, PREDICTION, AND CONTROL 9

Introduction to Transportation noise and vibration sources, Internal combustion engine noise prediction and control - Diesel, Exhaust and Intake noise and Acoustical design of mufflers, Tire/Road Noise - Generation, Measurement, and Abatement, Aerodynamic sound sources in vehicles - Prediction and Control, Transmission and Gearbox noise and vibration prediction and control, Brake noise prediction and control, Perception of Ride comfort

UNIT - IV INTERIOR TRANSPORTATION NOISE AND VIBRATION SOURCES - PREDICTION AND CONTROL 9

Introduction to Interior transportation noise and vibration sources, Automobile, Bus and Truck Interior noise and vibration prediction and control, Noise and Vibration in Off-Road vehicle Interiors - Prediction and control

UNIT - V NOISE AND VIBRATION ANALYSIS EQUIPMENT, SIGNAL PROCESSING, AND MEASURING TECHNIQUES 9

General Introduction to noise and vibration measuring equipment, Signal acquisition and processing, Acoustical transducer principles and Types of microphones, Sound level meters, Noise Dosimeters, Analyzers and signal generators, Equipment for data acquisition, Determination of sound power level and emission sound pressure level, Sound intensity measurements, Noise and vibration data analysis. Calibration of measurement microphones, Calibration of shock and vibration transducers, Metrology and traceability of vibration and shock measurements.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic concepts of noise and vibrations.

CO2: Dicuss the various techniques used to measure and control the automotive vibrations.

CO3: Apply the concepts and know its effects of transportation noise and its control techniques.

CO4: Analyze the effects of interior transportation noise and its control techniques

CO5: Analyze the processing of signal processing and measuring techniques in Automobiles.

TEXT BOOKS

1. David A.Bies and Colin H.Hansen, “Engineering Noise Control: Theory and Practice”, Spon Press, London, 2009.
2. Mathew Harrison, “Vehicle refinement Controlling Noise and vibration in road vehicles”, SAE International, Elsevier Butterworth-Heinemann, 2008.
3. Xu Wang, “Vehicle Noise and Vibration Refinement”, Woodhead Publishing Limited, 2010.

REFERENCE BOOKS

1. Allan G. Piersol, Thomas L. Paez, Harris, “Shock and Vibration Handbook”, McGraw-Hill, New Delhi, 2010.
2. Clarence W. de Silva, “Vibration Monitoring, Testing, and Instrumentation”, CRC Press, 2007.
3. Colin H Hansen, “Understanding Active Noise Cancellation”, Spon Press, London 2003.
4. Kewal Pujara, “Vibrations and Noise for Engineer”s, Dhanpat Rai & Sons, 1992.
5. Matthew Harrison, “Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles”, Elsevier Butterworth-Heinemann, Burlington, 2004.

WEB REFERENCES

1. https://link.springer.com/chapter/10.1007/978-94-007-0516-6_5
2. https://www.researchgate.net/publication/277705941_Drivetrain_Noise_Vibration_and_Harshness

ONLINE COURSES / RESOURCES:

1. https://umdearborn.edu/cecs/graduate-programs/certificates/automotive-noise-vibration-harshness-nvh
2. https://onlinecourses.nptel.ac.in/noc19_me72/preview
3. https://www.udemy.com/course/automotive-engineering-nvh-essentials/

21ME1908	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the key concepts, stages, and processes involved in the new product development lifecycle, from idea generation to commercialization.
- To analyse market needs, customer requirements, and competitor products to inform the development of innovative product concepts.
- To apply design thinking and creative problem-solving methodologies to generate and evaluate product ideas and prototypes.
- To evaluate the financial, technical, and strategic feasibility of new product ideas, ensuring alignment with organizational goals and market demands.

UNIT - I INTRODUCTION TO PRODUCT DEVELOPMENT 9

Introduction and design thinking - Tools for brainstorming - Customer need analysis and factor analysis

UNIT - II NETWORK EFFECT, STANDARDS AND PRODUCT SPECIFICATIONS 9

Product life cycle, innovation diffusion and crossing the chasm - Disruptive innovation and the innovator's dilemma - Network effects and standards - Product specifications

UNIT - III PRODUCT ARCHITECTURE AND PROTOTYPING 9

Product architecture and modularity - Mass customization and platforms - Agile development: Scrum; Kanban - Prototyping

UNIT - IV PRODUCT MARKETING 9

Forecasting and business case development - Marketing strategy and cluster analysis/ discriminant analysis - Pricing and conjoint analysis - Go to market plans

UNIT - V CONTEMPORARY TOPICS IN NPD 9

Open innovation; User innovation; Crowd sourcing; Free innovation - Continuous innovation and creating a culture of innovation

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the stages and processes involved in the new product development lifecycle, from concept to commercialization.
CO2: Analyze the concepts of networking effects, standards and specification of products.
CO3: Apply the concepts of mass manufacturing and customization in manufacturing of products.
CO4: Analyze the marketing strategies for development of ne products.
CO5: Analyze the innovation culture and sourcing concepts .

TEXT BOOKS

1. Ulrich, K. and Eppinger, S.; Product Design and Development; McGraw Hill; ISBN: 978-0-07- 802906-

REFERENCE BOOKS

1. Kelley, T.; The Art of Innovation; Doubleday; ISBN: 0-385-49984-1
2. Cross, N.; Design Thinking; Bloomsbury Academic; ISBN: 978-1-84-788636-1
3. Sutton, R.I.; Weird Ideas That Work; The Free Press; ISBN: 0-7432-1212-6
4. De Bono, E.; Lateral Thinking; Harper Perennial; ISBN: 978-0-06-090325-1
5. De Bono, E.; Five-Day Course in Thinking; Vermilion London; ISBN: 978-1-78-504086-3
6. Roth, B.; The Achievement Habit; Harper Collins; ISBN: 978-0-06-235610-9
7. von Hippel, E.; Free Innovation; The MIT Press; ISBN: 978-0-26-203521-7;
8. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866571
9. Christensen, C.M.; The Innovator's Dilemma; Harvard Business Review Press; ISBN: 978-1-63- 369178-0
10. Moore, G.A.; Crossing the Chasm; Harper Business; ISBN: 978-0-06-235394-8
11. Chesbrough, H. W.; Open Innovation; Harvard Business Review Press; ISBN: 978-1-42-210283-1
12. Blank, S. G.; The Four Steps to the Epiphany; K&S Ranch; ISBN: 978-0-98-920050-9
13. The Scrum Alliance; The Scrum Guide; Scrum.Org and Scrum Inc; https://www.scrumalliance.org/why-scrum/scrum-guide

WEB REFERENCES

1. https://hbr.org/1965/11/exploit-the-product-life-cycle
2. http://www.dw.com/en/network-effects-helped-facebook-win/a-40418818
3. https://www.fastcompany.com/3001702/rules-successful-skunk-works-projects

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/110104084

21ME1909	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand Gas and arc welding processes
- To understand resistance welding processes
- To apply solid state welding processes for suitable application.
- To apply modern welding processes for appropriate applications.
- To analyse different Weldability for different materials.

UNIT I GAS AND ARC WELDING PROCESSES 9

Introduction to metal joining processes-Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG and 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 9

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, Steels and other materials.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the fundamentals of gas and arc welding processes.
CO2: Analyze the fundamentals of resistance welding processes.
CO3: Apply the solid state the welding processes for suitable applications.
CO4: Apply the modern welding techniques for suitable applications.
CO5: Analyze the weldability for aluminium, steel and copper materials.

TEXT BOOKS

1. Little R.L., Welding and welding Technology, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2. 2.Parmer R.S., Welding Engineering and Technology, 1st Edition, Khanna Publishers, New Delhi, 2008.
3. Parmer R.S., Welding Processes and Technology, Khanna Publishers, New Delhi, 1992.

REFERENCE BOOKS

1. AWS- Welding Hand Book. 8th Edition. Vol- 2. Welding Process.
2. Christopher Davis. Laser Welding- Practical Guide. Jaico Publishing House.
3. Davis A.C., The Science and Practice of Welding, Cambridge University Press, Cambridge, 1993.

WEB REFERENCES

1. https://ewi.org/
2. https://awo.aws.org/category/resource-library/podcast/
3. https://theweldinginstitute.com/

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_mm01/preview
2. https://www.tpctraining.com/collections/welding-training-courses
3. https://www.aws.org/education/onlinecourses

21ME1910	MODERN MACHINING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand non-traditional metal removal processes.
- To understand thermal and electrical energy based metal cutting processes
- To apply chemical and electro-chemical metal removal processes suitable applications.
- To apply Modern finishing processes for suitable applications.
- To analyse process parameters and capabilities for different unconventional machining processes.

UNIT - I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Unconventional machining Process – Need – classification – merits, demerits and applications- Material removal in traditional and non-traditional machining process - considerations in process selection.

Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – Effect of process parameters - MRR- Applications, Limitation and case studies

UNIT - II THERMAL AND ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM), Working principle, Pulse generator circuit – RC and Controlled pulse generator – Analysis of RC circuit - Selection of process parameters, tool electrode, dielectric fluid, Machining characteristics of spark eroded surface – Recent development in EDM process - Wire Electrical discharge machining (WEDM) – working principle, process variables, characteristics, applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM), Electron Beam Machining (EBM) and Ion beam machining(IBM). Principles – Equipment –Types - Beam controltechniques – Applications.

UNIT - III CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR- Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process ParametersECG and ECH - Advantages, limitations and applications.

UNIT - IV ADVANCED NANO-FINISHING PROCESSES 9

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, Mechanism of material removal (word alteration), applications, advantages and limitations.

UNIT - V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, Process capabilities and applications. Selection and comparison of different non-traditional machining processes.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the Mechanical energy based non-traditional machining processes.
CO2: Analyze the process parameters of thermal and electrical energy based machining processes.
CO3: Apply chemical and electro-chemical machining processes for suitable applications.
CO4: Apply nano-finishing processes for suitable applications.
CO5: Analyse limitations of various unconventional machining processes.

TEXT BOOKS

1. VK Jain, “Advanced machining processes”, Allied publishers, New Delhi,2005.
2. Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, India, 2019.
3. P Pandey and H Shan, Modern Machining Processes, McGraw Hill Education, 2017.

REFERENCE BOOKS

1. M. Adithan, “Unconventional Machining Processes” -Atlantic, New Delhi, India, 2014.
2. McGeough, J. A, “Advanced Methods of Machining” Springer publisher; 1988
3. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., “Hybrid Machining Processes: Perspectives on Machining and Finishing”, 1st edition, Springer International Publishing., Switzerland, 2016.
4. H. El-Hofy, Fundamentals of Machining Processes: conventional and non-conventional, 2ndedition, CRC press, Taylor & Francis group, 2014.
5. Jagadeesha T., “Non-Traditional Machining Processes”, I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017

WEB REFERENCES

1. https://www.udemy.com/course/non-conventional-machining-processes/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112103202
2. https://onlinecourses.nptel.ac.in/noc22_me119/preview
3. https://www.udemy.com/course/non-conventional-machining-processes

21ME1911	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand fundamental principles of fluid Power systems.
- To understand actuators and control components of hydraulic system.
- To apply elements of fluid power system for designing Mechanical and hydraulic servo system.
- To apply elements of fluid power for designing pneumatic and electro- pneumatic system.
- To analyse the hydraulic and pneumatic servo systems for automation.

UNIT - I FLUID POWER PRINICIPLES 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 – Problems.

UNIT - II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Rodless Cylinder, Application, Hydraulic cushioning –Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Case studies - Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems in Actuators.

UNIT - III DESIGN OF HYDRAULIC CIRCUITS 9

Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Accumulator - Construction and Applications, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed-Control, Sizing of hydraulic systems, Hydrostatic transmission, Electro-hydraulic circuits – Servo and Proportional valves – Applications-Mechanical and 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 Circuit.

UNIT - V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids

Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications, Automatic Reciprocation of Cylinders using Limit Switches /Pressure Valve.

Design of Pneumatic circuits for metal working, Material handling, Clamping, Counter and Timer circuits - Low-cost Automation – Hydraulic and Pneumatic power packs.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fluid power principles in hydraulic pumps.
CO2: Understand the basics elements of fluid power systems
CO3: Apply the functional blocks of fluid power systems for designing closed loop Mechanical and hydraulic system.
CO4: Apply the functional blocks of fluid power systems for designing closed loop pneumatic and electro-pneumatic system.
CO5: Analyse automated hydraulic and pneumatic systems.

TEXT BOOKS

1. Srinivasan. R., Hydraulic and Pneumatic Control, Tata McGraw-Hill Education, 2012.
2. Shanmugasundaram.K. “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.

REFERENCE BOOKS

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, 7th edition, 2009.
2. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw-Hill, 2001.
3. Majumdar, S.R., Pneumatic Systems-Principles and Maintenance, Tata McGraw-Hill, 2007.
4. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
5. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997.

WEB REFERENCES

1. Hydraulics and Pneumatics. A Technician's and Engineer's Guide, https://doi.org/10.1016/C2009-0-64113-1

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/112/106/112106300/
2. https://www.udemy.com/course/hydraulic-systems-_-english/
3. https://www.udemy.com/course/industrial-pneumatics-basics/
4. https://www.udemy.com/course/zero-automation-fluidsim/
5. https://www.coursera.org/learn/fluid-power

21ME1912	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand significance of Additive manufacturing for various industries.
- To understand material extrusion and sheet lamination techniques for manufacturing.
- To apply photo polymerization and powder bed fusion for suitable applications.
- To apply jetting and direct energy deposition process for suitable applications.
- To analyze the design of additive manufacturing process for applications.

UNIT I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications in various industries -Benefits –Case studies.

UNIT II MATERIAL EXTRUSION AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM - Principle – Process - Materials – Advantages and Limitations - Applications – Bio extrusion. Sheet Lamination Process: LOM- Gluing or Adhesive bonding – Thermal bonding - Principle – Process - Materials – Advantages and Limitations - Applications – Case studies.

UNIT III VAT PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Vat Photo polymerization: SLA – Principle – Process - Photo curable Materials – Advantages and Limitations - Applications. Powder Bed Fusion: SLS – Principle – Process - Materials – Advantages and Limitations - Applications. Electron Beam Melting – Principle – Process - Materials – Advantages and Limitations - Applications - Case studies.

UNIT IV JETTING PROCESSES AND DIRECT ENERGY DEPOSITION PROCESSES 9

Material Jetting - Principle – Process - Materials – Droplet formation technologies : Continuous mode – Drop on Demand mode - Advantages and Limitations - Applications. Binder Jetting Principle – Process - Materials – Advantages and Limitations - Applications - Bio-plotter - Direct Energy Deposition Process: LENS - Principle – Process - Materials – Advantages and Limitations - Applications – Case studies.

UNIT V DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation - Design for Additive Manufacturing: Concepts and objectives - AM unique capabilities – DFAM for part quality improvement- Customized design and fabrication for medical applications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Evaluate the need and development of additive manufacturing technology for various industries.
CO2: Analyze the material extrusion and sheet lamination techniques for manufacturing
CO3: Apply photo polymerization and powder bed fusion for suitable applications.
CO4: Apply jetting and direct energy deposition process for suitable applications.
CO5: Analyse the additive manufacturing tools and procedures for the medical application.

TEXT BOOKS

1. Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing" Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.

REFERENCE BOOKS

1. Andreas Gebhardt "Understanding Additive Manufacturing: Rapid Prototyping, RapidManufacturing" Hanser Gardner Publication 2011.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
4. Tom Page "Design for Additive Manufacturing" LAP Lambert Academic Publishing, 2012.

WEB REFERENCES

1. https://home.iitk.ac.in/~nsinha/Additive_Manufacturing%20I.pdf
2. https://www.youtube.com/watch?v=t7yv4gSnNkE&list=PLwdnzlV3ogoWI8QEu4hsT-n_r8UbWbquy

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/specializations/3d-printing-additive manufacturing
2. https://www.coursera.org/learn/additive-manufacturing-3d-printing
3. https://unacademy.com/course/complete-course-on-additive-manufacturing-and-powder-metallurgy/X0KPO4SE

21ME1913	AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand principles and degree of automation in manufacturing systems.
- To understand supervision of automated manufacturing system
- To apply line balancing techniques for automated production system.
- To apply programmed supervision basics for automated production system.
- To analyze the automation levels in materials handling and storage system

UNIT I MANUFACTURING OPERATIONS 9

Automation in production systems - principles and strategies - Product/production relationships - Production concepts and mathematical models - manufacturing economics - Advanced Automation Functions, Levels of Automations

UNIT II CONTROL TECHNOLOGIES 9

Automated systems – elements, functions, levels, Continuous Vs discrete control, Computer process control, Sensors, Actuators, ADC, DAC, Programmable logic controllers – ladder logic diagrams.

UNIT III TRANSFER LINES 9

Automated production lines – applications, Analysis – with and without buffers, automated assembly systems, line unbalancing concept.

UNIT IV NUMERICAL CONTROL AND ROBOTICS 9

NC - CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications –End effectors – Industrial applications.

UNIT V AUTOMATED HANDLING AND STORAGE 9

Automated guided vehicle systems, AS/RS, Carousel storage, Automatic data capture - Bar code technology - Cellular manufacturing.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basics and levels of automation in automation manufacturing systems.
CO2: Analyze the d control elements of automated manufacturing system
CO3: Apply line balancing techniques for automated production system.
CO4: Apply CNC programming control techniques for industrial robots.
CO5: Analyse the materials handling and storage using AGV.

TEXT BOOKS

1. Mikell P.Groover, Automation, “Production Systems and Computer Integrated Manufacturing” PHI, 2008.

REFERENCE BOOKS

1. Mikell P.Groover, Emory W. Zimmers, Jr., “CAD/CAM: Computer - Aided Design and Manufacturing”, PHI, 2007.
2. Roger S.Pressman and John Ernest wiliams, “Numerical Control and Computer Aided Manufacturing”,John wiley& sons,1977.

WEB REFERENCES

1. https://www.productivity.com/benefits-of-automation/
2. https://blog.wesco.com/why-automation-in-manufacturing-is-good-for-business
3. https://www.britannica.com/technology/automation/Advantages-and-disadvantages-of-automation
4. https://www.techtarget.com/whatis/definition/industrial-automation
5. https://www.usccg.com/blog/5-ways-automation-is-changing-manufacturing-today/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112104288
2. https://youtu.be/LzMfq5RjYjM
3. https://www.machinemetrics.com/blog/automation-in-manufacturing
4. https://roboticsandautomationnews.com/2021/09/10/automation-in-manufacturing-what-you-need-to-know/46243/https://nividous.com/blogs/rpa-in-manufacturing-industry

21ME1914	DIGITAL MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand concept and components of digital manufacturing systems.
- To understand data analytics in product management system.
- To apply real-time performance measurement technology in production system.
- To apply eco-friendly manufacturing concepts.
- To analyze scope of industry 4.0 in production system.

UNIT I SENSORS SMART MANUFACTURING 9

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors.

UNIT II DATA ANALYTICS 9

Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL). Advances in data visualization & related tools-Statistical Techniques for Analytics, Descriptive Statistics Inferential statistics, Regression and ANOVA

UNIT III CYBER PHYSICAL SYSTEMS & IOT 9

Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS

Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

UNIT IV GREEN MANUFACTURING & E- MANUFACTURING 9

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing. World energy consumption – Greenhouse effect, Global warming. Energy conservation and measurement principles with their applicability in engineering and process industries.

Introduction of Agent based manufacturing- Difference between green manufacturing and E manufacturing. Agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing and E-manufacturing.

UNIT V INDUSTRY 4.0 9

Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies. Industry 5.0

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basics and significance of smart sensor in digital manufacturing
CO2: Analyze the ERP and PLM tools of management system.
CO3: Apply cyber physical system and IOT for production system.
CO4: Apply green manufacturing and E-manufacturing concepts in production system
CO5: Analysis opportunities and challenges in industries 4.0

TEXT BOOKS

1. Bahga and V. Madisetti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515.
2. Bahga and V. Madisetti, Cloud Computing, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2013, ISBN: 978-1494435141.
3. M. Skilton and F. Hovsepian, The 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017, ISBN: 978-3-319-62479-2.
4. M. P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing" Pearson Education, 4th Edition, 2016, ISBN: 978-0133499612.
5. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas and G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2017 ISBN: 978-1259006210 .
6. Yingfeng Zhang and Fei Tao, "Optimization of Manufacturing Systems Using the Internet of Things

REFERENCE BOOKS

1. Gilchirst, Industry 4.0: The Industrial Internet of Things, Apress (Springer), 1st Edition, 2016, ISBN: 978-1-4842-2046-7.
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580.
3. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.
4. N. Viswanandham, Y. Narhari "Performance Modeling of Automated Manufacturing Systems" Prentice-Hall, 1st Edition, 1994, ISBN: 978-8120308701.
5. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2nd Edition, ISBN: 978-9332902800.
6. Rao P.N., "CAD/CAM", 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2012, ISBN-13: 978-0070681934.
7. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013

WEB REFERENCES

1. https://openlibrary.org/search?q=DYNAMICS+OF+MACHINES&mode=everything
2. https://openlibrary.org/search?q=THEORY+OF+MACHINES&mode=everything
3. https://1lib.in/s/Dynamics%20of%20Machines

ONLINE COURSES / RESOURCES:

1. https://www.youtube.com/watch?v=YHyBy9WXnwo
2. https://www.youtube.com/watch?v=mEhzsuDltsE

21ME1915	INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand basics of industrial robots
- To understand mechanics of robot motion
- To apply robots fundamental for design of end effector and selection of robot
- To apply image processing techniques for robot vision system
- To analyse the capabilities of robots for various industrial applications

UNIT I INTRODUCTION 9

Types of industrial robots – Load handling capacity -general considerations in Robotic material handling – material transfer – machine loading and unloading – CNC machine tool loading – Robot centered cell.

UNIT II MECHANICS OF ROBOT MOTION 9

Translational and rotational velocities - Velocity Transformations - The Manipulator Jacobian - Forward and inverse kinematics of velocity - Singularities of robot motion.

UNIT III END EFFECTORS 9

Gripper force analysis and gripper design - design of multiple degrees of freedom - active and passive grippers. SELECTION OF ROBOT: Factors influencing the choice of a robot - robot performance testing -economics of robotization, Impact of robot on industry and society.

UNIT IV ROBOTS FOR INSPECTION 9

Robotic vision systems –image representation –object recognition and categorization – depth measurement – image data compression - visual inspection –software considerations.

UNIT V OTHER APPLICATIONS 9

Application of Robots in continuous arc welding - Spot welding - Spray painting - assembly operation –cleaning – robot for under water applications.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the fundamental concepts of robots and consideration of robots in materials handling

CO2: Analyze the kinematics of industrial robots

CO3: Apply fundamental and kinematics of robot for design of gripper and selection of robot for suitable applications.

CO4: Apply object recognition techniques for robot vision system.

CO5: Analyse the limitations of robots in industrial applications.

TEXT BOOKS

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, “Robotic Engineering – An integrated Approach” Prentice Hall India, New Delhi, 2001.
2. Mikell P. Groover,”Automation, Production Systems, and Computer Integrated Manufacturing“, 2nd Edition, John Wiley & sons, Inc, 2007

REFERENCE BOOKS

1. James A Rehg, “Introduction to Robotics in CIM Systems”, Prentice Hall of India,2002.
2. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994
3. S.K. Saha, “Introduction to Robotics”, Tata McGraw-Hill, 2014.
4. A. Ghosal, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press, 2009.

WEB REFERENCES

1. https://education.vex.com/stemlabs/workcell/stemlab/industrial-robotics/what-are-industrial-robots?lng=en
2. https://www.mhi.org/fundamentals/robots
3. https://link.springer.com/referenceworkentry/10.1007/978-3-540-30301-5_43
4. https://robotsdoneright.com/Articles/what-is-an-industrial-robot.html
5. https://ifr.org/industrial-robots

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105249 - Robotics
2. https://www.emerald.com/insight/publication/issn/0143-991x
3. https://www.automate.org/robotics

21ME1916	NANO TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand fundamentals of nano-technology and its constituents.
- To understand fabrications and characterization of nanomaterial.
- To apply microscopic techniques for nano materials properties measurement.
- To apply basics of nano materials to know nanostructures for various applications.
- To analyse the capabilities of nano technology for various applications.

UNIT - I INTRODUCTION TO NANOTECHNOLOGY 9

Basic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, size, and shape of nanoparticles - one-dimensional and two dimensional nanostructures - clusters of metals and semiconductors, bio nano-particles.

UNIT - II FABRICATION AND CHARACTERIZATION OF NANOMATERIALS 9

Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes) - Gas, liquid, and solid–phase synthesis of nano-materials - Lithography techniques (Photolithography, Dip-pen and Electron beam lithography) - Thin film deposition - Electrospinning - Bio-synthesis of nanomaterials.

UNIT - III PROPERTIES AND MEASUREMENT OF NANOMATERIALS 9

Optical Properties: Absorption, Fluorescence, and Resonance - Methods for the measurement of nanomaterials - Microscopy measurements: SEM, TEM, AFM and STM - Confocal and TIRF imaging.

UNIT - IV NANO STRUCTURES 9

Carbon Nanotubes - Fullerenes - Nanowires - Quantum Dots - Applications of nanostructures - Reinforcement in Ceramics - Drug delivery - Giant magneto-resistance - Cells response to Nanostructures.

UNIT - V APPLICATIONS OF NANOTECHNOLOGY 9

Nano electronics - Nano sensors - Nanotechnology in Diagnostics applications - Environmental and Agricultural Applications of nanotechnology - Nano technology for energy systems - Nanotechnology and AI integration.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the fundamental characteristics of Nano materials

CO2: Apply the lithographic synthesis and biosynthesis techniques for nanomaterial fabrication.

CO3: Apply SEM, TEM, AFM, STM and TIRF imaging techniques for nanomaterials properties measurement.

CO4: Apply fundamentals of nano materials to know nanostructures for various applications

CO5: Analyse the potentials of nanotechnology to energy and agricultural systems.

TEXT BOOKS

1. Springer Handbook of Nanotechnology by Bharat Bhushan 2004.
2. Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004.

REFERENCE BOOKS

1. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects,D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.
3. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.

WEB REFERENCES

1. https://physicsworld.com/c/materials/nanomaterials/
2. https://www.sciencedirect.com/journal/nano-today
3. https://www.rsc.org/journals-books-databases/about-journals/nanoscale-horizons/
4. https://www.sciencedaily.com/news/matter_energy/nanotechnology/
5. https://www.nanowerk.com/
6. https://iopscience.iop.org/article/10.1088/0957-4484/24/45/452002

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/topic/nanotechnology/
2. https://www.edx.org/learn/nanotechnology
3. https://www.coursera.org/courses?query=nanotechnology
4. https://onlinecourses.nptel.ac.in/noc19_mm21/preview
5. https://coursesity.com/free-tutorials-learn/nanotechnology

21ME1917	RENEWABLE ENERGY RESOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand radiation and its environmental impact to power.
- To understand various collectors used for storing solar energy.
- To apply solar heating and cooling techniques in various applications.
- To apply wind energy and biomass and its economic aspects in various application
- To analyse the geothermal energy with other energy sources

UNIT - I PRINCIPLES OF SOLAR RADIATION 10

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT - II SOLAR ENERGY COLLECTION 8

Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications. Recent advancements in solar power generation. Photovoltaic Devices and Systems. Types and usage of photovoltaic systems.

UNIT – III SOLAR ENERGY STORAGE AND APPLICATIONS 8

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications - solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion

UNIT - IV WIND AND BIO ENERGY 10

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C-Engine operation and economic aspects.

UNIT - V OCEAN AND GEOTHERMAL ENERGY 9

Wave Energy - Tidal energy –OTEC - site selection, construction, environmental issues. Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications- Environmental impact.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the solar power radiation and their characteristics.
CO2: Analyze the Flat plate and concentrating collectors and their classifications.
CO3: Apply Sensible, latent heat to stratified storage, solar ponds photo voltaic energy conversion.
CO4: Analyze the performance characteristics of windmill and Bio-gas application.
CO5: Analyze the OTEC and Geothermal energy.

TEXT BOOKS

1. Rai G.D., “Non-Conventional Energy Sources”, Khanna Publishers, 2011.
2. 2. Ramesh R & Kumar K.U, “Renewable Energy Technologies”,Narosa Publishing House, 2004.

REFERENCE BOOKS

1. Tiwari and Ghosal, “Renewable energy resources”, Narosa Publishing House, 2007.
2. Twidell&Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis), 2011.
3. Mittal K M, “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd, New Delhi, 2003.
4. Kothari D.P, Singhal ., K.C., “Renewable energy sources and emerging technologies”, P.H.I, New Delhi.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc21_ch11/preview
2. https://archive.nptel.ac.in/courses/103/103/103103206/

ONLINE COURSES / RESOURCES:

1. https://www.pdfdrive.com/non-conventional-energy-systems-nptel-e17376903.html.
2. https://www.iitr.ac.in/wfw/web_ua_water_for_welfare/education/proceeding_of_shortterm_training/diploma/hydropower_dev_engg_elec/lecture_notes/LECTURE_ON_RENEWABLE_ENERGY_SOURCES.pdf.
3. http://digimat.in/nptel/courses/video/103103206/L01.html..
4. https://onlinecourses.nptel.ac.in/noc20_ge06/preview.

21ME1918	ENERGY CONSERVATION AND WASTE HEAT RECOVERY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concept of energy conservations.
- To understand energy techniques subjected to buildings.
- To apply steam properties for assessment of energy savings in energy conservation systems.
- To analyze energy storage system in conventional and non-conventional energy system.
- To analyze source and applications of waste heat recovery system.

UNIT - I INTRODUCTION TO ENERGY CONSERVATION 9

Introduction to ENCON, Approach and modern techniques, benefits, trends. Energy Conservation Technology (Thermal Energy).Energy Conservation in Energy Intensive Industries. Techno-Economic evaluation of conservation technologies, Efficiency Improvements Thermal Utilities: Boilers, Steam System, Thermic Fluid Heating Systems, Furnaces, Heating and Melting Applications.

UNIT - II ENERGY EFFICIENT USED IN BUILDINGS 9

Introduction, Definition and concepts, Energy and Water as a resource, Criticality of resources and needs of modern living. Envelop heat loss and heat gain and its evaluation, Thermal Comport improvement methods, Optimum performance, other building comports, IAQ requirements, Electrical Energy Conservation, Opportunities and Techniques for energy conservation in Buildings. Adoption to sustainable resources, process and Technologies. Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture.

UNIT - III ENERGY CONSERVATION AND ITS EFFICIENCY 9

Thermic fluid heaters, super critical boilers; Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Steam utilization, Performance assessment more details, installation, thermo-compressor, steam pipe insulation, condensate pumping, steam dryers; Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

UNIT - IV NEED FOR ENERGY STORAGE 9

Need and importance of Energy storage in Conventional and Nonconventional Energy Systems. Technical Aspects (Measurements, Quantify) various forms of Energy Storage: Thermal, Chemical, Mechanical, Electrical and Nuclear Techno Commercial Analysis (Economical aspects), Energy Storage: Devices and Systems.

UNIT - V WASTE HEAT RECOVERY 9

Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential. Sources of waste heat and its potential applications, Waste heat survey and measurements, Data collection, Limitations and affecting. Cogeneration: Definition, need, application, advantages, classification, saving potentials. Heat balance, steam turbine efficiency, tri-generation, micro turbine.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the thermal heating systems.
CO2: Analyze the heat and heat gain in energy buildings.
CO3: Apply the energy saving opportunities in various thermal system
CO4: Analyze energy storage forms in conventional and non-conventional energy system
CO5: Aanalyze opportunities for waste heat recovery in economic aspect

TEXT BOOKS

1. Eastop T.D and Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific and Technical, 1990.
2. 2. Reay D.A, “Industrial Energy Conservation”, Pergamon Press, 1979.

REFERENCE BOOKS

1. Openshaw Taylor E, "Utilisation of Electric Energy", Orient Longman Ltd, 2003.
2. Donald R Wulfinghoff, “Energy Efficiency Manual”, Energy Institute Press, 1999.
3. Energy Audit Manual- The Practitioner’s Guide, EMC-Kerala and NPC 2017.
4. Bureau of Energy Efficiency -Energy Management Series, 2006.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc19_me60/preview/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105221L

21ME1919	NUCLEAR ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the microscopic approach of atom for nuclear model.
- To understand the characteristics of nuclear materials and its mechanism.
- To apply nuclear fuel cycles for fuel utilization characteristics.
- To analyze heat transfer in nuclear reactor.
- To analyze safety system in nuclear plant.

UNIT - I NUCLEAR PHYSICS 9

Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-halflife-neutron interactions-cross sections.

UNIT - II NUCLEAR REACTIONS AND REACTION MATERIALS 9

Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass andcomposition-nuclear fuel cycles and its characteristics-uranium production andpurification-Zirconium, thorium, beryllium.

UNIT - III REPROCESSING 9

Reprocessing: nuclear fuel cycles-spent fuel characteristics-role of solvent extraction inreprocessing-solvent extraction equipment.

UNIT - IV NUCLEAR REACTOR 9

Nuclear reactors: types of fast breeding reactors-design and construction of fast breeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusionreactors.

UNIT - V SAFETY AND DISPOSAL 9

Safety and disposal: Nuclear plant safety-safety systems-changes and consequences ofaccident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic concepts about nuclear physics.
CO2: Analyze the nuclear materials properties and its mechanisms
CO3: Apply nuclear fuel cycles for reprocessing the nuclear waste
CO4: Analyze heat transfer techniques in fast breeding nuclear reactors
CO5: Analyze criterions for safety system in nuclear power plant

TEXT BOOKS

1. Thomas J.Cannoly, “Fundamentals of nuclear Engineering” John Wiley 1978.
2. Collier J.G., and Hewitt G.F, “Introduction to Nuclear power”, Hemisphere86 publishing, New York. 1987

REFERENCE BOOKS

1. Irving Kaplan, “Nuclear Physics”, Narosa Book Distributors, 2002.
2. R.D. Evans, “The atomic Nucleus”, McGraw-Hill,1955.
3. D.C.Tayal, Nuclear Physics, Himalayan Publication house, Bombay ,1980.
4. J.H.Horlock ,”Combined Power Plants” ,Pergamon Press, 1992.
5. Wakil M.M.El., “Power Plant Technology” – McGraw-Hill International, 1984.

WEB REFERENCES

1. https://learningpath.org/articles/Free_Online_Nuclear_Engineering_Courses_from_Top_Universities.htmlttps://learningpath.org/articles/Free_Online_Nuclear_Engineering_Courses_from_Top_Universities.html.
2. https://www.classcentral.com/course/nuclearscience-479.

ONLINE COURSES / RESOURCES:

1. https://www.coursearena.io/topic/free-nuclear-engineering-courses

21ME1920	TURBO MACHINERY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various system, principles, operations and applications of different types of turbo machinery component.
- To understand the design parameters and flow analysis of centrifugal fans and blowers
- To analyze the performance of ccentrifugal compressors
- To analyze the performance of axial flow compressors
- To analyze performance of axial and radial flow turbines

UNIT - I PRINCIPLES 9

Energy transfer between fluid and rotor-classification of fluid machinery,-dimensionless parameters-specific speed-applications-stage velocity triangles-work and efficiency.

UNIT - II CENTRIFUGAL FANS AND BLOWERS 9

Types- stage and design parameters-flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise.

UNIT - III CENTRIFUGAL COMPRESSOR 9

Construction details, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.

UNIT - IV AXIAL FLOW COMPRESSOR 9

Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done simple stage design problems and performance characteristics. Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

UNIT - V AXIAL AND RADIAL FLOW TURBINES 9

Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics. Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic principles applied in fluid machinery.
CO2: Analyze the centrifugal fans, and blowers design aspects
CO3: Analyze the performance of centrifugal compressors
CO4: Analyze the performance of axial flow compressor
CO5: Analyze the performance of axial and radial flow turbines

TEXT BOOKS

1. Yahya, S.H., Turbines, Compressor and Fans, Tata McGraw Hill Publishing Company, 1996.
2. Dixon S.L, “Fluid Mechanics & Thermodynamics of Turbo machines”, Elsevier (2005).
3. 3. Kadambi. V and Manohar Prasad, “An Introduction to Energy Conversion”, Volume III Turbo machinery, New International Publishes reprint (2008).

REFERENCE BOOKS

1. Bruneck, Fans, Pergamom Press, 1973.
2. Earl Logan, Jr., Hand book of Turbomachinery, Marcel Dekker Inc., 1992..
3. Shepherd, D.G., Principles of Turbomachinery, Macmillan, 1969.
4. Stepanpff, A.J., Blowers and Pumps, John Wiley and Sons Inc. 1965.
5. Ganesan, V., Gas Turbines, Tata McGraw Hill Pub. Co., 1999.
6. Gopalakrishnan .G and Prithvi Raj .D, A Treatise on Turbo machines, Scifech Publications (India) Pvt. Ltd., 2002.

WEB REFERENCES

1. https://bmsit.ac.in/public/assets/pdf/mech/studymaterial/18ME54%20-%20Keerthi%20Kumar.pdf
2. https://backbencher.club/turbo-machines/

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/112/106/112106303/
2. https://nptel.ac.in/courses/112106200

21ME1921	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand basics of compressible fluid flow.
- To understand the compressible fluid flow with heat transfer through ducts
- To apply governing equations of compressible flow across shock waves
- To apply the jet propulsion theory across various turbo machinery
- To analyze performance of space propulsion system.

(Use of Standard Gas Tables permitted)

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 ofrocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the compressible isentropic fluid flow
CO2: Analyze the compressible fluid flow with heat transfer through constant area duct.
CO3: Apply the governing equations in normal and oblique shock waves
CO4: Apply the jet propulsion theory in turbojet, ramjet, turbofan and turboprop engine
CO5: Aanalyze the performance of space propulsion system

TEXT BOOKS

1. Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2012.
2. Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, 2002.
3. Balachandran. P., "Fundamentals of Compressible Fluid Dynamics",. PHI; 1st edition January 2006.

REFERENCE BOOKS

1. Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd.,1980
2. Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., 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, 1970.
6. Rathakrishnan E., "Gas Dynamics", PHI; 7th edition February 2017.

WEB REFERENCES

1. https://www3.nd.edu/~powers/ame.30332/notes.pdf
2. https://www.iare.ac.in/sites/default/files/PPT/AD%20II%20PPT.pdf
3. https://www.brainkart.com/article/Concept-of-Gas-Dynamics_5082/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112106196
2. https://nptel.ac.in/courses/112106166
3. https://nptel.ac.in/courses/101106044

21ME1922	SOLAR ENERGY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the solar radiation and various solar collectors.
- To understand the various solar thermal energy technologies and their applications.
- To understand the basics of solar PV cell
- To apply the solar PV design in solar array system.
- To analyze solar passive characteristics in heating and cooling system

UNIT - I SOLAR RADIATION AND COLLECTORS **9**

Solar angles – Sun path diagrams – Radiation – extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - testing methods evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

UNIT - II SOLAR THERMAL TECHNOLOGIES **9**

Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – Solar cooker : domestic, community – Solar pond – Solar drying-solar chimney-solar thermal electricity conversion.

UNIT - III SOLAR PV FUNDAMENTALS **9**

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetero junctions - metal-semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature - efficiency measurements - high efficiency cells – Solar thermo-photo voltaics.

UNIT - IV SPV SYSTEM DESIGN AND APPLICATIONS **9**

Solar cell array system analysis and performance prediction- Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - centralized and decentralized SPV systems - standalone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV.

UNIT - V SOLAR PASSIVE ARCHITECTURE **9**

Thermal comfort - bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling – Radiative cooling- application of wind, water and earth for cooling; shading - paints and cavity walls for cooling – roof radiation traps - earth air-tunnel – energy efficient landscape design - thermal comfort

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic of solar radiation and various solar collectors.
CO2: Analyze the various solar thermal energy technologies and their applications.
CO3: Analyze the basics of solar PV cell.
CO4: Apply the PV cell design in grid connected array system.
CO5: Analyze solar passive heating and cooling techniques for buildings.

TEXT BOOKS

1. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
2. Twidell, J.W. & Weir, A., “Renewable Energy Resources”, EFN Spon Ltd., UK, 2015.
3. Sukhatme S P, Nayak J K, Solar Energy – Principle of Thermal Storage and collection, Tata McGraw Hill, 2008.

REFERENCE BOOKS

1. Chetan Singh Solanki, Solar Photovoltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited, 2011.
2. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013.
3. Lovegrove K., Stein W., Concentrating Solar Power Technology, Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012.
4. Solar Energy International, Photovoltaic – Design and Installation Manual, New Society Publishers, 2006.

WEB REFERENCES

1. https://www.edx.org/learn/solar-energy
2. https://www.classcentral.com/course/solar-energy-basics-13794
3. https://asmedigitalcollection.asme.org/solarenergyengineering
4. https://archive.nptel.ac.in/courses/115/103/115103123/

ONLINE COURSES / RESOURCES:

1. https://www.academy.fraunhofer.de/en/continuing-education/energy-sustainability/solar-energy-engineering.html

21ME1923	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the refrigeration process and refrigerants properties.
- To understand the vapour compression refrigeration system.
- To apply the concepts of refrigeration to understand different refrigeration systems.
- To apply the psychometric properties to calculate refrigeration.
- To analyze the load estimation of refrigeration system.

UNIT - I INTRODUCTION **9**

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & 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 PSYCHROMETRIC PROPERTIES AND PROCESSES **9**

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT - V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION **9**

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the desirable properties of refrigerants.
CO2: Analyze the vapour compression refrigeration cycle.
CO3: Apply the concept of refrigeration cycle for different refrigeration effect.
CO4: Apply the refrigerant properties levels required for different refrigeration system
CO5: Analyse the capacity of different refrigeration systems.

CO6: Apply solar passive building techniques for cooling and heating applications.

TEXT BOOKS

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.

REFERENCE BOOKS

1. ASHRAE Hand book, Fundamentals, 2010
2. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.

WEB REFERENCES

1. https://www.youtube.com/watch?v=nlsNmhiID74&list=PLfUUbFVTz-XcXbSUD0BXdPxGXFGkcdLXa
2. https://www.youtube.com/watch?v=4mWsRUr0A7A&list=PLWRz8VB-kZuX-diHNiRDhGAhA6JM7WZqk
3. https://www.youtube.com/watch?v=zqXgmVnI3L8&list=PL23E4BD7B6C0265B6

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/112/107/112107208/
2. www.Swayam.gov.in
3. www.Nptel.ac.in

21ME1924	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand mathematical formulation of different fluid dynamics problems.
- To understand finite difference and finite volume approach for diffusion problems.
- To apply the finite volume approach for convection-diffusion problem.
- To apply the finite volume approach for different flow field.
- To analyse the turbulence model fluid dynamics problem.

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 behavior 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 – Taylor's series –First and second order accuracy – Finite volume formulation for steady state One and Two 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-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the mathematical formulation of different fluid dynamics problems.
CO2: Analyze the difference and finite volume approach for diffusion problems.
CO3: Apply the finite volume approach for convection-diffusion problem.
CO4: Apply the finite volume approach for different flow field.
CO5: Analyse the turbulence model fluid dynamics problem.

TEXT BOOKS

1. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw HillPublishing Company Ltd., 2017.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: Thefinite volume Method", Pearson Education Ltd.Second Edition, 2007.

REFERENCE BOOKS

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.

WEB REFERENCES

1. https://ocw.mit.edu/courses/2-29-numerical-fluid-mechanics-spring-2015/pages/lecture-notes-and-references/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105045

21ME1925	ADVANCED IC ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge in stoichiometry calculations
- To know usage of software for simulating the performance of IC engines.
- To analyse the cause and effect of pollutant gases of IC engine.
- To analyze alternate fuel usage and its application in IC engine
- To Understand Electronic engine management systems

UNIT - I 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 - II COMBUSTION MODELLING 9

Basic concepts of engine simulation - Governing equations, Classification of engine models- Thermodynamic models for Intake and exhaust flow process - Quasi steady flow - Filling and emptying - Gas dynamic Models, Thermodynamic based in cylinder models for SI engine and CI engines.

UNIT - III POLLUTANT FORMATION AND CONTROL 9

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

UNIT - IV ALTERNATE FUELS 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. Fuel cell-types and working.

UNIT - V ELECTRONIC ENGINE MANAGEMENT SYSTEMS 9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT).

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the stichiometric calculation of fuels.
CO2: Analyze the usage of simulation software in IC engine.
CO3: Analyze Engine pollution formation and control.
CO4: Analyze theeffective alternate fuel usage in IC engine.
CO5: Analyze the Electronic engine management systems as per recent trends.

TEXT BOOKS

1. Ganesan.V, “Internal Combustion Engines”, 4th edition, Tata McGraw Hill Publishing Co., 2012.
2. Heywood J.B, “Internal Combustion Engine Fundamentals”, 2nd edition, McGraw Hill Book Co., 2018.
3. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.

REFERENCE BOOKS

1. Ganesan.V, “Computer Simulation of Spark Ignition Engine Processes”, Universities Press (I) Ltd, Hyderabad, 2001
2. Mathur R.B and Sharma R.P., “Internal Combustion Engines”, Dhanpat Rai & Sons 2007.
3. Benson R.S, Whitehouse, N.D, “Internal Combustion Engines”, Pergamon Press, Oxford, 1979.

WEB REFERENCES

1. https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/lecture-notes/
2. https://www.powershow.com/viewfl/42add5-MjE1N/RECENT_TRENDS_IN_INTERNAL_COMBUSTION_ENGINE_powerpoint_ppt_presentation
3. https://iopscience.iop.org/article/10.1088/1742-6596/1626/1/012139/pdf
4. https://www.petro-online.com/article/fuel-for-thought/13/koehler-instrument-company/latest-trends-in-new-internal-combustion-engines/3201

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112103262
2. https://nptel.ac.in/courses/112104033
3. https://onlinecourses.nptel.ac.in/noc22_me65/preview
4. https://www.youtube.com/watch?v=DjjbItLWNVQ
5. https://www.youtube.com/watch?v=npzdgE4eREU

21ME1926	AUTOMOTIVE TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the construction and working principle of various parts of an automobile.
- To analyze engine electronics management systems.
- To understand various configuration of transmission and running systems used in vehicle.
- To understand types of fuel cell, Electric and hybrid vehicle functions and their requirements.
- To analyse the various modern systems usage in vehicle and its modifications required.

UNIT - I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

UNIT - II ENGINE ELECTRONIC MANAGEMENT SYSTEM 9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT - III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints,Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT - IV RUNNING SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types ofSuspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS),electronic brake force distribution (EBD) and Traction Control.

UNIT - V FUEL CELL, ELECTRIC AND HYBRID VEHICLE, SAFETY SYSTEMS 9

Hydrogen in Automobiles, Fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, relative merits and demerits, Electric and Hybrid Vehicles, Safety systems - seat belts, air-bag, speed sensing auto locking, OBD. HVAC system.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Recognize the various parts of the automobile and their functions and materials.
CO2: Discuss engine electronics and emission control system.
CO3: Distinguish the working of different types of transmission systems.
CO4: Distinguish the working of different types of running systems
CO5: Analyze Fuel cell, electric and hybrid vehicles and safety systems in automobile.

TEXT BOOKS

1. Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New
   Delhi, 13th Edition 2014..
2. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.
3. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New
   Delhi, 2002.

REFERENCE BOOKS

1. Mehrdad Ehsani, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press, 2005.
2. om Denton, “Electric and Hybrid Vehicles”, 1st edition, Routledge Publishers, 2017.
3. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
4. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.

WEB REFERENCES

1. https://www.my-cardictionary.com/chassis.html
2. https://www.britannica.com/technology/automobile/Transmission
3. https://en.wikipedia.org/wiki/Hybrid_electric_vehicle
4. https://en.wikipedia.org/wiki/Electric_vehicle

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/
3. https://www.careers360.com/courses-certifications/automobile-engineering-courses-brpg

21ME1927	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the working of electrical and electronic systems in vehicle.
- To understand the working of starting system, charging system of an engine for smooth operation.
- To understand the working of ignition and injection system of an engine.
- To analyze sensor and microprocessor applications in vehicle control systems.
- To analyze modern safety systems used in vehicle.

UNIT - I INTRODUCTION TO ELECTRICAL AND ELECTRONICS ACCESSORIES 9

Basic electrical principles, electronic components and circuits, digital electronics, microprocessor systems, electrical wiring, terminals and switching, multiplexed wiring systems, circuit diagrams and symbols, dashboard instruments, horn, trafficator.

UNIT - II STARTING SYSTEM, CHARGING SYSTEM, LIGHTING SYSTEM 9

Starter motor characteristics, drive mechanisms. DC Generators, Alternators and their characteristics, electronic regulators. Vehicle interior lighting system, vehicle exterior lighting system, lighting design.

UNIT - III ELECTRONIC IGNITION AND INJECTION SYSTEM 9

Spark plugs, advance mechanisms, different types of ignition systems, Electronic fuel injection systems, mono and multi point fuel injection system.

UNIT - IV SENSORS AND MICROPROCESSORS IN AUTOMOBILES 9

Basic sensor arrangements, Types of sensors – oxygen sensor, hot wire anemometer sensor, vehicle speed sensor, detonation sensor, accelerometer sensor, crank position sensor, Microprocessor and microcomputer controlled devices in automobiles such as voice warning system, travel information system, keyless entry system, and electronic steering system..

UNIT - V SAFETY SYSTEMS 9

Antilock braking system, air bag restraint system, voice warning system, seat belt system, road navigation system, anti-theft system.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic principles of electrical, electronics and automotive dashboard instruments.

CO2: Identify the requirements of the automotive starting system, charging system and lighting system.

CO3: Analyze of modern electronicssystem in automotive ignition and injection.

CO4: Analyze sensors and microcomputer controlled devices in automobiles.

CO5: Analyze the safety systems employed in vehicles.

TEXT BOOKS

1. Tom Denton," Automobile Electrical and Electronic Systems", Fifth Edition
2. Young, A.P. and Griffith, S.L., Automobile Electrical Equipments, ELBS and New Press.
3. Kholi .P.L.Automotive Electrical Equipment,Tata McGraw-Hill co ltd,New Delhi,2004

REFERENCE BOOKS

1. Crouse.W.H. Automobile Electrical Equi\pment,McGraw Hill Book Co Inc.NewYork,2005
2. Judge.A.W.Modern Electrical Equipments of Automobiles,Chapman& Hall, London 2004 .
3. Robert Bosch, Automotive Handbook, Bently Publishers,2004

WEB REFERENCES

1. https://www.sciencedirect.com/topics/engineering/automotive-electronics
2. https://www.elprocus.com/automotive-electronics-and-its-innovations/

ONLINE COURSES / RESOURCES:

1. https://www.youtube.com/watch?v=Zpbj3C4RtBc&list=PLQmc-I2-FO2EdLeWhXIo9xp7pLi_hNO9V
2. https://www.youtube.com/watch?v=JeLry3mJs6k
3. https://skill-lync.com/electrical-engineering-courses/introduction-to-automotive-electronics

21ME1928	VEHICLE BODY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge of construction of car body, bus body and commercial vehicles.
- To understand vehicle aerodynamics, design and safety.
- To understand the interior ergonomics.
- To analyze the design, safety and fatigue aspects of vehicle.

UNIT - I CAR BODY DETAILS 9

Types of Car body - Saloon, convertibles, Limousine, Estate Van, Racing and Sports car. Visibility - Regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars, Driver seat design, Car body construction-Various panels in car bodies - Design criteria and initial tests, Body trim items, body mechanisms. Modern painting process of a passenger car body, Anti-corrosion methods

UNIT - II VEHICLE AERODYNAMICS 9

Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments.Various body optimization techniques for minimum drag. Wind tunnels – Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test – measurement of various forces and moments by using wind tunnel balance.

UNIT - III INTERIOR ERGONOMICS 9

Introduction, seating dimensions, interior ergonomics, seat comfort, driver seat design, dash boardinstruments, electronicdisplays, commercial vehicle cabin ergonomics, mechanical package layout, goodsvehicle layout. Vehicle stability: Introduction, longitudinal, lateral stability, vehicle on a curvilinear path, criticalspeed for toppling and skidding, effect of operating factors on lateral stability, steering geometry andstabilization of steerable wheels, mass distribution and engine location on stability.

UNIT - IV BUS BODY AND COMMERCIAL VEHICLE DETAILS 9

Types of bus body: based on capacity, distance travelled and based on construction, Bus body layout for various types. Regulations – Constructional details: Conventional and integral, Driver seat design, Drivers cab design – Regulations. Commercial vehicle body technology, trends, Tipper body and Tanker body, special goods vehicle, special haulage vehicles. Buses and coaches, Passenger Specialty Vehicle (PSV) structural design, low floor and articulated buses, three wheelers and light weight trailers.

UNIT - V DESIGN, SAFETY AND FATIGUE ASPECTS 9

Types of materials used in body construction-Steel sheet, timber, plastics, Glass fiber reinforced plastics(GRP), properties of materials, Design for press working, design for spot welding, adhesives and sealants, goods vehicle structure design, chassis frame configuration, structural properties of chassis frame members, Safety aspects of car and body. Crash tests, forces in roll over, head on impact, plastic collapse and analysis, fatigue and vibration, structural vibration.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the different types of car bodies, their safety aspects and regulations.
CO2: Analyze the various aerodynamic forces calculation of the vehicle body.
CO3: Apply the suitable interior ergonomics of vehicle body as per requirements.
CO4: Analyze the construction, operation of different typesbus body and commercial vehicle body and its regulations.
CO5: Analyze the vehicle body with respect to design, safety and comfort.

TEXT BOOKS

1. John Fenton, “Handbook of Automotive Body and Systems Design”, John Wiley & Sons, 2013.
2. Powloski, J., "Vehicle Body Engineering", Business Books Ltd., 1998.

REFERENCE BOOKS

1. Braithwaite, J.B., "Vehicle Body building and drawing", Heinemann Educational Books Ltd., London, 1997.
2. Dieler Anselm., "The Passenger Car Body", SAE International, 2000.
3. Giles, G.J., "Body Construction and Design", Illiffe Books Butterworth & Co., 1991.
4. James E Duffy, “Modern Automotive Technology”, Seventh Edition, Goodheart-Willcox, 2011.
5. John Fenton, “Handbook of Automotive Construction and Design Analysis”, John Wiley & Sons, 2014.

WEB REFERENCES

1. https://eqmsol.com/vehicle-body-engineering.php
2. https://learnmech.com/types-of-automobile-bodies-and-requirement-of-automobile-body/
3. https://www.slideshare.net/friendsrtg/vehicle-body-engineering-introduction

ONLINE COURSES / RESOURCES:

1. https://www.youtube.com/watch?v=924_ZQMQh10
2. https://www.youtube.com/watch?v=cLMctU9--S8&list=PLQmc-I2-FO2HVThlQuHrMVObXEP6tjY_r
3. https://www.youtube.com/watch?v=wuQfBTI57Ls

21ME1929	VEHICLE DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the procedure to find the stability and performance of the vehicle.
- To understand the fundamentals of vehicle vibrations.
- To understand the concepts of mathematical modeling and design of vehicle suspension system and its control methods.
- To understand the effect of tyres dynamics.
- To analyze the vehicle handling characteristics and its effects of the vehicle.

UNIT - I LONGITUDINAL DYNAMICS AND CONTROL 9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Aerodynamic forces and moments, Equation of motion, Load distribution for three wheeler and four wheeler, Calculation of Maximum acceleration, Reaction forces for Different drives, Braking and Driving torque, Prediction of Vehicle performance, Anti-lock Braking System (ABS), Stability control, Traction control, Development of linear model using computer software.

UNIT - II CONCEPT OF VIBRATION 9

Free, Forced, Undamped and Damped Vibration, Response Analysis of Single Degrees of Freedom (DOF), Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed, Development of linear model using computer software.

UNIT - III VERTICAL DYNAMICS 9

Human response to vibration, Sources of Vibration, Design and analysis of Passive, Semi-active and Active suspension using Quarter car, Half car and Full car model, Influence of suspension stiffness, suspension damping, and tire stiffness, Control law for Linear Quadratic Regulator (LQR), H-Infinite, Skyhook damping, Air suspension system and their properties, Development of linear model using computer software.

UNIT - IV TIRES 9

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire, Performance of tire on wet surface, Ride property of tires, Magic formulae of tire model, Estimation of tire road friction, Test on Various road surfaces, Tire vibration, Development of linear model using computer software.

UNIT - V LATERAL DYNAMICS 9

Steady state handling characteristics, Steady state response to steering input, Testing of handling characteristics, Transient response characteristics, Direction control of vehicles, Roll center, Roll axis, Vehicle under side forces, Stability of vehicle on banked road and during turn, Effect of suspension on cornering, Development of linear model using computer software.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the stability of vehicles, tractive efforts, prediction of vehicle performance and effects on braking and driving torque.

CO2: Analyze the suitable methods to determine the frequency and mode shapes of free, forced and damped vehicle vibrations.

CO3: Design vehicle suspension system and its control methods.

CO4: Explore the effects of tyre dynamics on the vehicle performance.

CO5: Analyze the vehicle handling characteristics and its effects.

TEXT BOOKS

1. Rajesh Rajamani, “Vehicle Dynamics and Control”, 1st edition, Springer, 2005.
2. Wong J. Y, “Theory of Ground Vehicles”, 3rd Edition, Wiley-Interscience, 2001.

REFERENCE BOOKS

1. Dean Karnopp, “Vehicle Stability”, 1st edition, Marcel Dekker, 2004.
2. Hans B Pacejka, “Tire and Vehicle Dynamics”, 2nd edition, SAE International, 2005.
3. Michael Blundell & Damian Harty, “The Multibody Systems Approach to Vehicle Dynamics”, Elsevier, 2004.
4. Nakhaie Jazar. G., “Vehicle Dynamics: Theory and Application”, 1st edition, Springer, 2008.
5. Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, Society of Automotive Engineers Inc, 1992.

WEB REFERENCES

1. https://link.springer.com/book/10.1007/0-387-28823-6
2. https://www.sciencedirect.com/topics/engineering/longitudinal-dynamic
3. https://www.oreilly.com/library/view/integrated-vehicle-dynamics/9781118379998/c04.xhtml

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/107106080
2. https://www.udemy.com/course/fundamental-concepts-of-vehicle-dynamics/

21ME1930	VEHICLE MAINTENANCE AND SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand Maintenance procedure.
- To understand Engine and subsystem maintenance.
- To understand Transmission system maintenance.
- To analyse steering, brake, suspension, tyre and wheel maintenance.
- To analyze electrical and air conditioning maintenance.

UNIT - I MAINTENANCE, WORKSHOP PRACTICES, SAFETY AND TOOLS 9

Maintenance – Need, importance, primary and secondary functions, policies, classification of maintenance work, vehicle insurance, basic problem diagnosis, automotive service procedures, Workshop operations, preparation of workshop forms, vehicle identification number. Safety – personnel, machines and equipment, vehicles, fire safety, first aid. Basic tools, special service tools, measuring instruments, condition checking of seals, gaskets and sealants.

UNIT - II ENGINE AND ENGINE SUBSYSTEM MAINTENANCE 9

General engine service, dismantling of engine components, engine repair, working on the underside, front, top, ancillaries, service of basic engine parts, cooling and lubricating system, fuel system, intake and exhaust system, electrical system, electronic fuel injection and engine management service, fault diagnosis, servicing emission controls.

UNIT - III TRANSMISSION AND DRIVELINE MAINTENANCE 9

Clutch- general checks, adjustment and service, dismantling, identifying, checking and reassembling transmission, transaxle, road testing, removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints, rear axle service points, removing axle shaft and bearings, servicing differential assemblies, fault diagnosis, maintenance and service of automatic transmission.

UNIT - IV STEERING, BRAKE, SUSPENSION, TYRE AND WHEEL MAINTENANCE 9

Inspection, maintenance and service of steering linkage, steering column, Rack and pinion steering, Recalculating ball steering service- Worm type steering, power steering system. Drum brake, Disc brake, Parking brake. Bleeding of brakes. Inspection, maintenance and service of Mc person strut, coil spring, leaf spring, shock absorbers. Inspection, maintenance and service of tyres and wheels, Tyre rotation, Tyre wear indicator, Wheel balancing.

UNIT - V AUTO ELECTRICAL AND AIR CONDITIOING MAINTENANCE 9

Starting system, charging system and body electrical, fault diagnosis using scan tools, Theory of automotive air-conditioning refrigerants, maintenance of air conditioning parts like compressor, condenser, expansion valve, and evaporator, replacement of hoses, leak detection, AC Charging, fault diagnosis.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply the service procedures and safety methods practiced in an automotive workshop.

CO2: Analyze the procedure for the fault diagnosis and service of engine and its subsystems.

CO3: Analyze the fault diagnosis and service of transmission and driveline components.

CO4: Analyze the fault diagnosis and service of comfort and safety components of vehicle.

CO5: Analyze fault diagnosis and service of automotive electrical and air-conditioning components.

TEXT BOOKS

1. Jigar A. Doshi, Dhruv U. Panchal, Jayesh P. Maniar, “Vehicle Maintenance and Garage Practice”, Eastern Economy Edition, PHI Learning Private Limited, 2014.
2. William M. Metts, “Vehicle Maintenance Book”, Independently Published, 2019.

REFERENCE BOOKS

1. Bosch Automotive Handbook, Tenth Edition,2018
2. Vehicle Service Manuals from different manufactures
3. William Crouse, Donald Anglin Automotive Mechanics
4. Ed May, “Automotive Mechanics - Volume One”, Mc Graw Hill Publications, 2003.
5. Ed May, “Automotive Mechanics - Volume Two”, Mc Graw Hill Publications, 2003..

WEB REFERENCES

1. https://ncert.nic.in/vocational/pdf/ivas106.pdf
2. https://cvrt.ie/en/Operator-Driver-Obligations/Pages/maintenance-and-repairs.aspx
3. https://en.wikiversity.org/wiki/Automobile_Maintenance

ONLINE COURSES / RESOURCES:

1. https://alison.com/course/car-mechanic-training
2. https://internationalopenacademy.com/products/car-maintenance-online-course
3. https://kti.ac.in/courses/Certificate-Course-In-Four-Wheeler-Mechanic

21ME1931	HYBRID AND ELECTRICAL VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains.
- To expose on different types of AC and DC drives for electric vehicles.
- To learn and utilise different types of energy storage systems.
- To analyze energy management strategies and drive sizing.

UNIT - I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics,History of hybrid and electric vehicles, social and environmental importance of hybrid and electricvehicles, impact of modern drive-trains on energy supplies.

UNIT - II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flowcontrol in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept ofelectric traction, introduction to various electric drive-train topologies, power flow control in electricdrive-train topologies, fuel efficiency analysis.

UNIT - III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control -DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch ReluctanceMotor drives, drive system efficiency.

UNIT - IV ENERGY STORAGE AND MANAGEMENT STRATEGIES 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage andits analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of differentenergy storage devices. Energy Management Strategies: Introduction to energy management strategies usedin hybrid and electric vehicles, classification, and comparison of energy managementstrategies,Implementation issues.

UNIT - V THERMAL MANAGEMENT IN BATTERIES AND FUEL CELLS 9

Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Tesla Model-S Battery Module-bonding techniques, thermal management.Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the Characterise and configure hybrid drivetrains requirement for a vehicle.
CO2: Design and apply appropriate hybrid and electric drive trains in a vehicle.
CO3: Design and install suitable AC and DC drives for electric vehicles.
CO4: Analyze suitable energy storage system for a hybrid / electric vehicle.
CO5: Analyze energy management strategies to ensure better economy and efficiency.

TEXT BOOKS

1. Iqbal Husain, —Electric and Hybrid Vehicles: Design Fundamentals‖, Third Edition, 2021.
2. Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles by John G. Hayes and A. Goodarzi, Wiley Publication.
3. Mehrdad Ehsani, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press, 2005.
4. Tom Denton, “Electric and Hybrid Vehicles”, 1st edition, Routledge Publishers, 2017.

REFERENCE BOOKS

1. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication, 2005.
2. Ronald . Jurgen, “Electric and Hybrid-Electric Vehicles: Engines and Powertrains”, SAE International, 2015
3. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Softcover reprint of the original 1st ed, Springer, 2013.

WEB REFERENCES

1. https://en.wikipedia.org/wiki/Electric_vehicle
2. https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee112/course
2. https://www.udemy.com/course/electric-vehicles-comprehensive-course/

21ME1932	THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the working principle of Li-ion Batteries and Battery Packs.
- To understand the thermal management system in Battery modules.
- To analyze different case studies in Battery Thermal Management System.
- To understand principle of Fuel Cells cooling methods.
- To analyze Thermal Management Systems in various famous Electric and Fuel Cell Electric Vehicles.

UNIT - I ADVANCED BATTERIES 9

Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Super capacitors Vs batteries. Diamond battery concepts.

UNIT - II THERMAL MANAGEMENT IN BATTERIES 9

Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.

UNIT - III BATTERY THERMAL MANAGEMENT CASE STUDIES 9

EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li- Ion Battery Pack with COMSOL Multiphysics- simulation concepts.

UNIT - IV THERMAL MANAGEMENT IN FUEL CELLS 9

Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications.Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

UNIT - V FUEL CELL THERMAL MANAGEMENT CASE STUDIES 9

Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the different Li-ion Batteries and Fuel Cell performances.
CO2: Design a Battery Pack with appropriate PCM.
CO3: Analyze Cooling Models by understanding different thermal management case studies .
CO4: Analyze the characteristics of fuel cell.
CO5: Utilize different Thermal Management System approaches during real world usage.

TEXT BOOKS

1. Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric Vehicle
   Battery Systems’’, Wiley, 2017.
2. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin
   Electric Drive Vehicles’’, Wiley, 2015.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design’’, CRC Press, 2005.
4. John G. Hayes and G. Abas Goodarzi, “Electric Powertrain”, Wiley, 2018
5. Davide Andrea, “Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

REFERENCE BOOKS

1. Nag.P.K, “Engineering Thermodynamics”, 5th Edition, Tata McGraw Hill Education, NewDelhi, 2013.
2. “Vehicle thermal Management Systems Conference Proceedings”, 1st Edition; 2013, Coventry Techno centre, UK
3. Younes Shabany,” Heat Transfer: Thermal Management of Electronics Hardcover” 2010, CRC Press.
4. T. Yomi Obidi, “Thermal Management in Automotive applications”, 2015, SAE International.
5. Jerry Sergent, Al Krum, “Thermal Management Handbook: For Electronic AssembliesHardcover”, 1998, Mc Graw- Hill.

WEB REFERENCES

1. https://en.wikipedia.org/wiki/Electric_vehicle
2. https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee112/course
2. https://www.udemy.com/course/electric-vehicles-comprehensive-course/

21ME1933	ENGINEERING ETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the guiding principles for human and professional excellence.
- To understand theories of Integrities and moral values and incorporate in engineering society.
- To apply the ethical issues related to engineering and the code of ethics.
- To analyze the safety, responsibilities and rights in the engineering society.
- To analyze the comprehensive ethical issues and play the role of engineers ethically.

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 : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the human values and professional excellence.
CO2: Apply the theories of Ethics and moral values and incorporate in engineering society.
CO3: Apply the ethical issues related to engineering and apply the code of ethics.
CO4: Analyze the safety, responsibilities and rights in the engineering society.
CO5: Analyze the global ethical issues and play the role of engineers ethically.

TEXT BOOKS

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
4. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
5. 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.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011.

WEB REFERENCES

1. https://www.asce.org/career-growth/ethics/code-of-ethics
2. https://www.nspe.org/resources/ethics/code-ethics
3. https://engineering.purdue.edu/MSE/academics/undergraduate/ethics.pdf
4. https://www.ieee.org/about/corporate/governance/p7-8.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/110105097
2. https://nptel.ac.in/courses/109106117
3. https://nptel.ac.in/courses/109104032
4. https://www.digimat.in/nptel/courses/video/110105097/L01.html

21ME1934	INDUSTRIAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various types and functional aspects of production.
- To understand the product planning and process planning phases.
- To apply basic concepts of scheduling theory for production control.
- To apply estimation procedures for different types of manufacturing processes.
- To Analyze the machining time for different production processes.

UNIT - I INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT 9

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect -

Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT - II PRODUCT PLANNING AND PROCESS PLANNING 9

Product planning-Extending the original product information-Value Analysis-Problems in lack of product planning-Process planning and routing-Prerequisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

UNIT - III PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual Loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning, KANBAN – Dispatching-Progress reporting and expediting. Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT - IV COST ESTIMATION 9

Importance of costing and estimation- Types of estimates – Estimating procedure-Methods of costing-elements of cost estimation, Estimation labor cost, material cost- allocation of overhead charges- Calculation of depreciation cost, Estimation of Different Types of Jobs - Estimation of Sheet metal Shop, Forging Shop, Welding Shop and Foundry Shop.

UNIT - V MACHINING TIME CALCULATION & RECENT TRENDS IN INDUSTRIAL ENGINEERING 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. Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic concepts of production and operations management with cost considerations

CO2: Analyze the concepts of value analysis, process capabilities, balancing for product and process planning

CO3: Apply fundamental concepts of scheduling theory by determining an optimal schedule for a flow shop and complex job shop problems, and various feasible job shop schedules.

CO4: Apply both the costing and estimating procedures for all type of industry

CO5: Analyze the importance of machining time along with recent trends like JIT, MRP - II and ERP.

TEXT BOOKS

1. Martand T Telsang, “Industrial Engineering and Production Management”, Third Revised edition, S. Chand and Company, 2018.
2. Narang GBS and Kumar V, Production and Costing, Khanna Publishers, 2014.

REFERENCE BOOKS

1. Panneerselvam. R, Production and operations Management, PHI, 3rd Edition, 2012
2. James. B. Dilworth,” Operations management – Design, Planning and Control for manufacturing and services” McGraw Hill International edition 1992.
3. William J Stevenson, Operations Management, McGraw Hill,13th Edition,2018.
4. Chary. S.N., “Production and Operations Management”, Tata McGraw Hill, 6thEdition, 2019.
5. Banga T R and Sharma S C, Estimating and Costing, Khanna Publishers, 2001.

WEB REFERENCES

1. https://onlinelibrary.wiley.com/journal/19375956
2. https://www.managementstudyguide.com/production-and-operations-management.htm
3. https://www.slideshare.net/zimbar/product-and-process-planning
4. https://nulab.com/learn/project-management/production-scheduling-important/
5. https://www.smartsheet.com/ultimate-guide-project-cost-estimating

ONLINE COURSES / RESOURCES:

1. https://www.digimat.in/nptel/courses/video/110107141/L01.html
2. https://www.digimat.in/nptel/courses/video/110101132/L01.html
3. https://www.youtube.com/watch?v=NzyhYxUCjlg
4. https://www.youtube.com/watch?v=R2NhJAtKtpo
5. https://www.youtube.com/watch?v=MP51tDcdJSo
6. https://www.youtube.com/watch?v=30Z7f7dpGYU

21ME1935	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- To explain the TQM Principles for application.
- To define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- To describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- To Illustrate and apply QMS and EMS in any organization.

UNIT - I INTRODUCTION 9

. Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT - II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT - III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT - IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT - V QUALITY MANAGEMENT SYSTEM 9

Introduction - Benefits of ISO Registration—ISO 9000 Series of Standards—Sector - Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements— Implementation—Documentation—Internal Audits—Registration.

Environmental management system**:** Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001— Benefits of EMS.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the significance of quality in organizations, the evolution of quality concepts, the foundational principles of Total Quality Management.

CO2: Apply the role of leadership in quality management, strategic quality planning, fostering employee involvement, driving continuous process improvement, and building strong supplier partnerships to enhance overall organizational performance

CO3: Acquire knowledge of traditional and modern quality tools, Six Sigma methodologies, benchmarking practices, and Failure Mode and Effects Analysis

(FMEA) to identify, analyze, and improve processes across various sectors

CO4: Analyze the Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR for achieving operational excellence.

CO5: Apply the ISO standards, their benefits, sector-specific applications, implementation processes for sustainable and efficient organizational practices.

TEXT BOOKS

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCE BOOKS

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality",8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO 9001-2015 standards

WEB REFERENCES

1. https://www.iso.org/iso-9001-quality-management.html
2. https://www.sciencedirect.com/science/article/pii/B0122272404001854
3. https://www.researchgate.net/publication/312054032_Total_Quality_Management

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/110104080
2. https://www.digimat.in/nptel/courses/video/110104080/L01.html
3. https://www.digimat.in/nptel/courses/video/110104085/L01.html

21ME1936	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of process planning.
- To understand various Process Planning Activities.
- To understand fundamentals of costing and estimation.
- To apply the basics of estimation in different manufacturing processes.
- To analyze the production rate for different metal cutting 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 fixture selection 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 overhead 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 : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the d selection of equipment and tools for various processes.
CO2: Analyze the preparation of process planning activity chart.
CO3: Analyze the estimation procedure for different resources for jobs.
CO4: Apply the cost estimation procedure for forging, welding and foundry shop.
CO5: Analyze the machining time for different metal cutting processes.

TEXT BOOKS

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2. Sinh a B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

REFERENCE BOOKS

1. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
2. Os twalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley,1998.
3. Ru ssell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.
4. Mik ell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”,Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, KhannaPublishers 1990.

WEB REFERENCES

1. http://ndl.ethernet.edu.et/bitstream/123456789/54967/1/83.pdf
2. https://www.researchgate.net/publication/284188843_Manufacturing_Process_Planning
3. http://alvarestech.com/temp/capp/0-livro-PrinciplesofProcessPlanningAlogica%20approach.pdf
4. https://www.pdfdrive.com/process-planning-and-cost-estimation-e34406789.html
5. https://www.pdfdrive.com/cost-estimation-methods-and-tools-e185217474.html

ONLINE COURSES / RESOURCES:

1. https://youtu.be/f66GMSqkNio
2. https://youtu.be/_z4-7xr6ur8
3. https://youtu.be/20_K7c65Swg
4. https://youtu.be/y24meNZbUoU
5. https://youtu.be/6NhyqMEW4ms

21ME1937	INDUSTRIAL SAFETY AND MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand unsafe conditions and recognize safety alerts.
- To understand the rules and regulations for safety operations.
- To apply the procedure for prevention of environmental hazards.
- To analyse the hazard elements and risk assessment.
- To analyse records to formulate safety regulations.

UNIT - I INTRODUCTION 9

. Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT - II CHEMICAL HAZARDS 9

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

UNIT - III ENVIRONMENTAL CONTROL 9

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

UNIT - IV HAZARD ANALYSIS 9

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

UNIT - V SAFETY REGULATIONS 9

Explosions – Disaster management – catastrophe control, hazard control , Factories Act, Safety regulations Product safety – case studies.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the risky conditions and recognize unsafe signals.
CO2: Analyze the procedure for safety operations.
CO3: Apply the techniques for environmental safety.
CO4: Analyse the hazard elements and risk assessment.
CO5: Analyse records to formulate safety guidelines.

TEXT BOOKS

1. John V.Grimaldi, “Safety Management”, AITB S Publishers, 2003.

REFERENCE BOOKS

1. David L.Goetsch, “Occupational Safety and Health for Technologists”, Engineers and Managers, Pearson Education Ltd. 5th Edition, 2005.
2. Deshmukh L M, “Industrial Safety Management”, Tata McGraw-Hill Publishing Company Ltd.,2005
3. Safety Manual, “EDEL Engineering Consultancy”, 2000.

WEB REFERENCES

1. https://www.asme.org/codes-standards/publications-information/safety-codes-standards
2. https://www.nfpa.org/Codes-and-Standards/All-Codes-and-Standards/List-of-Codes-and-Standards
3. https://link.springer.com/chapter/10.1007/978-1-84882-472-0_22

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/110105094
2. http://www.nitttrc.edu.in/nptel/courses/video/110105094/L51.html
3. https://www.digimat.in/nptel/courses/video/110105094/L01.html

21ME1938	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the behavioural characteristics of entrepreneurship.
- To understand the theories of motivations for entrepreneurs.
- To apply the concepts of entrepreneurship to identify business opportunities and formulate structure.
- To apply the fundamental concepts of finance and accounting to enterprise.
- To analyse the supporting regulations for entrepreneurship

UNIT - I ENTREPRENEURSHIP 9

Entrepreneur – Characteristics – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Role of Entrepreneurship in Economic Development – Factors Affecting Entrepreneurial Growth – Economic, Non-Economic, Government Actions.

UNIT - II MOTIVATION 9

Entrepreneurial Motivation: Theories and Factors, Achievement Motivation –Entrepreneurial Competencies – Entrepreneurship Development Programs – Need, Objectives – Business Game, Thematic Apperception Test, Self-Rating, Stress management.

UNIT - III BUSINESS 9

Small Enterprises – Definition, Characteristics, Project Identification and selection – Project Formulation: Significance, content, formulation of project report – Project Appraisal: Concept and method – Ownership Structures: Selection & Pattern

UNIT - IV FINANCING AND ACCOUNTING 9

Finance: Need, Sources, Capital Structure, Term Loans – Accounting: Need, Objectives, Process, Journal, Ledger, Trial Balance, Final Accounts – Working Capital Management: Significance, Assessment, Factors, Sources, Management, Inflation adjusted decisions – procedure to adjust inflation

UNIT - V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business: Concept, Signals, Symptoms, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in Small Scale Enterprise – Institutional Support to Entrepreneurs: Need and Support – Taxation Benefits to Small Scale Industry: Need, Depreciation, Rehabilitation, Investment.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the core competence progress of entrepreneurs.
CO2: Apply the concepts of entrepreneurship to prepare the report of opportunities and structures of business.
CO3: Apply the fundamental concepts of economics and accounting to enterprise.
CO4: Analyze the core competence progress of entrepreneurs.
CO5: Analyse the supporting principles for entrepreneurship.

TEXT BOOKS

1. S.S.Khanka, "Entrepreneurial Development" S.Chand& Co. Ltd. Ram Nagar NewDelhi,1999.
2. Kurahko&Hodgetts, "Entrepreneurship – Theory, process and practices", Thomson learning 6th edition.

REFERENCE BOOKS

1. Charantimath, P. M., Entrepreneurship Development and Small Business Enterprises, Pearson, 2006.
2. Hisrich R D and Peters M P, "Entrepreneurship" 5th Edition Tata McGraw-Hill, 2002.
3. Mathew J Manimala," Entrepreneurship theory at crossroads: paradigms and praxis" Dream tech, 2nd edition 2006.
4. Rabindra N. Kanungo, "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.
5. Singh, A. K., Entrepreneurship Development and Management, University Science Press, 2009.

WEB REFERENCES

1. https://www.slideshare.net/esmatullahamini1/entrepreneurial-developmentbook-pdf
2. https://www.academia.edu/10068660/ENTREPRENEURSHIP_DEVELOPMENT
3. http://eagri.org/eagri50/ARM402/index.html

ONLINE COURSES / RESOURCES:

1. https://www.digimat.in/nptel/courses/video/110106141/L01.html
2. https://www.digimat.in/nptel/courses/video/110105067/L01.html
3. https://nptel.ac.in/courses/127105007
4. https://onlinecourses.nptel.ac.in/noc21_mg70/preview

21ME1939	QUALITY AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concept and control variables of quality.
- To understand process control charts for quality attributes.
- To apply sampling techniques for standard sampling plan.
- To apply failure data of simple problems to quantity reliability.
- To analyze reliability and quality for product development**.**

UNIT - I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

. Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart- uses of control chart –X chart, R chart and chart - process capability – process capability studies and simple problems. Six sigma concepts

UNIT - II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for non conformings– p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT - III ACCEPTANCE SAMPLING 9

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT - IV LIFE TESTING – RELIABILITY 9

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT - V QUALITY AND RELIABILITY 9

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development–Product life cycles. **Note:** Use of approved statistical table permitted in the examination.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basics of and control variables of quality.
CO2: Analyze the process control charts for quality attributes
CO3: Apply sampling techniques for standard sampling plan.
CO4: Apply failure data of simple problems to quantity reliability.
CO5: Analyze reliability and quality for product development**.**

TEXT BOOKS

1. Douglas.C. Montgomery, “Introduction to Statistical quality control”, 7th edition, John Wiley, 2012.
2. Srinath. L.S., “Reliability Engineering”, Affiliated East west press, 2008.

REFERENCE BOOKS

1. Besterfield D.H., “Quality Control”, Prentice Hall, 2013.
2. Connor, P.D.T.O., “Practical Reliability Engineering”, JohnWiley, 2012
3. Danny Samson, “Manufacturing & Operations Strategy”, Prentice Hall, 1991
4. Grant, Eugene .L “Statistical Quality Control”, McGraw-Hill, 2017
5. Gupta. R.C, “Statistical Quality control”, Khanna Publishers, 2001.

WEB REFERENCES

1. https://link.springer.com/chapter/10.1007/978-3-662-05409-3_7
2. https://www.emerald.com/insight/publication/issn/0265-671X

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/110105088
2. https://nptel.ac.in/courses/116102019
3. https://nptel.ac.in/courses/112107259
4. https://nptel.ac.in/courses/105108128

21ME1940	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To gain knowledge of optimization techniques and approaches.
- To understand a real-world problem as a mathematical programming model.
- To apply mathematical, computational and communication skills needed for the practical utility of Operations Research.
- To knowledge to solve networking problems.
- To knowledge to solve various inventory problems.
- To gain knowledge on solving different waiting line models

UNIT I LINEAR MODELS **15**

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT II TRANSPORTATION MODELS AND NETWORK MODELS **8**

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT III INVENTORY MODELS **6**

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV QUEUEING MODELS **6**

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT V DECISION MODELS **10**

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life –Economic life– Single / Multi variable search technique.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the linear programming, graphical method, Simplex algorithm, duality, and sensitivity analysis..

CO2: Analyze the ransportation/assignment models, Traveling Salesman, shortest route, minimal spanning tree, maximum flow, CPM/PERT, and sequencing models.

CO3: Analyze EOQ, quantity discount, stochastic inventory, multi-product models, and real-world inventory control

CO4: Analyze queueing systems, single/multi-server models, Poisson input, exponential service, constant rate, and simulation..

CO5: Analyze game theory, graphical/algebraic/LP solutions, replacement models, and optimization techniques.

TEXT BOOKS

1. Taha H.A., “Operations Research”, Sixth Edition, Prentice Hall of India, 2003.
2. Hillier and Libeberman, “Operations Research”, Holden Day, 2005.

REFERENCE BOOKS

1. Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, John Wiley, 2009.
2. Panneerselvam R., “Operations Research”, PHI Learning, 2006.
3. Philip D.T. and Ravindran A., “Operations Research”, JohnWiley, 1992.
4. Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.

WEB REFERENCES

1. http://www.nitttrc.edu.in/nptel/courses/video/112106134/lec1.pdf
2. https://www.slideshare.net/drrama/operational-research-50589320
3. https://link.springer.com/book/10.1007/978-1-4471-5577-5

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112106134
2. https://nptel.ac.in/courses/110106062
3. https://www.digimat.in/nptel/courses/video/110106062/L02.html
4. https://nptel.ac.in/courses/111107128

21ME1941	WAREHOUSING AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental role and operations of warehouses.
- To understand the need and the process of warehouse.
- To summarize to warehouse management systems and layout.
- To study the various handling equipment & cost for warehouse maintenance
- To analyze the importance of warehouse in future environment.

UNIT I INTRODUCTION **9**

The role of the warehouse, Types of warehouse operation, Why do we hold stock? Warehouse location, Number of warehouses, Supply chain trends affecting warehouses, The growth of e-fulfilment and its effect on the warehouse, Specialized warehousing, Role of the warehouse manager, Warehouse trade-offs, The warehouse manager's challenges, Lean warehousing, People management and People challenges, Attracting and retaining warehouse employees, An ageing and constantly changing workforce, Operating hours, Training, Warehouse audit and Quality systems

UNIT II PROCESS OF WAREHOUSE **9**

Receiving - Pre-receipt, In-handling, Preparation, Offloading, Cross docking, Recording, Quality control and put-away, pickup preparation and Warehouse pick area layout, Picker to goods, Goods to picker, Types of automated picking, Examples of automated picking systems and Order Picking methods. Replenishment - Value-adding services, Indirect activities, Stock management, Stock or inventory counting, Cycle counting or perpetual inventory, counts - The count itself, Security - Returns processing
Despatch and Documentation, Role of the driver.

UNIT III WAREHOUSE MANAGEMENT SYSTEMS AND LAYOUT **9**

Why does a company need a WMS? Choosing a WMS - the process, selecting the right WMS, what to look for in a system, selecting a partner, before the final decision - Implementation, Warehouse layout - Data collection and analysis, Space calculations, Aisle width, Other space, Warehouse layout examples - Finding additional space

UNIT IV HANDLING EQUIPMENT & COST FOR WAREHOUSE MAINTENANCE **9**

Storage equipment, Storage options, Shuttle technology with a difference, Very high bay warehouses, Other storage media, Warehouse handling equipment, Vertical and horizontal movement, Automated storage and retrieval systems (AS/RS), Specialized equipment, Recent technical advances. Warehouse costs - Return on investment (ROI), Traditional versus activity-based costing systems, Charging for shared-user warehouse services, Logistics charging methods - Hybrid.

UNIT V WAREHOUSE IN FUTURE ENVIRONMENT **9**

Legislation and other pressures, Warehouse energy usage, Energy production, The environment and waste, Packaging, Pallets, Stretch wrap, Cartons, Labelling, Product waste, Waste disposal, Hazardous waste, Forklift trucks - Equipment disposal, warehouse of the future - Views of the future: the landscape and the warehouse.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the role of the warehouse manager, including managing people, lean warehousing practices, and quality systems.

CO2: Analyze the role of automation in picking, stock management, and the importance of security and returns processing in efficient warehouse operations..

CO3: Understand the importance of a Warehouse Management System

CO4: Analyze different costing methods for efficient warehouse management.

CO5: Analyze future trends and environmental considerations for warehouse operations.

TEXT BOOKS

1. Gwynne Richards, "Warehouse management", 3rd Edition, Kogan Page Limited., 2011 .
2. Balaji R Kannappan, Hari Shankar Tripathy, Vinay Krishna, "Warehouse Management with SAP EWM", Rheinwerk Publishing., 2009

REFERENCE BOOKS

1. Stuart Emmett, " Excellence in Warehouse Management: How to Minimise Costs and Maximise Value ", John Wiley &Sons., 2005.
2. Ernst F. Bolten, "Managing Time and Space in the Modern Warehouse: With Ready-to-Use Forms, Checklists, & Documentation ", AMACOM, 1997.
3. Carter M.B., Lange J., Bauer F.-P., Persich C., Dalm T., SAP Extended Warehouse Management: Processes, Functionality and Configuration, Galileo press., 2010.

WEB REFERENCES

1. https://www.ijariit.com/manuscripts/v5i5/V5I5-1156.pdf
2. https://journals.vilniustech.lt/index.php/Transport/article/download/1126/874

ONLINE COURSES / RESOURCES:

1. https://www.interlakemecalux.com/blog/warehouse-technology
2. https://www.thebrimichgroup.com/warehouse-technology-trends-in-operations/
3. https://www.coursera.org/lecture/supply-chain-principles/warehouse-management-systems-FPzuc
4. https://www.erpsoftwareblog.com/2021/11/six-important-warehouse-processes/

21ME1942	MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the principles and concepts of material handling.
- To understand the classification, selection, and application of material handling equipment
- To understand the role of automated systems in handling components and assemblies..
- To apply reliability concepts for optimizing system performance and maintenance strategies.
- To analyze role of human factors in optimizing maintenance processes and operations.

UNIT I INTRODUCTION TO MATERIALS HANDLING **9**

Objectives and benefits of Material handling, Relationship between layout and Material handling, Principles of material handling, Unit load concept.

UNIT II MATERIAL HANDLING EQUIPMENT **9**

Classification of material handling equipments, Equipment selection, Packaging, material handling systems, handling of components and assemblies, Automated guided vehicle systems.

UNIT III REPAIR & RELIABILITY **9**

Analysis of downtime – Repair time distribution – Maintainability prediction – Measures ofmaintainability – Availability definitions – System Availability – Replacement decisions – Economic life. Analysis of downtime-Repair time distribution (exponential, lognormal)-MTTR- Reliability prediction-MTBF, MTTF-Reliability of series & parallel systems-Reliability Centred Maintenance. System repair time-Maintainability prediction.

UNIT IV MAINTENANCE CONCEPT **9**

Need for maintenance-Challenges in maintenance-Objectives of maintenance-Maintenance Organization- Scope of maintenance department- Maintenance management- Tero Technology-Five zero concept-Maintenance performance measurement- Maintenance costs-Maintenance audit.

UNIT V MAINTENANCE POLICIES & LOGISTICS **9**

Planned vs unplanned maintenance-Preventive maintenance vs Breakdown maintenance-Predictive maintenance-Corrective maintenance-Opportunistic maintenance-Design outmaintenance-Condition Based Maintenance (CBM)- Proactive and Reactive maintenance-Minimum vs Extensive maintenance-Work order form- Maintenance planning-Maintenance scheduling-Spare parts control & inventory management- Human factors in maintenance-Maintenance crew size-Replacement models.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the benefits of using unit load concepts for optimized material flow.

CO2: Analyze the role of automated guided vehicle systems in improving handling efficiency.

CO3: Analyze different material handling equipment types, their selection criteria

CO4: Apply reliability measures for effective maintenance and system availability management.

CO5: Apply inventory management for efficient maintenance operations.

TEXT BOOKS

1. James, Apple, “Material Handling System design”, Ronald Press, 1980.
2. Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2007.
3. Tanmoy Deb, "Maintenance Management and Engineering", Ane Books Pvt.Ltd., 2011.

REFERENCE BOOKS

1. Pannerselvam.R, “Production and Operations Management”, PHI, 2nd Edition, 2005.
2. Jiang, Renyan, "Introduction to Quality and Reliability Engineering", Springer, 2015
3. Charles E.Ebeling, "An Introduction to Reliability and Maintaibaility Engineering", Mc Graw Hill Education (India) Pvt.Ltd, 2013.
4. Mishra.R.C. Pathak. K, "Maintenance Engineering and Management", Second Edition, PHI Learning, 2012.

WEB REFERENCES

1. https://mrcet.com/downloads/digital_notes/ME/IV%20year/PLMH%20NOTES.pdf
2. https://www.businessmanagementideas.com/materials-management-2/equipments-materials-management-2/material-handling-equipment-selection-and-maintenance/10772
3. https://www.davuniversity.org/images/files/study-material/MEC250-Production%20and%20Operations%20Management-Repair%20and%20Maintenance.pdf
4. https://gppanchkula.ac.in/wp-content/uploads/2022/04/PMMH-6th-Sem-E-CONTENTS.pdf

ONLINE COURSES / RESOURCES:

1. https://youtu.be/uiz4s6W6LMs
2. https://youtu.be/T_tDTuBgYws
3. https://youtu.be/uO4WfYDOWxo

21ME1943	PLANT LAYOUT DESIGN AND ERGONOMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the knowledge of basic human science and Engineering science
- To understand the factors influencing location decisions, various qualitative and quantitative models for selecting optimal warehouse locations.
- To understand the importance of facility layout planning, different layout procedures for optimizing space and workflow.
- To understand various methods for designing process layouts for optimizing production flow and efficiency.
- To understand the scope, principles, and design of material handling systems.
- To analyse principles of ergonomics and its application in designing work systems.

UNIT I PLANT LOCATION **9**

Introduction, Factors affecting location decisions, Qualitative models, Quantitative models, Break-Even analysis model, Brown & Gibbs model, Single facility location models, Gravity location models, Mini-Sum model, Mini-Max model, Multi facility location models, Covering model, Warehouse location model.

UNIT II FACILITIES LAYOUT DESIGN **9**

Need for layout study, Objectives of a good facility layout, Classification of layout, Layout procedure – Nadler's ideal system approach – Immer's basic steps – Apple's layout procedure – Reed's layout procedure, Layout planning – Systematic layout planning(SLP) – Information gathering, Flow analysis & Activity analysis, Relationship diagram, Space requirement and availability, Designing the layout.

UNIT III COMPUTERIZED LAYOUT PLANNING AND DESIGNING PRODUCT LAYOUT **9**

Designing the process layout – CRAFT, ALDEP, CORELAP – Trends in computerized layout, Group technology models – Production flow analysis (PFA) – Rank order clustering (ROC). Line balancing – Objectives, Line balancing techniques – Largest candidate rule (LCR) – Kilbridge & Wester method (KWM) – Rank Positional Weight method (RPW) – COMSOAL, Mixed model assembly line balancing

UNIT IV MATERIALS HANDLING AND PACKAGING **9**

Scope and definitions of material handling – Objectives, Principles of material handling, Unit load concept, Material handling system design, Classification of material handling equipments, Equipment selection & specification, JIT impact on facilities design, Packaging.

UNIT V ERGONOMICS **9**

Ergonomics – Interdisciplinary nature- Human–machine systems -Ergonomics and its areas of application in the work system - Future directions for ergonomics- Biostatic and Biodynamic Mechanics. Problems of body size- Anthropometry measures- Work posture– Design for standing and seated workers - Design of repetitive tasks - Design of manual handling tasks- VDT work stations – Hand tool design. Design and Assessment in Hot, cold workplaces and the design of the physical environment–Noise and vibration- Vision – Human errors and Accidents – OSHA: Ergonomics Safety and Health Management rules –

Personal Protective Equipments.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Apply different location models for effective warehouse site selection and decision-making.
CO2: Apply layout planning techniques and space requirements, to design efficient facility layouts.
CO3: Apply layout design tools to improve workflow and assembly line performance.
CO4: Analyze different material handling equipment and design efficient systems
CO5: Ability to apply ergonomic principles to design workplaces for the improvement of human performance.

TEXT BOOKS

1. Tompkins, J.A. and White J A et al., “Facilities planning”, John Wiley & Sons, 2010.
2. Martin Helander, “A guide to Ergonomics of Manufacturing”, TMH, 2006.

REFERENCE BOOKS

1. James, Apple, “Material Handling System Design”, Ronald Press, 1980.
2. Krajewski. J and Ritzman, “Operations management – Strategy and Analysis”, Addison –Wesley publishing company, 5th edition, 1999.
3. Pannerselvam.R, “Production and Operations Management”, PHI, 2017
4. Richard Francis. L. and John A. White, “Facilities Layout and location - an analytical approach”, PHI., 2002.
5. Bridger, R. S.”Introduction to Ergonomics”, 3rd ed. CRC Press, New York and London,2008

WEB REFERENCES

1. https://www.ilo.org/global/topics/safety-and-health-at-work/normative-instruments/code-of-practice/lang--en/index.htm
2. https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/instructionalmaterial/wcms_178593.pdf
3. https://www.ilo.org/global/topics/labour-administration-inspection/resources-library/publications/guide-for-labour-inspectors/machinery-plant-equipment/lang-en/index.htm

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112107292
2. https://www.digimat.in/nptel/courses/video/107103004/L01.html
3. https://www.digimat.in/nptel/courses/video/112107238/L17.html

21ME1944	LOGISTICS IN MANUFACTURING, SUPPLY CHAIN AND DISTRIBUTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the key concepts of business logistics, supply chain management for optimizing operational efficiency and decision-making.
- To understand decision-making techniques, distribution network design for optimizing supply chain networks and logistics operations.
- To understand the Inventory models and warehouse functions.
- To understand the key factors in transportation management, packaging design considerations in logistics optimization.
- To analyze organizational structure, management choices, and control systems in enhancing inter-functional and inter-organizational collaboration.

UNIT - I INTRODUCTION 9

Business logistics and supply chain – importance, objectives and drivers. Strategy – planning, selecting proper channel, performance measurement. Outsourcing- Make vs buy approach – sourcing strategy

UNIT - II MANAGING FLOWS 9

Planning Networks – Decision making under risk – Decision trees – Decision making under uncertainty. Distribution Network Design – Role - Factors Influencing Options, Value Addition.. Supply Chain Network optimization models. Logistics information system - Role of IT – Framework for IT adoption.

UNIT - III INVENTORY AND WAREHOUSING 9

Inventory–objectives, bullwhip effect, control - Probabilistic inventory models, Risk pooling, Vendor managed inventory, Multi-echelon inventory. Warehousing Functions – Types – Site Selection – Decision Model – Layout Design – Costing – Virtual Warehouse

UNIT - IV TRANSPORTATION AND PACKAGING 9

Transportation – Drivers, Modes, Measures - Strategies for Transportation, 3PL and 4PL, Vehicle Routing and Scheduling. Packaging- Design considerations, Material and Cost. Packaging as Unitisation. Consumer and Industrial Packaging.

UNIT - V ORGANISATION AND CONTROL 9

Organization Structure – need and development. Organizational – Choices, Orientation and positioning. Inter functional and inter organizational management – alliances and partnerships. Control – Process framework, system details, information, measurement and interpretation.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the importance of logistics, supply chain strategies, and performance measurement

CO2: Apply decision trees, optimize distribution networks, and leverage IT frameworks for efficient supply chain and logistics management

CO3: Analyze warehouse functions and the impact of site selection and layout on cost efficiency.

CO4: Apply importance of unitization and the difference between consumer and industrial packaging.

CO5: Organizational structure, management strategies, and control processes in decision-making across functions and organizations.

TEXT BOOKS

1. Ronald H. Ballou and Samir K. Srivastava, Business Logistics and Supply Chain Management, Pearson education,Fifth Edition
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 2007.

REFERENCE BOOKS

1. Bowersox Donald J, Logistics Management – The Integrated Supply Chain Process,Tata McGraw Hill, 2010
2. Vinod V. Sople, Logistics Management-The Supply Chain Imperative, Pearson. 2012.
3. Coyle et al., The Management of Business Logistics, Thomson Learning, 7th Edition, 2004.
4. Mohanty R.P and Deshmukh S.G, Supply chain theories and practices, Biztantra publications, 2007.
5. Leenders, Johnson, Flyn, Fearon, Purchasing and supply management, Tata McGraw Hill, 2010.

WEB REFERENCES

1. https://www.axestrack.com/roles-of-logistics-in-supply-chain-management/
2. https://www.investopedia.com/terms/s/scm.asp
3. https://scm.ncsu.edu/scm-articles/article/what-is-supply-chain-management-scm
4. https://www.michiganstateuniversityonline.com/resources/supply-chain/what-is-supply-chain-management/

ONLINE COURSES / RESOURCES:

1. https://youtu.be/KMeKkIkj-4Q
2. https://youtu.be/Mi1QBxVjZAw
3. https://youtu.be/YdTbM4XlizY

21ME1945	DATA SCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize students with the data science process.
- To understand the data manipulation functions in Numpy and Pandas.
- To explore different types of machine learning approaches.
- To understand and practice visualization techniques using tools.
- To learn to handle large volumes of data with case studies

UNIT - I INTRODUCTION 9

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Definingresearch goals – Retrieving data – data preparation - Exploratory Data analysis – build the model –presenting findings and building applications - Data Mining - Data Warehousing – Basic statisticaldescriptions of Data

UNIT - II DATA MANIPULATION 9

Python Shell - Jupyter Notebook – IPython Magic Commands - NumPy Arrays-Universal Functions– Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Datamanipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchicalindexing – Combining datasets – Aggregation and Grouping – String operations – Working with timeseries – High performance

UNIT - III MACHINE LEARNING 9

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning -Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

UNIT - IV DATA VISUALIZATION 9

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density andcontour plots – Histograms – legends – colors – subplots – text and annotation – customization –three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

UNIT - V HANDLING LARGE DATA 9

Problems - techniques for handling large volumes of data - programming tips for dealing with largedata sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools andtechniques needed - Research question - Data preparation - Model building – Presentation andautomation..

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the data science process and warehousing techniques.

CO2: Analyze the Python tools for data manipulation, analysis, and high-performance operations.

CO3: Analyze the different types of machine learning, including supervised, unsupervised, and semi-supervised learning

CO4: Understand the various visualization using tools.

CO5: Analyze the techniques for handling large datasets, including data preparation, model building, and automation

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.

REFERENCE BOOKS

1. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green TeaPress,2014.

21ME1946	THERMAL POWER ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the types, characteristics, and calorific values calculation.
- To understand the different types of boilers and compute their performance parameters.
- To understand the classification and efficiency parameters of compressors
- To understand the working principles and performance characteristics of various refrigeration systems.
- To understand psychrometric properties, processes, and air conditioning systems.

UNIT – I FUELS AND COMBUSTION 9

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis – Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values

UNIT – II BOILERS 9

Types and comparison, Mountings and Accessories. Performance calculations, Boiler trial.

UNIT – III AIR COMPRESSORS 9

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors

UNIT – IV REFRIGERATION SYSTEMS 9

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration.

UNIT – V PSYCHROMETRY AND AIR-CONDITIONING 9

Psychrometric properties – Property calculations using Psychrometric chart and expressions. Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

CO1: Determine the properties of fuels such as moisture content, calorific value, and differentiate between gross and net calorific values.

CO2: Analyze different types of boilers and compute their performance parameters.

CO3: Analyze the performance of reciprocating and rotating compressors.

CO4 Analyze the effects of superheating, sub-cooling, and perform performance calculations for different refrigeration systems.

CO5: Analyze air conditioning systems, and perform cooling load calculations.

TEXT BOOKS:

1. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.
2. Balla ney. P, “ Thermal Engineering”, 25th Edition, Khanna Publishers, 2017.

REFERENCES BOOKS:

1. Ananthanarayanan P.N, “ Basic Refrigeration and Air-Conditioning”, 4th Edition, Tata McGraw Hill,2013.
2. Arora, “ Refrigeration and Air-Conditioning”, 2nd Edition, Prentice Hall of India, 2010.
3. Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
4. Nag P.K, “ Basic and Applied Thermodynamics”, 2nd Edition, Tata McGraw Hill, 2010
5. Soman. K, “Thermal Engineering”, 2nd Edition, Prentice Hall of India, 2011.

WEB REFERENCES

1. https://www.udemy.com/topic/power-engineering/
2. https://npti.gov.in/post-graduate-certificate-course-thermal-power-plant-engineering
3. https://npti.gov.in/post-graduate-certificate-course-thermal-power-plant-engineering

ONLINE COURSES / RESOURCES:

1. https://www.classcentral.com/course/swayam-power-plant-engineering-17735
2. https://mech.iitm.ac.in/meiitm/course/
3. https://www.manchester.ac.uk/study/masters/courses/list/04435/msc-thermal-power-and fluid-engineering/

21ME1947	SELECTION OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the factors involved in selecting materials for various engineering applications.
- To understand the factors influencing material selection, including failure analysis.
- To understand the relationship and the techniques used for producing various materials and components.
- To understand testing and characterization methods for various materials.
- To analyze the selection of materials for specialized applications.

UNIT - I ENGINEERING MATERIALS 9

Introduction – classification of engineering materials –classification metal and alloys, polymers, ceramics and glasses, composites, natural materials,-non metallic materials- smart materials - physical, metrical properties of metals - selection of materials for engineering purposes –selection of materials and shape

UNIT - II MATERIAL PROPERTIES 9

Mechanical properties – fatigue strength – fracture Toughness - Thermal Properties - Magnetic Properties - Fabrication Properties –electrical , optical properties - Environmental Properties , Corrosion properties –shape and size - Material Cost and Availability– failure analysis

UNIT - III MANUFACTURING PROCESSING AND ECONOMIC ANALYSIS 9

Interaction of Materials Selection, Design, and Manufacturing Processes - Production Processes and Equipment for Metals - Metal Forming, Shaping, and Casting - Plastic Parts Processing - Composites Fabrication Processes - Advanced Ceramics Processing – surface treatment - Resource -The Price and Availability of Materials

UNIT - IV MATERIALS SELECTION CHARTS AND TESTING 9

Ashby material selection charts- Professional and Testing Organizations -Testing of Metallic Materials - Plastics Testing - Characterization and Identification of Plastics - Ceramics Testing - Nondestructive Inspection.

UNIT - V APPLICATIONS AND USES 9

Selection of Materials for Biomedical Applications - Medical Products - Materials in Electronic Packaging - Advanced Materials in Sports Equipment - Advanced Materials in Telecommunications - Materials Selection for Wear Resistance - Using Composites - Manufacture and Assembly with Plastics, fiber and Diamond Films.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the material selection criteria based on physical and mechanical properties for specific engineering purposes.

CO2: Analyze and assess materials based on properties

CO3: Apply appropriate production processes for manufacturing requirements.

CO4: Analyze appropriate testing and characterization of materials for performance evaluation.

CO5: Analyze appropriate advanced materials for various applications, and understand their manufacturing and assembly processes..

TEXT BOOKS

1. Ashby, M. F., Materials selection in mechanical design, 3rd edition. Elsevier, 2005.
2. Ashby, M. F. and Johnson, K., Materials and design – the art and science of material selection in product design, Elsevier, 2002.
3. P. Field Foster, The Mechanical Testing of Metals and Alloys, 7thedition, Cousens Press, 2007.

REFERENCE BOOKS

1. Charles, J. A., Crane, F. A. A. and Furness, J. A. G., Selection and use of engineering materials, 3rd edition, Butterworth-Heinemann, 1997.
2. Myer Kutz, Handbook of Materials Selection, John Wiley & Sons, Inc., NewYork, 2002.
3. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.

WEB REFERENCES

1. http://www.utc.fr/~hagegebe/UV/MQ12/CORRECTIONS_TD/%5BASHBY99%5D%20-20Materials%20Selection%20In%20Mechanical%20Design %202Ed.pdf
2. https://uomustansiriyah.edu.iq/media/lectures/5/5_2016_05_01!08_27_09_PM.pdf

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_me59/preview
2. https://automaterials.files.wordpress.com/2018/09/selecting-material-for-engineering-applications.pdf

21ME1948	INTERNET OF THINGS FOR MECHANICAL ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand IoT, Overview of IoT Building Blocks.
- To understand commonly used IoT Simulation Hardware platforms.
- To understand different Communication Technologies used in IoT.
- To understand of application level protocol and Security of IoT Ecosystem.
- To understand IoT applications in different domains.

UNIT - I INTRODUCTION TO THE INTERNET OF THINGS (IOT) 9

.Overview, History, Definition and Characteristics, Connectivity Terminologies, Building blocks, Types of technologies used in IoT System, Baseline Technologies (Machine-to-Machine (M2M) communications, Cyber-Physical-Systems (CPS)), IoT Vs M2M, IoT enabled Technologies, IoT Levels and Templates, Design Methodology, The Physical Design Vs Logical Design of IoT, Functional blocks of IoT and Communication Models/Technologies, Development Tools used in IoT, IoT Architecture and Protocols, Various Platforms for IoT, Real time Examples of IoT, Challenges in IoT, The process flow of an IoT application, Evolution of Connected Devices, Applications of IoT, IoT Enablers, Overview of Governance, Privacy and Security Issues.

UNIT - II IOT SIMULATION ENVIRONMENT HARDWARE PLATFORMS AND ENDPOINT INTERFACING 9

IoT supported Hardware platforms: Introduction to IoT Simulation Environment and Devices (Raspberry Pi, Espressif Processors, Arduino), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, I2C), Programming with focus on interfacing for reading input from pins, connecting external gadgets/sensors/actuators, Controlling and Displaying Output, Libraries, Basics of Embedded C programming, Interfacing: Interfacing Input, Intermediate, Output and Display Sensors, Converters, Actuators, Controlling Hardware, Controllers and Network Devices, IoT Architecture: Building architecture and Open source architecture (OIC), Main design principles and needed capabilities, An IoT architecture outline, Standards Considerations

UNIT - III INTERFACING AND COMMUNICATION FOR BUILDING IOT APPLICATIONS 9

Communication: Overview and Working of Controlled Systems, Connectivity models - TCP/IP Vs OSI model, IoT Communication Models, IoT Communication APIs, Serial Vs Parallel Communication, Wires Vs Wireless Communication, their Technologies and Hardware

IoT Communication Protocols: Protocol Standardization for IoT, Role of M2M in IoT, M2M Value Chains, IoT Value Chains, M2M and WSN Protocols (SCADA and RFID)

Physical Servers and Cloud Platforms: Web server, Posting sensor(s) data to web server, Introduction to Cloud Storage models and Communication APIs Webserver, API Virtualization concepts and Cloud Architecture, Advantages and limitations of Cloud computing, IoT Cloud platforms, Cloud services.

UNIT - IV IOT APPLICATION DEVELOPMENT AND SECURITY OF IOT ECOSYSTEM **9**

Application Protocols: MQTT, REST/HTTP, SQL Back-end Application Designing (Designing with Apache, MySQL, HTML, CSS), Non SQL Back-end Application Designing (MongoDB Object Type Database, jQuery for UI Designing), JSON lib for data processing.

Security: Need of security in IoT, Security & Privacy during development, Privacy for IoT enabled devices, IoT security for consumer devices, Security levels, protecting IoT devices, Security, Privacy and Trust in IoT-Data-Platforms

UNIT - V PRESENT AND FUTURE DOMAIN SPECIFIC APPLICATIONS OF IOT ECOSYSTEM **9**

IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, Business, Manufacturing, Smart Homes/Home automation, Surveillance applications, Connected Vehicles, Agriculture, Healthcare, Activity Monitoring, Retail, Logistics, Security, Health and Lifestyle, Legal challenges, IoT in Environmental Protection Modern Day IoT Applications, Smart Grid, Smart Cities - Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities

Future: Future IoT ecosystem, Need of powerful core for building secure algorithms, Examples for new trends (AI, ML penetration to IoT)

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the Applications/Devices, Protocols and Communication Models of IoT.
CO2: Analyze the and Select commonly used IoT Simulation Hardware platforms.
CO3: Analyze the Application of Interfacing and Communication Technologies for IoT.
CO4: Analyze the d IoT Application development and Security of IoT Ecosystem.
CO5: Analyze the Present and Future Domain specific Applications of IoT Ecosystem.

TEXT BOOKS

1. Bahga, A. and Madisetti, V., (2015), “Internet of Things - A Hands-on Approach,” Universities Press, ISBN: 9788173719547.
2. Hajjaj, S S H. and Gsangaya, K. R., (2022), “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers,” CRC Press, ISBN: 9781032110950.
3. Raj, P. and Raman, A. C., (2017), “The Internet of Things: Enabling Technologies, Platforms, and Use Cases,” Auerbach Publications/CRC Press, ISBN: 9781498761284
4. Adrian McEwen, A. and Cassimally, H., (2013), “Designing the Internet of Things,” John Wiley and Sons, ISBN:
5. Veneri, G., Capasso, A., (2018), “Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0,” Packt Publishing, ISBN: 9781789537222.
6. Hersent, O, Boswarthick, D., Elloumi, O., (2012), “The Internet of Things: Key Applications and Protocols”, Wiley, ISBN: 9781119994350 .
7. Uckelmann, D., Harrison, M., Michahelles, F., (2011), “Architecting the Internet of Things,” Springer, ISBN: 9781119994350.

REFERENCE BOOKS

1. DaCosta, F., (2013), “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, Apress Publications, ISBN: 9781430257417.
2. Waher, P., (2015), “Learning Internet of Things,” Packt Publishing, ISBN: 9781783553532.
3. Ovidiu, V. and Friess, P., (2014), “Internet of Things - From Research and Innovation to Market Deployment,” River Publishers, ISBN: 9788793102941, https://www.riverpublishers.com/pdf/ebook/RP_E9788793102958.pdf.
4. Ida, N., (2020), “Sensors, Actuators and Their Interfaces,” SciTech Publishers, ISBN: 9781785618352.
5. Pfister, C., (2011), “Getting Started with the Internet of Things,” O’Reilly Media, ISBN: 9781449393571.
6. Wallace, S., Richardson, M., Wolfram Donat, W., (2021), “Getting Started With Raspberry Pi: Getting to Know the Inexpensive ARM-Powered Linux Computer,” Make Community, LLC, ISBN: 9781680456998.
7. Elangovan, U., (2019), “Smart Automation to Smart Manufacturing: Industrial Internet of Things,” Momentum Press, ISBN: 9781949449266.
8. Jha, S., Tariq, U., Joshi, G. P., Solanki, V. K., (2022), “Industrial Internet of Things: Technologies, Design, and Applications,” CRC Press, ISBN: 9780367607777
9. Schwartz, M., (2016), “Internet of Things with Arduino Cookbook,” Packt Publishing, ISBN: 9781785286582.
10. Kurniawan, A., (2019), “Internet of Things Projects with ESP32: Build exiting and powerful IoT projects using the all-new Expresif ESP32,” Packt Publishing, ISBN: 9781789956870.

WEB REFERENCES

1. http://playground.arduino.cc/Projects/Ideas
2. http://www.megunolink.com/articles/arduino-garage-door-opener
3. http://www.willward1.com/arduino-wifi-tutorial
4. http://www.toptechboy.com/arduino-lessons
5. https://www.eprolabs.com
   http://www.makeuseof.com/tag/pi-overdose-heres-5-raspberry-pi-alternatives

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/106105166
2. https://www.udemy.com/internet-of-things-iot-for-beginners-getting-started/

21ME1949	MACHINE VISION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand machines to visually inspect objects for quality control, sorting, or measurement tasks.
- To understand the fundamental principles of colour systems, light sources, and lighting techniques.
- To understand techniques for processing binary and gray scale images.
- To understand and compare different classification methods.
- To explore the applications of imaging and classification technologies in various industries.

UNIT - I INTRODUCTION TO MACHINE VISION 9

Machine Vision use of machine vision – tasks for a vision system – relation to other fields – place of vision in CIM.

UNIT - II IMAGE ACQUISITION AND CONVERSION 9

Colour systems – light sources – lighting techniques – image formation by lensing – image scanning – television cameras – sensors, charge coupled devices – camera and system interface – frame buffers and frame grabbers – digital and smart cameras.

UNIT - III PATTERN RECOGNITION 9

Processing of binary images – thresholding, geometrical properties, topological properties – processing of gray scale images statistical operations, spatial operations, segmentation edgedetection, morphological operations – image analysis – factors extraction – decision making.

UNIT - IV MACHINE VISION APPLICATIONS 9

Fundamentals – parametric classifiers – nonparametric, classifiers nearest neighbour CART, neural networks, generic classifiers.

UNIT - V ISOPARAMETRIC FORMULATION 9

Applications in user industries automotive, semiconductor, electronic manufacturing, printing industries etc. – generic applications founding manufacturing metrology, inspection assembly verification – application analysis and implementation.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basics of machine vision.
CO2: Analyze the image acquisition and conversion techniques.
CO3: Apply the image processing techniques.
CO4: Apply the machine vision techniques to pattern recognizing.
CO5: Apply the machine vision in manufacturing industries in process implementation, assembly.

TEXT BOOKS

1. Milan Sonka, Vaclav Hlavac, Roger Boyie, "Image Processing Analysis and machine vision" Cengage Learning India Pvt Ltd (2008)

REFERENCE BOOKS

1. Richard O.Duda, Peter E. Hurt, Pattern Classification and Scene Analysis Publisher, 1973
2. Rafael C. Gonzaies, Richard E. Woods, Digital Image processing publisher, 1992
3. Nellazuech, 'Understanding & applying machine vision Marceldekker Inc. 2000.

WEB REFERENCES

1. https://nptel.ac.in/courses/106105216
2. https://nptel.ac.in/courses/108103174
3. https://www.coursera.org/courses?query=computer%20vision management/

21ME1950	ADVANCED VEHICLE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of electric vehicle and their characteristics.
- To understand different types of motors and the selection of motor for vehicle applications.
- To understand different sensors and systems used in autonomous andconnected vehicles.
- To analyze networking with sensors and systems.
- To analyze the modern methods of diagnosing on-board the vehicle troubles.

UNIT - I ELECTRIC VEHICLES 9

EV architectures, advantages and disadvantages, Electrical and mechanical energy storagetechnologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT - II ELECTRIC VEHICLE MOTORS 9

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

UNIT - III AUTONOMOUS AND CONNECTED VEHICLES 9

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT - IV AUTOMOTIVE NETWORKING 9

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT - V ON-BOARD TESTING 9

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the electric vehicles and their importance in automotive.
CO2: Analyze the characteristics and the selection of traction motor.
CO3: Analyze the vehicle-to-vehicle and autonomous technology.
CO4: Analyze networking of various modules in automotive systems, communication protocols.
CO5: Analyze the modern methods of diagnosing on-board the vehicle troubles.

TEXT BOOKS

1. 1 John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & SonsLtd., 2018
2. Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and AutonomousVehicles in Smart Cities, CRC Press, 1st Edition, 2020.

REFERENCE BOOKS

1. Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
2. Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms &Implementation‖, Springer, 2011
3. Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science,
4. Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew MWright and Harrison R Scott | 5 September 2012
5. Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002
6. Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011

WEB REFERENCES

1. https://en.wikipedia.org/wiki/Electric_vehicle
2. https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee112/course
2. https://www.udemy.com/course/electric-vehicles-comprehensive-course/

21ME1951	NON DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of NDT.
- To understand the concepts of Liquid penetrant test in surface non destructive evaluation.
- To understand the concepts of magnetic particle test in surface non destructive evaluation.
- To understand the concepts of thermography and Eddy current testing.
- To understand the concepts of Ultrasonic testing and Acoustic emission.
- To understand the concepts 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 NDE METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants - Developers - Advantages and limitations of various methods - Testing Procedure - Interpretation of results - Case study.

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 (ET) 9

Thermography - Principles - Contact and non contact inspection methods - Techniques for applying liquid crystals - Advantages and limitations - 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 (AE) 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 - Case study.

Acoustic Emission Technique – Principle - AE parameters - Applications.

UNIT - V RADIOGRAPHY (RT) 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 -Precautions against radiation hazards.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

Upon completion of the course, students will be able to

CO1: Analyze the basic concepts in Non-Destructive testing.
CO2: Analyze the fundamentals involved in liquid penetrant testing.
CO3: Analyze the fundamentals involved in magnetic particle testing.
CO4: Apply the concepts of thermography and eddy current non-destructive testing.
CO5: Apply the concepts of ultrasonic testing and acoustic emission.

TEXT BOOKS

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2014.
2. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010

REFERENCE BOOKS

1. ASM Metals Handbook, ”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
3. Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.
4. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005

WEB REFERENCES

1. https://inspectioneering.com/tag/nondestructive+testing
2. https://www.twi-global.com/technical-knowledge/faqs/what-is-non-destructive-testing
3. https://www.ndt.net/article/az/preface.htm
4. https://www.youtube.com/watch?v=5cNWF61Tmj0&list=PLyAZSyX8Qy5AePdV6vbGP4OJQOpbga-0Q
5. https://www.youtube.com/watch?v=jv4bA5UexjU
6. https://www.youtube.com/watch?v=UjvUyXGAjoo

ONLINE COURSES / RESOURCES:

1. https://www.udemy.com/course/non-destructive-testing-methods/
2. http://www.twivirtualacademy.com/online-courses/ndt/
3. https://ndttrainingonline.com/
4. https://onlinecourses.nptel.ac.in/noc22_mm13/preview
5. https://trinityndt.com/
6. https://www.classcentral.com/course/swayam-theory-and-practice-of-non-destructive-testing-9872