VELAMMAL

COLLEGE OF ENGINEERING & TECHNOLOGY, MADURAI – 625 009

(Autonomous)

(Accredited by NAAC with 'A' Grade and by NBA for 5 UG Programmes)

(Approved by AICTE and affiliated to Anna University, Chennai)

DEPARTMENT OF MECHANICAL ENGINEERING

B.E. MECHANICAL ENGINEERING

CURRICULUM and SYLLABUS

(I to VIII Semesters)

VELAMMAL COLLEGE OF ENGINEERING AND TECHNOLOGY
VIRAGANOOR, MADURAI – 625 009.
(AUTONOMOUS)
B.E. MECHANICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM
REGULATIONS 2021
I TO VIII SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	Category	L	T	P	C
1	21IP101	Induction Programme (*Common to all B.E/B.Tech. Programmes*)	-	0	0	0	0
THEORY							
2	21EN101	Professional English – I (*Common to all B.E/B.Tech. Programmes*)	HS	3	2	0	4
3	21MA101	Matrices and Calculus (*Common to all B.E/B.Tech. Programmes*)	BS	3	2	0	4
4	21PH101	Engineering Physics (*Common to all B.E/B.Tech. Programmes*)	BS	3	0	0	3
5	21CH101	Engineering Chemistry (*Common to all B.E/B.Tech. Programmes*)	BS	3	0	0	3
6	21CS101	Problem Solving and Python Programming (*Common to all B.E/B.Tech. Programmes*)	ES	3	0	0	3
7		Cambridge Course*	EE	1	0	0	1
PRACTICAL COURSES							
8	21CS102	Problem Solving and Python Programming Laboratory (*Common to all B.E/B.Tech. Programmes*)	ES	0	0	4	2
9	21PC101	Physics and Chemistry Laboratory (*Common to all B.E/B.Tech. Programmes*)	BS	0	0	4	2
Total Credits							**22**

*** Naan Mudhalvan Scheme Course**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	Category	L	T	P	C
THEORY							
1	21EN102	English – II *(Common to all B.E. / B.Tech. Programmes)*	HS	3	0	0	3
2	21MA102	Vector Calculus and Complex Variables *(Common to Civil, EEE & Mechanical)*	BS	3	2	0	4
3	21PH106	Physics for Mechanical Engineering	BS	3	0	0	3
4	21ME101	Engineering Graphics *(Common to all B.E. / B.Tech. Programmes)*	ES	2	0	2	3
5	21ME102	Engineering Mechanics	PC	3	0	0	3
6	21CH103	Environmental Science *(Common to all B.E. / B.Tech. Programmes)*	BS	2	0	0	2
THEORY WITH PRACTICAL COURSE							
7	21EE103	Basic Electrical and Electronics Engineering (*Common to Civil & Mechanical*)	ES	3	0	2	4
PRACTICAL COURSE							
8	21EM101	Engineering Practices Laboratory *(Common to all B.E. / B.Tech. Programmes)*	ES	0	0	4	2
						Total	**24**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	Category	L	T	P	C
THEORY							
1	21MA201	Transforms and Partial Differential Equations *(Common to Civil, ECE, & Mechanical)*	BS	3	2	0	4
2	21ME201	Engineering Thermodynamics	PC	3	0	0	3
3	21ME202	Strength of Materials for Mechanical Engineers	PC	3	0	0	3
4	-	Microsoft office Fundamentals*	EE	1	0	0	1
THEORY WITH PRACTICAL COURSES							
5	21ME203	Engineering Metallurgy	PC	3	0	2	4
6	21ME204	Manufacturing Technology – I	PC	3	0	2	4
7	21EE216	Electrical Drives and Controls	ES	3	0	2	4
PRACTICAL COURSE							
8	21EN201	Interpersonal Skills Laboratory - Listening & Speaking	HS	0	0	2	1
						Total	**24**

*** Naan Mudhalvan Scheme Course**

SEMESTER IV

S. No.	COURSE CODE	COURSE TITLE	Category	L	T	P	C
THEORY							
1	21MA204	Probability, Statistics and Numerical Methods *(Common to Civil & Mechanical)*	BS	3	2	0	4
2	21ME205	Manufacturing Technology – II	PC	3	0	0	3
3	21ME206	Kinematics and Dynamics of Machines	PC	3	0	0	3
4	21ME207	Thermal Engineering	PC	3	0	0	3
THEORY WITH PRACTICAL COURSE							
5	21ME208	Fluid Mechanics and Machinery	PC	3	0	2	4
PRACTICAL COURSES							
6	21ME209	Manufacturing Technology Laboratory – II	PC	0	0	4	2
7	21ME210	Thermal Engineering Laboratory	PC	0	0	4	2
8	21ME211	Kinematics and Dynamics Laboratory	PC	0	0	4	2
9	21EN202	Advanced Reading and Writing Laboratory	HS	0	0	2	1
						Total	**24**

SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	Category	L	T	P	C
THEORY							
1	21ME301	Design of Machine Elements	PC	3	0	0	3
2	21ME302	Productivity and Quality Management	PC	3	0	0	3
3	21ME303	Fluid power automation	PC	3	0	0	3
4	21PMEXX	Professional Electives I	PE	3	0	0	3
5	-	Naan Mudhalvan Scheme Course **	EE	2	0	0	2*
6	21MCC01	Constitution of India	MC	2	0	0	0
THEORY WITH PRACTICAL COURSES							
7	21ME304	Heat and Mass Transfer	PC	2	0	2	3
8	21ME305	Metrology and Measurements	PC	2	0	2	3
9	21ME306	Computer Aided Product Development	PC	2	0	2	3
PRACTICAL COURSE							
10	-	Summer Internship***	EE	0	0	0	1
						Total	**22**

**** Robotics Simulation for Manufacturing/ E-Vehicles for Mechanical Engineers /Machine Learning / IoT / Industry 4.0**

*****Two weeks Summer Internship.**

SEMESTER VI

S. No.	COURSE CODE	COURSE NAME	Category	L	T	P	C
THEORY							
1	21ME307	Design of Transmission System	PC	3	0	0	3
2	21PMEXX	Professional Electives II	PE	3	0	0	3
3	21OXXX	Open Elective – I	OE	3	0	0	3
4	21OXXX	Open Elective – II	OE	3	0	0	3
5	-	Naan Mudhalvan Scheme Course **	EE	2	0	0	2*
6	21MCC02	Essence of Indian Traditional Knowledge	MC	2	0	0	0
THEORY WITH PRACTICAL COURSES							
7	21ME308	Finite Element Analysis	PC	3	0	2	4
8	21ME309	Mechatronics and IoT*	PC	2	0	2	3
PRACTICAL COURSES							
9	21ME310	Design Thinking and Prototype Development	EE	0	0	4	2
10	21EN301	Professional Communication Laboratory	HS	0	0	2	1
11	-	One Credit Course	EE	0	0	2	1
						Total	**23**

SEMESTER VII

S. No.	COURSE CODE	COURSE NAME	Category	L	T	P	C
THEORY							
1	21PMEXX	Professional Electives III	PE	3	0	0	3
2	21 PMEXX	Professional Electives IV	PE	3	0	0	3
3	21OXXX	Open Elective – III	OE	3	0	0	3
4	21OXXX	Open Elective – IV	OE	3	0	0	3
5		Nan Mudhalvan Scheme Course**	EE	2	0	0	2*
PRACTICAL COURSE							
6	21ME401	Project Work I	EE	0	0	4	2
						Total	**14**

SEMESTER VIII

S. No.	COURSE CODE	COURSE NAME	Category	L	T	P	C
THEORY COURSES							
1	21PMEXX	Professional Electives V	PE	3	0	0	3
2	21PMEXX	Professional Electives VI	PE	3	0	0	3
PRACTICAL COURSE							
3	21ME402	Project Work II	EE	0	0	20	10
						Total	**16**

**** Robotics Simulation for Manufacturing/ E-Vehicles for Mechanical Engineers /Machine Learning / IoT / Industry 4.0**

Total Credits: 169

CATEGORY	I	II	III	IV	V	VI	VII	VIII	TOTAL CREDITS
BS	12	9	4	4					**29**
ES	5	9	4						**18**
HS	4	3	1	1		1			**10**
PC		3	14	19	18	10			**64**
PE					3	3	6	6	**18**
OE						6	6		**12**
EE	1		1		1+(2*)	3+(2*)	2+(2*)	10	**18**
MC					√	√			**-**
TOTAL	**22**	**24**	**24**	**24**	**22**	**23**	**14**	**16**	**169**

S.No.	Topic
1	Humanities and Social Sciences including Management (HS)
2	Basic Sciences (BS)
3	Engineering Sciences including workshop, drawing, basics of electrical/mechanical/computer etc. (ES)
4	Professional Core Courses (PC)
5	Professional Elective : Courses relevant to chosen specialization/ branch (PE)
6	Open Electives : Courses from other technical and/or emerging courses (OE)
7	Project work, Seminar and Internship in Industry –Employability Enhancement Courses (EE)
8	Mandatory Course (MC)
9	One Credit Courses (OC)

** ***Naan Mudhalvan Scheme Course- Subject to guidelines provided by Government of Tamil Nadu***

VERTICAL 1: PRODUCT AND PROCESS DEVELOPMENT

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21PME01	Design Concepts in Engineering	PE	3	0	0	3
2	21PME02	Product Life Cycle Management	PE	3	0	0	3
3	21PME03	Computer Integrated Manufacturing	PE	3	0	0	3
4	21PME04	Additive Manufacturing	PE	2	0	2	3
5	21PME05	Composite Materials in Product Development	PE	3	0	0	3
6	21PME06	Ergonomics in Design	PE	3	0	0	3
7	21PME07	Design for Manufacturing and Assembly	PE	3	0	0	3

VERTICAL 2: DIGITAL AND GREEN MANUFACTURING

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21PME08	Non-Traditional Machining Processes	PE	3	0	0	3
2	21PME09	Casting and Welding Processes	PE	3	0	0	3
3	21PME10	Non Destructive Testing	PE	3	0	0	3
4	21PME11	Surface Engineering	PE	3	0	0	3
5	21PME12	Industrial Automation Systems	PE	3	0	0	3
6	21PME13	Green Supply Chain Management	PE	3	0	0	3
7	21OPH01	Modern Material Characterization Techniques	PE	3	0	0	3

VERTICAL 3: CLEAN AND GREEN ENERGY TECHNOLOGIES

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21PME14	Renewable Energy Technologies	PE	3	0	0	3
2	21PME15	Bioenergy Conversion Technologies	PE	3	0	0	3
3	21PME16	Energy Storage Devices	PE	3	0	0	3
4	21PME17	Solar Energy Technologies	PE	3	0	0	3
5	21PME18	Energy Conservation in Industries	PE	3	0	0	3
6	21PME19	Equipment for Pollution Control	PE	3	0	0	3
7	21PME20	Environment Sustainability and Impact Assessment	PE	3	0	0	3

VERTICAL 4: LOGISTICS AND SUPPLY CHAIN MANAGEMENT

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21PME21	Logistics in Manufacturing, Supply Chain and Distribution	PE	3	0	0	3
2	21PME22	Materials Management	PE	3	0	0	3
3	21PME23	Enterprise Resource Planning	PE	3	0	0	3
4	21PME24	Warehousing Automation and	PE	3	0	0	3

		Container Logistics					
5	21PME25	Material Handling Equipment, Repair and Maintenance	PE	3	0	0	3
6	21PME26	Process Planning and Cost Estimation	PE	3	0	0	3
7	21PME27	Production Planning and Control	PE	3	0	0	3

VERTICAL 5: THERMAL POWER PROCESSES AND EQUIPMENT

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21PME28	Thermal Power Engineering	PE	3	0	0	3
2	21PME29	Automobile Engineering	PE	3	0	0	3
3	21PME30	Advanced Internal Combustion Engines	PE	3	0	0	3
4	21PME31	Refrigeration and Air Conditioning	PE	3	0	0	3
5	21PME32	Gas Turbines and Jet Propulsion	PE	3	0	0	3
6	21PME33	Power Plant Engineering	PE	3	0	0	3
7	21OCH02	Materials Chemistry	PE	3	0	0	3

VERTICAL 6: INDUSTRIAL SYSTEM ENGINEERING

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21PME34	Principles of Management	PE	3	0	0	3
2	21PME35	Total Quality Management	PE	3	0	0	3
3	21PME36	Lean Manufacturing	PE	3	0	0	3
4	21PME37	Industrial safety	PE	3	0	0	3
5	21PME38	Industry 4.0	PE	3	0	0	3
6	21PME39	Professional Ethics	PE	3	0	0	3
7	21PME40	Entrepreneurship Development	PE	3	0	0	3
8	21PME41	Operations Research	PE	3	0	0	3

ONE CREDIT COURSES

S. No.	Course Code	Course Name	Category	L	T	P	C
1	21OCME01	Design for Additive Manufacturing- SIEMENS	EE	0	0	2	1
2	21OCME02	Product Design and Development- Thors E learning	EE	0	0	2	1
3	21OCME03	Testing of Materials-CIPET	EE	0	0	2	1
4	21OCME04	Alternate Fuels- Optima Heat Technologies	EE	0	0	2	1
5	21OCME05	Startup- MSME	EE	0	0	2	1
6	21OCME06	Lean Six Sigma- Intelligence Quality	EE	0	0	2	1

SEMESTER – I

21IP101	INDUCTION PROGRAMME *(Common to all B.E./ B.Tech. programmes)*	L	T	P	C
		0	0	0	0

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, as a citizen and as a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration

of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and **therefore there shall be no tests / assessments** during this programme.

REFERENCE: Guide to Induction program from AICTE

21EN101	PROFESSIONAL ENGLISH-1 *(Common to all B.E./B.TECH. Programmes)*	L	T	P	C
		3	2	0	4

COURSE OBJECTIVES:

- To develop learners skills in listening and responding effectively
- To apply basic grammar for better communication
- To employ reading passages for understanding vocabulary
- To construct logical sentences and participate in pair presentation, extempore
- To organize ideas for various compositions in writing

UNIT I	INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION	12

Listening – Listening for general information - Specific details - Conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form; **Speaking -** Self Introduction; Introducing a friend; Conversation - Politeness strategies; Telephone conversation; Leave a voicemail; Leave a message with another person; asking for information to fill details in a form; **Reading -** Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails; **Writing -** Writing emails / letters introducing oneself; **Grammar -** Present Tense (simple, continuous); Question types: Wh/ Yes or No/ and Tags **Vocabulary -** Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II	NARRATION AND SUMMATION	12

Listening - Listening to podcast, anecdotes / stories / event narration; documentaries and interviews with celebrities; **Speaking** - Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarizing of documentaries / podcasts/ interviews; **Reading** - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs; **Writing** - Guided writing - Paragraph writing Short Report on an event (field trip etc.); **Grammar** - Past tense (Simple, continuous); Subject-Verb Agreement; and Prepositions; **Vocabulary** - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III	DESCRIPTION OF A PROCESS / PRODUCT	12

Listening - Listen to a product and process descriptions; a classroom lecture; and advertisements about a products; **Speaking** - Picture description; Giving instruction to use the product; Presenting a product; and Summarizing a lecture; **Reading** - Reading advertisements, gadget reviews; user manuals; **Writing** - Writing definitions; instructions; and Product /Process description; **Grammar** - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect, Present and past perfect continuous tenses; **Vocabulary** - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words)

UNIT IV	CLASSIFICATION AND RECOMMENDATIONS	12

Listening - Listening to TED Talks; Scientific lectures; and educational videos; **Speaking** – Small Talk; Mini presentations and making recommendations; **Reading** - Newspaper articles; Journal reports - Non Verbal Communication (tables, pie charts etc,) **Writing** - Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart, graph etc, to verbal mode) **Grammar** - Articles; Pronouns - Possessive & Relative pronouns; **Vocabulary** - Collocations; Fixed / Semi fixed expressions

UNIT V	EXPRESSIONS	12

Listening - Listening to debates/ discussions; different viewpoints on an issue; and panel discussions; **Speaking** - Group discussions, Debates, and Expressing opinions through Simulations & Role-play; **Reading** - Reading editorials; and Opinion Blogs; **Writing** - Essay Writing (Descriptive or narrative); **Grammar** - Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences; **Vocabulary** - Cause & Effect Expressions - Content vs. Function words.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Listen and comprehend complex academic texts

CO2: Read and infer the denotative and connotative meanings of technical texts

CO3: Write definitions, descriptions, narrations and essays on various topics

CO4: Speak fluently and accurately in formal and informal communicative contexts

CO5: Express their opinions effectively in both oral and written medium of communication

TEXT BOOKS:

1. Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University. English for Science & Technology. Cambridge University Press, 2021
2. Board of Editors, Department of English, Anna University. English for Engineers & Technologists. Orient Blackswan Private Ltd, 2020.
3. Board of Editors, Department of English, Anna University. Using English Orient Blackswan Private Ltd, 2017

REFERENCES:

1. Meenakshi Raman & Sangeeta Sharma. Technical Communication – Principles And Practices Oxford University Press, New Delhi, 2016
2. Lakshminarayanan K.R. A Course Book on Technical English. SciTech Publications (India) Pvt. Ltd., 2012
3. Ayesha Viswamohan. English For Technical Communication (With CD). McGraw Hill Education, ISBN: 0070264244. 2008.
4. Kulbhusan Kumar, RS Salaria, Effective Communication Skill. Khanna Publishing House. 1st Edition, 2018.
5. Dr. V. Chellammal. Learning to Communicate. Allied Publishing House, New Delhi, 2003.

21MA101	MATRICES AND CALCULUS (*Common to all B.E. / B.Tech. Programmes*)	L	T	P	C
		3	2	0	4

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To explain the students about differential calculus.
- To demonstrate the functions of several variables technique to solve problems in many engineering branches.
- To demonstrate the various techniques of integration.
- To prepare the student to use mathematical tools in evaluating multiple integrals and their applications.

UNIT I	MATRICES	12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II	DIFFERENTIAL CALCULUS	12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

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 – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV	INTEGRAL CALCULUS	12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications: Hydrostatic force and pressure, moments and centre of mass.

UNIT V	MULTIPLE INTEGRALS	12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Use the matrix algebra methods for solving engineering problems.

CO2: Apply differential calculus tools in solving various application problems.
CO3: Make use of differential calculus ideas on several variable functions.
CO4: Identify suitable methods of integration in solving practical problems.
CO5**:** Solve practical problems of areas, volumes using multiple integrals.

TEXT BOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, New Delhi, 2016.
2. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
3. James Stewart, "Calculus: Early Transcendentals", 8th Edition, Cengage Learning, New Delhi, 2015.

REFERENCES:

1. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", 7th Edition, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 2009.
2. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", 5th Edition, Narosa Publications, New Delhi, 2016.
3. Ramana. B.V., "Higher Engineering Mathematics", 6th Edition, McGraw Hill Education Pvt. Ltd, New Delhi, 2010.
4. Thomas. G. B., Hass. J and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

21PH101	ENGINEERING PHYSICS *(Common to I Year B.E. / B.Tech. Students)*	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To illustrate the students effectively to achieve an understanding of mechanics.
- To infer the students to gain knowledge of electromagnetic waves and its applications.
- To explain the basics of oscillations, optics and lasers.
- To outline the importance of quantum physics.
- To relate the students towards the applications of quantum mechanics.

UNIT I	MECHANICS	9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum– double pendulum –Introduction to nonlinear oscillations.

UNIT II	ELECTROMAGNETIC WAVES	9

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence.

UNIT III	OSCILLATIONS, OPTICS AND LASERS	9

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave – sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference– Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO2 laser, semiconductor laser –Basic applications of lasers in industry.

UNIT IV	BASIC QUANTUM MECHANICS	9

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in an infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V	APPLIED QUANTUM MECHANICS	9
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		
		TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: Explain the importance of mechanics.

CO2: Extend their knowledge in electromagnetic waves.

CO3: Illustrate a strong foundational knowledge in oscillations, optics and lasers.

CO4: Interpret the importance of quantum physics.

CO5: Summarize quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow, "An Introduction to Mechanics", 1st Edition, McGraw Hill Education, 2017.
2. E.M.Purcell and D.J.Morin, "Electricity and Magnetism", 3rd Edition, Cambridge University Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", 7th Edition, McGraw-Hill, 2017.

REFERENCES

1. R.Wolfson. "Essential University Physics", Volume 1 & 2. , 1st Edition (Indian Edition) Pearson Education, 2009.
2. Paul A. Tipler, "Physics" - Volume 1 & 2, 1st Edition (Indian Edition), CBS Publishers & Distributors, 2004.
3. K.Thyagarajan and A.Ghatak. "Lasers: Fundamentals and Applications", 2nd Edition, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R. Resnick and J. Walker, "Principles of Physics", 10th Edition (Indian Edition), Wiley, 2015.
5. N.Garcia, A.Damask and S.Schwarz, "Physics for Computer Science Students", 1st Edition, Springer Verlag, 2012.

21CH101	ENGINEERING CHEMISTRY *(Common to all B.E / B.Tech. Programmes)*	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe water quality parameters and water treatment techniques.
- To discuss basic principles and preparatory methods of nanomaterials.
- To demonstrate the basic concepts and applications of phase rule and composites.
- To identify different types of fuels, their preparation, properties and combustion characteristics.
- To illustrate the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I	WATER AND ITS TREATMENT	9

Water: Sources and impurities, **Water quality parameters:** Definition and significance of-colour, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. **Municipal water treatment:** primary treatment and disinfection (UV, Ozonation, break-point chlorination)**.Desalination of brackish water**: Reverse Osmosis. **Boiler troubles:** Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming &foaming. **Treatment of boiler feed water**: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

UNIT II	NANOCHEMISTRY	9

Basics: Distinction between molecules, nanomaterials and bulk materials; **Size-dependent properties** (optical, electrical, mechanical and magnetic); **Types of nanomaterials**: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. **Preparation of nanomaterials:** sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. **Applications** of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III	PHASE RULE AND COMPOSITES	9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Properties and applications of**: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. **Hybrid composites** - definition and examples.

UNIT IV	FUELS AND COMBUSTION	9

Fuels: Introduction: Classification of fuels; **Coal and coke**: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). **Petroleum and Diesel:**

Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; **Power alcohol and biodiesel.**

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; **Ignition temperature**: spontaneous ignition temperature, Explosive range; **Flue gas analysis** - ORSAT Method. **CO_2 emission and carbon foot print.**

UNIT V	**ENERGY SOURCES AND STORAGE DEVICES**	**9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. **Solar energy conversion:** Principle, working and applications of solar cells**; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries:** Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; **Electric vehicles-working principles; Fuel cells:** H_2-O_2 fuel cell, microbial fuel cell; **Supercapacitors:** Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO 1: Infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

CO 2: Describe the basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

CO 3: Apply the knowledge of phase rule and composites for material selection requirements.

CO 4: Identify suitable fuels for engineering processes and applications.

CO 5: Demonstrate different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", 1st Edition, Tata McGraw-Hill Publishing Company Ltd, NewDelhi, 2008.
3. S.S. Dara, "A text book of Engineering Chemistry", 12th Edition, S. Chand Publishing, 2018.

REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B.B. Rath and James Murday, "Text book of nanoscience and nanotechnology", 1st Edition,Universities Press-II M Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" 2nd Edition, McGraw Hill Education (India) Private Limited, 2017.
3. Friedrich Emich, "Engineering Chemistry", 1st Edition,Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", 2nd Edition,

Cambridge University Press, Delhi, 2019

5. O.V. Roussak and H.D. Gesser, "Applied Chemistry-A Text Book for Engineers and Technologists", 2nd Edition, Springer Science Business Media, New York, 2013.

21CS101	PROBLEM SOLVING AND PYTHON PROGRAMMING *(Common to all B.E./B.Tech Programmes)*	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe the basics of algorithmic problem solving.
- To solve problems using Python conditionals and loops.
- To illustrate Python functions and use function calls to solve problems.
- To make use of Python data structures - lists, tuples, and dictionaries to represent complex data.
- To explain input/output with files in Python.

UNIT-I	COMPUTATIONAL THINKING AND PROBLEM SOLVING	9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, and guess an integer number in a range, Towers of Hanoi.

UNIT-II	DATA TYPES, EXPRESSIONS, STATEMENTS	9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT-III	CONTROL FLOW, FUNCTIONS, STRINGS	9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-else-if-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT-IV	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; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT-V	FILES, MODULES, PACKAGES	9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Make use of design approaches to solve computational problems.

CO2: Develop and execute basic Python programs using expressions and input/output statements.

CO3: Utilize strings, functions and control statements to develop real world problems.

CO4: Construct programs using Python data types like lists, tuples and dictionaries.

CO5: Prepare a Python application by incorporating files and exceptions.

TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher,"Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
3. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc- Graw Hill, 2018.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", 1st Edition, Pearson Education, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", 3rd Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019

21CS102	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY *(Common to all B.E./B.Tech Programmes)*	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To describe the basics of algorithmic problem solving.
- To solve problems using Python conditionals and loops.
- To illustrate Python functions and use function calls to solve problems.
- To make use of Python data structures - lists, tuples, and dictionaries to represent complex data.
- To explain input/output with files in Python.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.,)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.,- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error,voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.,

TOTAL:60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1:Develop algorithmic solutions to simple computational Problems

CO2: Illustrate and execute basic Python programs using simple statements.

CO3: Build program for scientific problems using strings, functions and control statements.

CO4: Utilize compound data types lists, tuples and dictionaries for real-time applications.

CO5: Experiment the python packages, files and exceptions for developing software applications

21PC101	PHYSICS AND CHEMISTRY LABORATORY *(Common to all B.E / B.Tech. Programmes)*	L	T	P	C
		0	0	4	2

CHEMISTRY LABORATORY

COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters such as acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electro analytical techniques such as pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles.
- To analyze the quality of coal sample using proximate analysis.

List of Experiments (Any 7 experiments)

1. Preparation of Na_2CO_3 as a primary standard and estimation of acidity of a water sample using the primary standard.
2. Determination of types and amount of alkalinity in water sample.
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate. (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel.
15. Proximate analysis of Coal.

COURSE OUTCOMES : At the end of the course, learners will be able to

CO1: To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.

CO2: To determine the amount of metal ions through volumetric and spectroscopic techniques.

CO3: To analyse and determine the composition of alloys.

CO4: To learn simple method of synthesis of nanoparticles.

CO5: To quantitatively analyse the impurities in solution by electro analytical techniques.

Text Book:

J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, "Vogel's Textbook of Quantitative Chemical Analysis" 2009.

21EN102	ENGLISH-II (Common to all B.E./B.TECH. Programmes)	L 3	T 0	P 0	C 3

COURSE OBJECTIVES:

- To develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- To prepare and write convincing job applications and effective reports.
- To demonstrate their speaking skills to make technical presentations and participate in group discussions.
- To apply their Listening skill which will help them comprehend lectures and talks in their areas of specialization
- To choose appropriate soft skills to suit the situation.

UNIT I	INTRODUCTION TO TECHNICAL ENGLISH	9

Listening - Factual and Academic speeches; **Speaking** - Asking for and giving directions - **Reading** - Technical texts from - Newspapers /websites; **Writing -** Statements - Definitions - issue based writing instructions - Checklists - Recommendations; **Vocabulary Development**- technical vocabulary; **Grammar** - Error spotting - Compound words; **Soft skills** - Leadership Skills.

UNIT II	READING AND STUDY SKILLS	9

Listening - Listening to longer technical talks and completing exercises based on them; **Speaking** - Describing a general process; **Reading** - Reading longer technical texts - Identifying the various transitions in a text - Paragraphing; **Writing** - Interpreting charts, graphs; **Vocabulary Development** - Vocabulary used in formal letters/emails and reports **Grammar -** Impersonal passive voice, numerical adjectives - **Soft skills** - Teamwork

UNIT III	TECHNICAL WRITING AND GRAMMAR	9

Listening - Listening to classroom lectures, talks on engineering /technology; **Speaking** - introduction to technical presentations; **Reading** - longer texts both general and technical, practice in speed reading; **Writing** - Describing a technical process; **Vocabulary Development** - Sequence words - Misspelled words; **Grammar** - Embedded sentences ; **Soft skills** - Decision making

UNIT IV	JOB APPLICATIONS	9

Listening - Listening to documentaries and making notes. **Speaking** - Mechanics of presentations; **Reading -** Reading for detailed comprehension; **Writing** - Email etiquette - job application - Cover Letter - Resume preparation(via email and hard copy) - Analytical essay writing - **Vocabulary Development -** finding suitable synonyms - paraphrasing; **Grammar** - clauses - If conditionals - **Soft skills** - Time Management

UNIT V	GROUP DISCUSSION AND REPORT WRITING	9

Listening - TED talks; **Speaking** - Participating in a group discussion - **Reading** - Reading and understanding technical articles; **Writing** - Writing reports - Survey report, accident report and minutes of a meeting - **Vocabulary Development** - Verbal analogies; **Grammar** - reported speech; **Soft skills** - Conflict Resolution.

	TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1: Interpret by reading information in technical texts

CO2: Choose appropriate language to write convincing job applications, resume and reports

CO3: Formulate the technical ideas effectively in spoken and written forms

CO4: Analyze and understand spoken language in lectures and talks

CO5: Demonstrate basic soft skills in life

TEXT BOOKS:

1. Board of Editors, Fluency in English-A Course book for Undergraduate Engineers and Technologist. Orient Blackswan Pvt Ltd, Hyderabad: 2018
2. Jawahar, Jewelcy & Rathna.P. Communicative English Workbook. VRB Publishers Pvt Ltd. Chennai. 2018.
3. Board of Editors, Department of English, Anna University, Chennai. Mindscapes-English for Technologists and Engineers. Orient Black Swan Pvt Ltd, Chennai, 2012.

REFERENCES:

1. Verma, Shalini. Technical Communication for Engineers. Vikas Publishing House Pvt Ltd. New Delhi. 2015
2. Raman, Meenakshi & Sharma, Sangeeta. Technical Communication English Skills for Engineers. Oxford University Press. 2008.
3. Rizvi, Ashraf.M. Effective Technical Communication. MC Graw Hill Education Pvt Ltd. New Delhi. 2016.

21MA102	VECTOR CALCULUS AND COMPLEX VARIABLES (*Common to B.E. CIVIL Engg., EEE & MECH Engg.*)	L	T	P	C
		3	2	0	4

COURSE OBJECTIVES:

- To explain the students with the concepts of vector calculus, needed for problem solving in all engineering disciplines.
- To choose the effective mathematical methods for finding the solutions of partial differential equations.
- To identify and develop the standard techniques of complex variables.
- To apply with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow of electric current.
- To prepare the student to acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.

UNIT I	VECTOR CALCULUS	12

Gradient , Divergence and Curl – Directional derivation – Irrotational and solenoidal vector fields – Vector integration – Greens theorem in a plane , Gauss Divergence theorem and Stoke's theorem (excluding proof) – Simple applications involving cubes and rectangular parallelepiped

UNIT II	PARTIAL DIFFERENTIAL EQUATIONS	12

Formation of partial differential equations – Solutions of standard types of first order PDE : f(p, q) = 0, f(z ,p,q)=0, z=px+ qy + f(p,q), f(x, p) = f(y, q) – Lagrange's linear equations – linear partial differential equations of second and higher order with constant coefficients of homogeneous type.

UNIT III	ANALYTIC FUNCTIONS	12

Analytic functions – necessary and sufficient conditions for analyticity-properties – Harmonic conjugates- construction of analytic function – conformal mapping –Mapping by functions- Bilinear transformation $w = c + z\ , az\ , \frac{1}{z}, z^2$.

UNIT IV	COMPLEX INTEGRATION	12

Complex Integration – Cauchy's integral theorem and integral formula (excluding proof)-Taylor series and Laurent's series –Residues – Cauchy's residue Theorem (excluding proof) – Application of Residue theorem to evaluate real integrals around unit circle and semi- circle (excluding poles on the real axis).

UNIT V	ORDINARY DIFFERENTIAL EQUATIONS	12

Linear equations of second order with constant and variable coefficients-Homogeneous equations of Euler type – Equations reducible to homogeneous form –Variation of parameters-Simultaneous first order with constant coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the concept of vector calculus which naturally arises in many engineering Problems.

CO2: Solve the Partial Differential Equations by using various techniques.

CO3: Construct an analytic function using the properties of analytic function.

CO4: Apply suitable formula to evaluate the given integral.

CO5: Use a suitable method, solve the given differential equation of first & second order.

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", 10th Edition, John Wiley and Sons, New Delhi**,** 2016.
2. James Stewart, " Calculus: Early Transcendentals", 8th Edition, Cengage Learning New Delhi, 2015.
3. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson Education, 2018.

REFERENCES :

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, 2015.
2. P. Kandasamy, Thilagavathy and K.Gunavathy, "Engineering Mathematics Vol-II", 3rd Edition, S. Chand Limited, 2015.
3. P. Kandasamy, Thilagavathy and K.Gunavathy, "Engineering Mathematics Vol-III", 3rd Edition, S. Chand Limited, 2015.

21PH106	PHYSICS FOR MECHANICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the basics of crystallography and its importance in studying materials properties.
- To illustrate the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To infer the knowledge on physics of semiconductors, determination of charge carriers and device applications
- To summarize the knowledge on different optical properties of materials, optical displays and applications
- To translate the significance of nano structures, quantum confinement in nano device applications.

UNIT I	CRYSTALLOGRAPHY	9

Crystal structures: BCC, FCC and HCP - Directions and planes - Linear and planar densities - Crystal imperfections- Edge and screw dislocations - Grain and twin boundaries - Burgers vector and elastic strain energy - Slip systems, plastic deformation of materials - X-ray diffraction - Braggs law - Powder X-ray diffraction.

UNIT II	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	9

Classical free electron theory - Expression for electrical conductivity - Thermal conductivity, expression - Quantum free electron theory: Tunneling – degenerate states - Fermi-Dirac statistics - Density of energy states - Electron effective mass - Concept of hole. Magnetic materials: dia, para and ferromagnetic effects - Domain theory of ferromagnetism - Hysteresis behaviour - quantum interference devices - GMR devices.

UNIT III	SEMICONDUCTORS AND TRANSPORT PHYSICS	9

Intrinsic Semiconductors - Energy band diagram - direct and indirect band gap semiconductors - Carrier concentration in intrinsic semiconductors - extrinsic semiconductors - Carrier concentration in n-type & p-type semiconductors - Variation of carrier concentration with temperature - Carrier transport in Semiconductors: Drift, mobility and diffusion - Hall effect and devices - Ohmic contacts - Schottky diode.

UNIT IV	OPTICAL PROPERTIES OF MATERIALS	9

Classification of optical materials - Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells - Optoelectronic devices: light detectors and solar cells - light emitting diode - laser diode - optical processes in organic semiconductor devices - excitonic state - Electro-optics and nonlinear optics: Modulators and switching devices.

UNIT V	NANOELECTRONIC DEVICES	9

Quantum confinement - Quantum structures - quantum wells, wires and dots - Zener - Bloch oscillations - Resonant tunneling - Quantum interference effects - Mesoscopic structures - Single electron phenomena - Single electron Transistor. Semiconductor photonic structures - 1D, 2D and 3D photonic crystal. - Photo processes - Spintronics - Carbon nanotubes: properties and applications.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the basics of crystallography and its importance for various material properties.

CO2: Infer the electrical and magnetic properties of materials and their applications.

CO3: Relate the semiconductor physics and functioning of semiconductor devices.
CO4: Summarize the optical properties of materials and working principles of various optical devices.
CO5: Translate the importance of functional nanoelectronic devices.

TEXT BOOKS:

1. V. Raghavan, "Materials Science and Engineering: A First Course", 6th Edition, Prentice Hall India Learning Private Limited, 2015.
2. S.O. Kasap, "Principles of Electronic Materials and Devices", 4th Edition (Indian Edition), Mc-Graw Hill Publication, 2018.
3. Jasprit Singh, "Semiconductor Devices: Basic Principles", 1st Edition (Indian Edition), Wiley Publication, 2007.
4. Jasprit Singh, "Semiconductor Optoelectronics: Physics and Technology", 1st Edition (Indian Edition) Mc-Graw Hill Publication, 2019.
5. G.W. Hanson, "Fundamentals of Nanoelectronics", Indian Standard Edition, Pearson Education, 2009.

REFERENCES

1. R. Balasubramaniam, "Callister's Materials Science and Engineering", 2nd Edition (Indian Edition), Wiley Publication, 2014.
2. Wendelin Wright and Donald Askeland, "Essentials of Materials Science and Engineering", 1st Edition, CL Engineering Publishers, 2013.
3. Robert F. Pierret, "Semiconductor Device Fundamentals", Standard Edition, Pearson Education, 2006.
4. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", 1st Edition, Pearson Education, 2017.
5. Ben Rogers, Jesse Adams and Sumita Pennathur, "Nanotechnology: Understanding Small Systems", 1st Edition, CRC Press, 2017.

21ME101	ENGINEERING GRAPHICS (Common to all B.E./B.Tech. Programmes)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To sketch the projection of points, lines and planes.
- To sketch the projection of simple solids
- To sketch the projection of sectioned solids and development of lateral surfaces
- To sketch the isometric and perspective views of simple solids.
- To sketch the orthographic projection of various objects freehandly.

UNIT I	PROJECTIONS OF POINTS, LINES AND PLANE SURFACE	12

Importance of graphics in engineering applications – Use of drafting instruments - Lettering and dimensioning.

Introduction to Orthographic projections - Principles -Principal planes-First angle projection. Projection of points located in all quadrants. Projection of straight lines inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method.

Projection of planes (regular polygonal and circular surfaces) inclined to both the principal planes by rotating object method. (Not for Examination)

UNIT II	PROJECTION OF SOLIDS	12

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

UNIT III	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	12

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

UNIT IV	ISOMETRIC AND PERSPECTIVE PROJECTIONS	12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method .

UNIT V	FREEHAND SKETCHING	12

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Introduction to drafting packages and demonstration. (Not for examination).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Construct the orthographic projections of points, straight lines and plane surfaces.
CO2: Sketch the orthographic projections of simple solids
CO3: Sketch the orthographic projections of sectional solids and lateral surfaces of the solids.
CO4: Construct the isometric projections and perspective projections of simple solids.
CO5: Sketch the orthographic projection of objects using freehand.

TEXT BOOKS:

1. Natarajan K.V., "A text book of Engineering Graphics", 31st Edition, Dhanalakshmi Publishers, Chennai, 2018.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", 15th Edition, New Age International (P) Limited, 2018.
3. Bhatt N.D. and Panchal V.M., "Engineering Drawing", 53rd Edition, Charotar Publishing House, 2014.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", 2nd Edition, Tata McGraw Hill Publishing Company Limited, 2013.
2. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", 2nd Edition, Oxford University, Press, New Delhi, 2015.
3. Shah M.B., and Rana B.C., "Engineering Drawing", 2nd Edition, Pearson, 2009.

21ME102	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To calculate the effect of force in particle and rigid bodies.
- To interpret various forces acting on a structure.
- To predict the centroid and moment of inertia.
- To demonstrate the laws of motion, kinematics of motion and their relation.
- To calculate the types of friction for moving bodies and problems related to friction.

UNIT I	STATICS OF PARTICLES AND RIGID BODIES	9

STATICS OF PARTICLES: Force on a particle – resultant of two forces and several concurrent forces – resolution of a force – equilibrium of a particle-free body diagram – force in space – equilibrium of a particle in space.

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

UNIT II	ANALYSIS OF STRUCTURES	9

Simple trusses-Method of joints, method of sections – joints under special loading conditions – space trusses – analysis of frames

UNIT III	PROPERTIES OF SURFACES AND SOLIDS	9

Centroids of areas, composite areas, determination of moment of inertia of plane figures, polar moment of inertia-radius of gyration – mass moment of inertia of simple solids

UNIT IV	DYNAMICS OF PARTICLES	9

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V	FRICTION AND RIGID BODY DYNAMICS	9

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL PERIODS	45

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Solve problems on particles and rigid bodies using the concept of static equilibrium.

CO2: Interpret the effect of structure on acting forces

CO3: Calculate the center of gravity and moment of inertia of the given geometry

CO4: Determine a suitable method for solving problems on kinematics and kinetics of particles

CO5: Predict the effect of friction in rigid bodies.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Meriam J.L and Kraig L.G, 'Engineering Mechanics-Statics and Dynamics', 9th Edition, John Wiley & sons, 2021.
3. Vela Murali, "Engineering Mechanics", 3rd Edition, Oxford University Press, 2017.

REFERENCES:

1. Hibbler, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education (2010).
2. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics",4th Edition, Pearson Education (2006)
3. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., (2005).
4. Bhavikatti, S.S, and Rajashekarappa, K.G., "Engineering Mechanics", 5th Edition, New Age International (P) Limited Publishers, 2015.
5. Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing Company, 2008.

21CH103	ENVIRONMENTAL SCIENCE *(Common to all B.E / B.Tech. Programmes)*	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- To describe the structure and function of an ecosystem and biodiversity
- To interpret the environmental impacts of natural resources.
- To demonstrate causes, effects and control measures of different types of pollution.
- To manipulate the importance of disaster management, environmental ethics and values.
- To dramatize the important social issues and sustainable practices.

UNIT-I	ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY	6

Multidisciplinary nature of environmental studies - ecosystem- general structure and function of an ecosystem- ecological succession-biodiversity-types-values of biodiversity- endangered and endemic species-red data book- hot spots of biodiversity-criteria- hot spots in India-threats to biodiversity(man-animal conflicts, habitat loss, poaching)-case studies-conservation of biodiversity-in-situ and ex-situ conservation.

UNIT-II	NATURAL RESOURCES AND ITS ENVIRONMENTAL IMPACTS	6

Natural resources-forest resource-ecological functions – causes, effects and control measures of deforestation-water resource-sources-conflict over water-dams benefits and problems-food resource-overgrazing- impacts of over grazing- impacts of modern agriculture-energy resource-environmental impacts of wind mills and solar panels- role of an individual in conservation of natural resources.

UNIT III	ENVIRONMENTAL POLLUTION AND CONTROL	6

Air pollution-causes, effects and control methods - water pollution- causes, effects-waste water treatment-soil pollution-causes, effects-solid waste management–e-waste- causes, effects and management-Pollution control acts-air(prevention and control of pollution) act,1981-water(prevention and control of pollution) act,1974- wildlife (protection) act,1972 - e-waste management rules,2016-case studies - role of an individual in control of pollution.

UNIT IV	DISASTER MANAGEMENT AND ENVIRONMENTAL ETHICS	6

Disaster management-causes, effects and management of- flood, landslide, earthquake and tsunami-case studies- environmental ethics- value education-traditional value systems in India-water conservation-rain water harvesting-watershed management.

UNIT V	SOCIAL ISSUES AND SUSTAINABLE PRACTICES	6

Unsustainable development- social issues-climate change-causes, effects and control measures-global warming-causes, effects and control measures-Acid rain-causes, effects and control measures-ozone layer depletion-causes, effects and control measures-nuclear accident and holocausts-EIA-Sustainable development-goals-target- green buildings- ISO 14000 series.

30 PERIODS

COURSE OUTCOMES : At the end of the course, learners will be able to

CO1: Explain the concept, structure and function of an ecosystem and biodiversity.
CO2: Demonstrate the environmental impacts of natural resources.
CO 3: Illustrate the suitable management method for pollution control.
CO 4: Relate the proper way of managing disaster with environmental ethics.
CO 5: Apply social issues and adopt suitable sustainable practices.

Text Books:

1. Kaushik, A &Kaushik. C.P, "Environmental Science and Engineering", 6th Edition, New Age

International, 2018.
2. Garg S.K &Garg, Ecological and Environmental studies, Khanna Publishers, 2015.
3. Wright &Nebel, Environmental science towards a sustainable future, 12thEditon, Prentice Hall of India Ltd, 2015.

Reference Books:

1. ErachBharucha, "Text book of Environmental studies for Undergraduate courses", 3rd Edition, UGC, 2021.
2. Ravi P. Agrahari, Environmental ecology, Biodiversity, climatic change & Disaster management, 1st Edition, McGraw Hill, 2020
3. Benney Joseph, "Environmental Science and Engineering", 1st Edition, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2017.

21EE103	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Theory with Practical Course) *(Common to B.E., Civil Engg. & Mechanical Engg.)*	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To outline the basics of electric circuits and analysis
- To classify wires and domestic wiring
- To summarize the working principles and application of electrical machines
- To outline the characteristics of semiconductor devices
- To explain the functional elements and working of transducers

UNIT I	ELECTRICAL CIRCUITS	9

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor.

UNIT II	MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS	9

Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.

Domestic wiring , types of wires and cables, earthing, protective devices- switch, fuse unit - safety precautions and First Aid.

UNIT III	ELECTRICAL MACHINES	9

Construction and Working principle- DC Separately and Self excited Generators, Types and Applications. Working Principle of DC motors, Types and Applications. Construction, Working principle and Applications of Transformer, working of Three phase Alternator and Three Phase Induction Motor.

UNIT IV	ANALOG & DIGITAL ELECTRONICS	9

Resistor, Inductor and Capacitor in Electronic Circuits- Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, Rectifier.

Review of number systems, binary codes, Combinational logic - representation of logic functions.

UNIT V	INSTRUMENTATION SYSTEM	9

Classification of instruments – Operating Principles of indicating Instruments and Digital Energy meter. Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

	TOTAL: 45 PERIODS
PRACTICAL COURSE	**15**

List of Experiments

1. Verification of Ohms Laws
2. Verification of Kirchhoff's Laws
3. Residential Wiring
4. Load test on DC Shunt Motor
5. Characteristics of PN Diode
6. Characteristics of Zener Diode
7. Ripple factor calculation for half wave rectifier
8. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

OUTCOMES: At the end of the course, learners will be able to:

CO1. Summarize the electric circuit parameters for simple problems

CO2: Outline the safety precautions in electrical installation

CO3. Explain the working principle and applications of electrical machines

CO4. Show VI characteristics of semiconductor devices

CO5. Demonstrate the types and operating principles of sensors and transducers

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", 2nd Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", 2nd Edition Pearson Education, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Coursein Electrical & Electronic Measurements &Instrumentation', Dhanpat Rai and Co, 2015.

REFERENCES

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", 4th Edition, McGraw HillEducation, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th Edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGrawHill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

21EM101	ENGINEERING PRACTICES LABORATORY *(Common to all B.E / B.Tech. Programmes)*	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To draw pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
- To demonstrate the basic switch board wiring, fluorescent lamp wiring and stair case wiring using various electrical components.
- To choose various joints in steel plates using arc welding work and machining various simple processes like turning, drilling, tapping in parts
- To build a tray out of metal sheet using sheet metal work.
- To develop electronic circuit and testing for soldering and desoldering using PCB board.

LIST OF EXPERIMENTS:

GROUP – A (CIVIL & ELECTRICAL)

PART – I

CIVIL ENGINEERING PRACTICES

PLUMBING WORK:

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

WOOD WORK:

- Sawing,
- Planning and Making joints like T-Joint, Cross lap and Dovetail joint.

PART – II

ELECTRICAL ENGINEERING PRACTICES

- Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
- Staircase wiring
- Fluorescent Lamp wiring with introduction to CFL and LED types.
- Energy meter wiring and related calculations/ calibration
- Study of Iron Box wiring and assembly
- Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
- Measurement of resistance to earth of an electrical equipment.

GROUP – B (MECHANICAL & ELECTRONICS)

PART III

MECHANICAL ENGINEERING PRACTICES

WELDING WORK:

- Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- Practicing gas welding.

BASIC MACHINING WORK:

- Usage of Spanners and screw drivers
- Facing and Turning.
- Taper Turning

ASSEMBLY WORK:

- Assembling a centrifugal pump.
- Assembling a household mixer.
- Assembling an air conditioner.

SHEET METAL WORK:

- Making of a square tray

FOUNDRY WORK:

- Demonstrating basic foundry operations.

PART IV

ELECTRONIC ENGINEERING PRACTICES

SOLDERING WORK:

- Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

- Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

- Study elements of smart phone.
- Assembly and dismantle of computer / laptop

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Build various plumbing joints

CO2: Develop various carpentry joints.

CO3: Construct various wiring electrical joints in common household electrical wire work.

CO4: Construct various welded joints, sheet metal and basic machining operations

CO5: Develop the electronic circuit for soldering and testing using PCB board.

21MA201	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS (*Common to B.E. CIVIL Engg., ECE & MECH. Engg.*)	L	T	P	C
		3	2	0	4

COURSE OBJECTIVES:

- To use various methods of Laplace transforms for efficiently solving the problems that occur in various branches of engineering disciplines.
- To identify Fourier series which is essential to many applications in engineering.
- To explain the mathematical tools for the solutions of partial differential equations that model several physical processes.
- To explain the student with Fourier transform techniques used in wide variety of situations.
- To develop Z transform techniques to solve difference equations for discrete time systems

UNIT I	LAPLACE TRANSFORM	12

Laplace transform- conditions for existence –Transform of elementary functions –Basic properties – First shifting theorem –Transform of derivatives on $t\,f(t), f(t)/t$ and periodic functions- Transform of unit step function and impulse functions. Inverse Laplace transform by partial function method and convolution theorem (excluding proof)-Initial and finial value theorems- Solutions of linear ODE of second order with constant coefficients using Laplace transform techniques.

UNIT II	FOURIER SERIES	12

Dirichlet's conditions – General Fourier series odd and even functions – Half range sine series – half range cosine series – Parseval's identity – Harmonic Analysis.

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12

Classifications of PDE – Solutions of one dimensional wave equations – one dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT IV	FOURIER TRANSFORMS	12

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

UNIT V	Z- TRANSFORMS AND DIFFERENCE EQUATIONS	12

Z- Transforms – Elementary properties – Inverse Z- Transforms (Using partial fractions and residues) – Convolution theorem – Formation of difference equations – Solution of difference equations using Z-transforms.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1**:** Calculate Laplace transform and inverse Laplace transform of different functions.

CO2: Express the Fourier series expansion to represent the given function in the given interval.

CO3: Classify the second order PDE and to know about solving initial and final

value problems.

CO4: Apply Fourier transform techniques to evaluate the given integral.

CO5: Solve the given difference equations using Z-transforms.

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", 10th Edition, John Wiley and Sons, New Delhi, 2016.
2. Peter V.O. Neil "Advanced Engineering Mathematics", 7th Edition, Cengage, New Delhi, 2012.
3. Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016.

REFERENCES:

1. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", 6th Edition, Tata McGraw-Hill, New Delhi, 2012.
3. Datta K.B., "Mathematical Methods of Science and Engineering", 2nd Edition, Cengag Learning India Pvt Ltd, Delhi, 2013.

21ME201	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate units and notations in Thermodynamics.
- To apply the principles of thermodynamics and to use it in accounting for the bulk behaviour of the simple physical systems.
- To integrate study of thermodynamic principles, state and relations.
- To apply principles of psychrometric and properties of pure substances.
- To demonstrate basic concepts of Vapour power cycles.

UNIT I	BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS	9

Basic concepts - concept of continuum, macroscopic approach. Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics – concept of temperature and heat. First law of thermodynamics – application to closed and open systems, steady flow process with reference to various thermal equipment.

UNIT II	SECOND LAW OF THERMODYNAMICS	9

Second law of thermodynamics – Kelvin-Planck and Clausius statements of second law, Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, Coefficient of Performance (COP). Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy –Availability and Unavailability (Qualitative treatment).

UNIT III	PROPERTIES OF PURE SUBSTANCE	9

Properties of pure substances, thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam, Calculations of work done and heat transfer in non-flow and flow processes. Rankine cycle.

UNIT IV	IDEAL, REAL GASES AND THERMODYNAMIC RELATIONS	9

Properties of ideal and real gases, equation of state, Avogadro's Law, Van der Waal's equation of state, compressibility factor, Exact differentials. Thermodynamic Relations, Maxwell's Equations, Tds equations, Clausius- Clapeyron Equation, Thermodynamic relations for changes in Entropy, Enthalpy & Internal Energy, Joule-Thomson coefficient & inversion curve.

UNIT V	PROPERTIES OF MIXTURES AND PSYCHROMETRY	9

Ideal gas mixtures – Evaluation of properties, Dalton's law of partial pressure, properties of air-water vapour mixtures: DBT, WBT, RH, dew point temperature, degree of saturation, thermodynamic wet bulb temperature, enthalpy of moist air, psychrometric processes, bypass factor, calculating the properties of air using psychrometric table and chart.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Demonstrate the first law of thermodynamics for systems and processes CO2: Apply the second law of thermodynamics for systems and processes CO3: Assess the thermodynamics laws for pure substances CO4: Apply the thermodynamics relations for ideal and real gases. CO5: Demonstrate the psychrometric processes in air-water vapor mixtures.
TEXT BOOKS:
1. Yunus A. Cengel & Michael A. Boles, "Thermodynamics-An Engineering Approach", 9th Edition, 2019. 2. R.K.Rajput, "A Text Book of Engineering Thermodynamics ", 6th Edition, Laxmi Publications, 2019. 3. Michael J. Moran, Howard N. Shapiro, "Fundamentals of Engineering Thermodynamics", 8th Edition, Willey, 2014.
REFERENCES:
1. Arora C.P, "Thermodynamics", 12th Edition, Tata McGraw-Hill, 2017. 2. Borgnakke &Richard E. Sonnatag, "Fundamental of Thermodynamics", 8th Edition, 2016. 3. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition, Oxford University Press, 2016. 4. Nag. P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw-Hill, 2017.

21ME202	STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the concepts of stress, strain, principal stresses and principal planes.
- To use the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To calculate stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To predict the stresses and deformations induced in thin and thick cylindrical shells

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 over – hanging beams. Theory of simple bending – bending stress distribution – Load carrying capacity – Proportioning of sections.

UNIT III	TORSION OF SHAFTS AND SPRINGS	9

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

UNIT IV	DEFLECTION OF BEAMS	9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems

UNIT V	THIN CYLINDERS, SPHERES AND THICK CYLINDERS	9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply Hooke's law in structural members.
CO2: Construct the shear force and bending moment diagrams for various beams.
CO3: Interpret the design of shafts and springs.
CO4: Calculate the slope and deflection of beams
CO5: Solve the stresses and deformations in cylindrical and spherical shells.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", 6th Edition, Laxmi Publications (P) Ltd., 2022
2. Egor. Popov "Engineering Mechanics of Solids" 2nd Edition, Prentice Hall of India, 2015.
3. Subramanian R., "Strength of Materials", 3rd Edition, Oxford University Press, Oxford

Higher Education Series, 2016.

REFERENCES:

1. Jindal U.C., "A text book on Strength of Materials", 2nd Edition, Asian Books Pvt. Ltd., 2012
2. Ferdinand P. Beer, Russell Johnson, J.r. and John T. Dewolf "Mechanics of Materials", 7th Edition, Tata McGraw Hill Publishing ‘co. Ltd., 2014.
3. Hibbeler, R.C., "Mechanics of Materials", 9th Edition, Pearson Education, Low Price Edition, 2018.

21ME203	ENGINEERING METALLURGY (Theory with Practical Course)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To apply the concepts of alloys, microstructure and properties of steel and iron.
- To illustrate the concept of various heat treatment process and its effects on materials.
- To demonstrate the composition and properties of various ferrous and non-ferrous metals.
- To relate the composition and properties of various non-metallic materials.
- To illustrate deformation mechanisms and mechanical properties of materials.

UNIT I	ALLOYS AND PHASE DIAGRAMS	9

Crystal structure – BCC, FCC and HCP structure – unit cell, Crystallographic planes and directions, Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectoid, eutectic, peritectic, and peritectroid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron, microstructure, properties and applications.

UNIT II	HEAT TREATMENT	9

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

UNIT III	FERROUS AND NON-FERROUS METALS	9

Effect of alloying additions on steel- α and β stabilisers– stainless and tool steels – HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT IV	NON-METALLIC MATERIALS	9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites- Classifications- Metal Matrix and FRP - Applications of Composites.

UNIT V	MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS	9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms. Surface Treatments: Hard facing - Hard chromium plating – Metal Spraying.

TOTAL: 45 PERIODS

PRACTICAL COURSE	15

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 - Brinell 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.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Interpret material constituents from phase diagram

CO2: Prepare the various heat treatment process

CO3: Predict the effect of alloying elements on ferrous and non-ferrous metals.

CO4: Illustrate the properties and applications of non-metallic materials.

CO5: Predict the various mechanical properties of materials.

TEXT BOOKS:

1. Avner, S.H, "Introduction to Physical Metallurgy", 2nd edition, McGraw Hill Education, 2017.
2. Williams D Callister, "Material Science and Engineering An Introduction" 9th Edition, Wiley India Pvt Ltd, 2013.
3. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", 9th Edition, Prentice Hall of India Private Limited, 2009.

REFERENCES:

1. Raghavan.V, "Materials Science and Engineering", 6th Edition, Prentice Hall of India Pvt. Ltd., 2015.
2. U.C.Jindal, "Engineering Materials and Metallurgy", 1st Edition, Pearson, 2011.
3. Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", 1st Edition, Viva Books Pvt. Ltd., New Delhi, 2006.

21ME204	MANUFACTURING TECHNOLOGY – I (Theory with Practical Course)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To apply the working principles of various metal casting processes.
- To demonstrate and select suitable materials for various engineering applications.
- To illustrate the working principles of various metal joining processes.
- To experiment various metal forming processes.
- To demonstrate the working principles of plastics moulding.

UNIT I	METAL CASTING PROCESSES	9

Sand Casting: Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Moulding sand Properties – Cores –Types and applications – Melting furnaces: Blast and Cupola Furnaces; Principle of special casting processes: Shell - investment –Defects in Sand casting.

UNIT II	BASIC MACHINING PROCESSES	9

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

UNIT III	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. Weld defects: types, causes and cure.

UNIT IV	METAL FORMING PROCESSES	9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations–Drawing Process: Wire and tube drawing - Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Working principle and applications.

UNIT V	MANUFACTURE OF PLASTIC COMPONENTS	9

Plastic forming Processes: Plastics, general properties and applications of thermo plastics and thermosets, Forming/shaping and applications of plastics: Extrusion, Injection Moulding, Blow Moulding, Rotational Moulding, Thermoforming and Compression Moulding – Powder metallurgy – Introduction – Process – Applications.

TOTAL: 45 PERIODS

PRACTICAL COURSE	15

LIST OF EXPERIMENTS:

1. Preparation of green sand moulds.
2. Taper & eccentric turning
3. Internal thread cutting
4. External thread cutting
5. Knurling
6. Square head shaping
7. Hexagonal head shaping
8. Fabrication of simple structural shapes using Arc Welding

9. Joining of plates using arc welding
10. Manufacturing of simple sheet metal components using shearing and bending operations

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Predict the various metal casting processes.
CO2: Relate the various metal joining processes.
CO3: Illustrate the various metal forming processes.
CO4: Interpret the various sheet metal processes.
CO5: Demonstrate various types of manufacturing of plastic components.

TEXT BOOKS:

1. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, Tata Machgraw Hill, 2017
2. Kalpakjian. S, "Manufacturing Engineering and Technology", 7th Edition, Pearson Education India, 2014.
3. Roy. A. Lindberg, "Processes and Materials of Manufacture", 3rd Edition, Pearson education, 2015

REFERENCES:

1. Hajra Chouldhary S.K and Hajra Choudhury. AK. "Elements of workshop Technology", volume I and II, 15th Edition, Media promoters and Publishers Private Limited, 2008.
2. Paul Degarmo E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" 13th Edition, Prentice – Hall of India, 2019.
3. Sharma, P.C., "A Text book of production Technology", 4th Edition, S.Chand and Co. Ltd., 2014.

21EE216	ELECTRICAL DRIVES AND CONTROL (Theory with Practical Course)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To explain the basic concepts of different types of electrical machines.
- To illustrate the Drive motor characteristics.
- To summarize different methods of starting DC motors and induction motors.
- To relate the conventional and solid-state drives for DC drives.
- To compare the conventional and solid-state drives for 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 - single phase and three phase induction motors – Specifications and sizing of Machines

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	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	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

PRACTICAL COURSE	15

LIST OF EXPERIMENTS

1. Load test on DC Shunt motor
2. Load test on DC Series motor
3. O.C.C & Load characteristics of DC Shunt generator
4. O.C.C & Load characteristics of DC Series generator
5. Speed control of DC shunt motor (Armature, Field control)
6. Dynamic Braking on DC Drives
7. Regulation of an alternator by EMF & MMF methods.
8. Load test on three phase squirrel cage Induction motor
9. Speed control of three phase slip ring Induction Motor
10. Study of DC & AC Starters

TOTAL: 60 PERIODS

COURSE OUTCOMES: At the end of the course, learners will be able to

CO1: Classify different types of electrical drives

CO2: Summarize various characteristics of Drive motors and understand their working principle.

CO3: Compare the usage of different types of Starters in DC and AC motors

CO4: Construct suitable Conventional and Solid-state Electric drives for DC motors.

CO5 : Interpret Conventional and Solid-state Electric drives for AC motors

TEXT BOOKS:

1. Vedam Subramanian, "Electric Drives Concepts and Applications", 2nd Edition, Tata McGraw-Hill, 2011.
2. Nagrath.I.J & Kothari.D.P, "Electrical Machines", 4th Edition, Tata McGraw-Hill, 2010.
3. Pillai.S.K "A First Course on Electric Drives", 3rd Edition, Wiley Eastern Limited, 2012.

REFERENCES

1. Singh. M.D., K.B.Khanchandani, "Power Electronics", 2nd Edition, Tata McGraw-Hill, 2006.
2. Partab. H., "Art and Science and Utilization of Electrical Energy", 6th Edition, Dhanpat Rai and Sons, 2017.
3. Gnanavadivel.J, Karthikeyan.J, Chitra Selvi.S, Yogalakshmi.P, "Electrical Drives and Control",4th Edition, Anuradha Publications, 2019.

21EN201	Interpersonal Skills Laboratory-Listening and Speaking (B.E. - Mechanical Engineering)	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. To demonstrate their ability to comprehend English language in different accents and speak fluently in neutral accent
2. To develop the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
3. To choose appropriate spoken language and use in basic general classroom conversation and to engage in specific academic speaking activities.
4. To discriminate the language of general topics with academic domain
5. To express ideas effectively in presentations.

UNIT I	Basic Pronunciation and Articulation	6

Listening as a key skill - Its importance - Speaking - To give personal information - Ask for personal information - Express ability - Enquire about ability - Ask for clarification Improving pronunciation -Sounds of English - Consonant Sounds - Pronunciation basics - Taking lecture notes - Preparing to listen to a lecture - Articulate a complete idea as opposed to producing fragmented utterances.

UNIT II	Simple Conversations in English	6

Listen to process information - Give information, as part of a simple explanation - Conversation starters: small talk - Sounds of English - Vowel Sounds - Stressing syllables and speaking clearly - Intonation patterns - Compare and contrast information and ideas from multiple sources - Converse with reasonable accuracy over a wide range of everyday topics.

UNIT III	Greetings and Intonation	6

Lexical chunking for accuracy and fluency - Factors influence fluency - Intonation - Deliver a five -minute informal talk - Greet - Respond to greetings - Describe health and symptoms - Invite and offer - Accept - decline - Take leave - Listen for and follow the gist - Listen for detail

UNIT IV	Non Verbal Communication in Presentation and Group Discussion	6

Being an active listener: giving verbal and non - verbal feedback - Extempore Activity - Small Talks - participating in a group discussion - summarizing academic readings and lectures conversational speech listening to and participating in conversations - persuade.

UNIT V	Academic Presentation	6

Formal and informal talk - Listen to follow and respond to explanations, directions and instructions in academic and business contexts - Strategies for presentations and interactive communication - Group/pair presentations - Negotiate disagreement in group work.

TOTAL: 30 PERIODS

COURSE OUTCOMES: At the end of the course, learners will be able to:

CO1. Comprehend the spoken words of native speakers

CO2. Respond appropriately to the speeches of native speakers

CO3. Take part in group discussions

CO4. Make effective presentations

CO5. Take part confidently and appropriately in both formal and informal conversations

TEXT BOOKS:

1. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014
2. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
3. 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. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
3. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.
4. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.

21MA204	PROBABILITY, STATISTICS AND NUMERICAL METHODS (*COMMON TO B.E. MECH Engg. & CIVIL Engg.*)	L	T	P	C
		3	2	0	4

COURSE OBJECTIVES:

- To describe the necessary basic concepts in probability
- To explain the concept of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To discuss the basic concepts of solving algebraic and transcendental equations and numerical techniques of integration which plays an important role in engineering and technology disciplines.
- To describe various techniques and methods of solving ordinary differential equations.
- To explain various techniques and methods of solving partial differential equations.

UNIT I	PROBABILITY	12

Introduction-Sample Spaces and Events-Axioms of Probability-Interpretations and Properties of Probabilities-Conditional Probabilities - Baye's theorem- Independence.

UNIT II	TESTING OF HYPOTHESIS	12

Large sample test based on Normal distribution for single mean and difference of means – Tests based on t, $\chi 2$ and F distributions for testing means and variances – Contingency table (Test for Independency) – Goodness of fit.

UNIT III	SOLUTION OF EQUATIONS AND NUMERICAL INTEGRATION	12

Newton Raphson method – Solution of linear system of equations: Gauss elimination method – Pivoting – Gauss Jordan method – Gauss Seidel method – Numerical integration by Trapezoidal and Simpson's rule.

UNIT IV	NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS	12

Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equation – Milne's Predictor and Corrector method – Adam's Bashforth predictor – corrector method for solving first order equation.

UNIT V	BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	12

Finite difference methods for solving second order two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1**:** Use the basic concepts of Probability and Random variables.

CO2 : Explain the test of hypothesis for small and large samples by using various test

Like t-test, F-test, Z-test and $\chi 2$ test.

CO3**:** Apply a suitable method to solve algebraic and transcendental equations.

CO4 : Explain the knowledge of various techniques and methods for solving first and second order Ordinary differential equations.

CO5 : Solve the partial and ordinary differential equations with initial and Boundary conditions by Using certain techniques with engineering applications.

TEXT BOOKS:

1. JAY.L. Devore, "Probability and Statistics for Engineering and the Science", 8th Edition, Cengage Learning, 2012.
2. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis", 7th Edition, Pearson Education, Asia, New Delhi, 2006.
3. Johnson, R.A., Miller, I and Freund J, "Probability and Statistics for Engineers", 8th Edition, Pearson Education, Asia, 2015.

REFERENCES:

1. S.C.Gupta, V.K.Kapoor, "Fundamentals of Mathematical Statistics", 11th Edition, Sultan Chand & Sons, 2015.
2. Chapra. S.C. and Canale. R.P, "Numerical Methods for Engineers", 5th Edition, Tata McGraw Hill, New Delhi, 2007.
3. S.K.Gupta, "Numerical Methods for Engineers", 7th Edition, New age international private Ltd publishers, 2015.

21ME205	MANUFACTURING TECHNOLOGY – II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the mechanism of chip formation
- To demonstrate the working procedure and various process of turning machine
- To demonstrate the working principle of drilling, milling and Gear cutting machines
- To interpret the various types of grinding and broaching machines
- To demonstrate the CNC program

UNIT I	THEORY OF METAL CUTTING	9

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

UNIT II	ADVANCED TURNING MACHINES	9

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

UNIT III	DRILLING, MILLING AND GEAR CUTTING MACHINES	9

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

UNIT IV	ABRASIVE PROCESS AND BROACHING	9

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

UNIT V	CNC MACHINING	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate the mechanism of material removal processes.

CO2: Relate the constructional and operational features of centre lathe and other special purpose lathes

CO3: Demonstrate the constructional and operational features of shaper, milling, and gear manufacturing process.

CO4: Describe the grinding and other finishing processes.

CO5: Relate CNC part programming

TEXT BOOKS:

1. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 4th Edition, Tata McGraw-Hill, New Delhi, 2018.

2. Serope Kalpakjian and Steven R.Schmid, 'Manufacturing Engineering and Technology', 8th Edition, PHI, 2020.
3. Hajra Choudhury, "Elements of Workshop Technology", Vol-II, 15th Edition, Media Promoters 2016.

REFERENCES:

1. Paul Degarma E., Black J.T. and Ronald A. Kosher, "Materials and Processes, in Manufacturing", 8th Edition, Prentice Hall of India, 1997.
2. Sharma, P.C., "A Textbook of Production Technology", 10th Edition, S.Chand and Co. Ltd., 2004.
3. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", 3rd Edition, Mc Graw Hill, 2005.

21ME206	KINEMATICS AND DYNAMICS OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the basic components and layout of linkages in the assembly of a system /machine.
- To apply the principles of displacement, velocity and acceleration at any point in a link of a mechanism.
- To sketch the cam profile
- To apply the concepts of toothed gearing and kinematics of gear trains
- To illustrate the balancing of rotating and reciprocating masses

UNIT I	BASICS OF MECHANISMS	9

Classifications of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler'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

UNIT III	KINEMATICS OF 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 – Sped ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains

UNIT V	BALANCING	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Relate the fundamental principles of kinematics and kinetics for simple mechanisms.
CO2: Sketch the velocity and acceleration diagram for simple mechanisms.
CO3: Sketch the profile of the cam mechanisms.
CO4: Assess the law of toothed gearing in various gear trains.

CO5: Calculate the balancing of rotating and reciprocating masses.
TEXT BOOKS:
1. Uicker, J.J., Penock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4th Edition, Oxford University Press, 2014. 2. Ratan, S.S, "Theory of Machines", 5th Edition, Tata McGraw-Hill, 2019. 3. R.S. Khurmi, "Theory of Machine", 14th Edition, S Chand, 2020.
REFERENCES:
1. Cleghorn. W. L, "Mechanisms of Machines", 2nd Edition, Oxford University Press, 2014 2. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Pvt. Ltd., New Delhi, 2006. 3. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.

21ME207	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the principles of thermodynamics and gas power cycle
- To demonstrate the basic concepts of vapour power cycles
- To experiment the performance of compressors
- To apply the thermodynamic concepts into various thermal application like IC engines andrefrigeration
- To manipulate the principle of Refrigeration and Air conditioning system

UNIT I	GAS POWER CYCLES	9

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

UNIT II	AIR COMPRESSORS	9

Classification and working principle, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency, working principle of Multistage air compressor and intercooling.

UNIT III	INTERNAL COMBUSTION ENGINES	9

IC engine – Classification, working, components and their functions. - two stroke & four stroke SI & CI engines – comparison. of SI and CI engines.– Knocking – phenomena and control, Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems.

UNIT IV	STEAM NOZZLE AND BOILER	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. Boiler - types and Comparison-Mountings and Accessories. - Boiler trial. IBR Certification.

UNIT V	REFRIGERATION	9

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air refrigeration cycle, vapour absorption system, and Thermoelectric refrigeration. Eco friendly refrigerants.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply thermodynamic concepts to different air standard cycles and solve problems.
CO2: Solve problems in single stage and multistage air compressors
CO3: Calculate the functioning and features of IC engines, components and performance parameters of IC Engines
CO4: Solve problems for steam nozzle and boilers.
CO5: Solve problems using refrigerant table.

TEXT BOOKS:

1. Rajput. R. K., "Thermal Engineering" 11th Edition, Laxmi Publications, 2020.

2. Kothandaraman. C.P., Domkundwar. S,Domkundwar. A.V., “A course in thermal Engineering", 15th Edition, Dhanpat Rai & sons, 2016.
3. T.D Eastop “Applied Thermodynamics for engineering technologists” 5th Edition, Longman, 1993.

REFERENCES:

1. Ganesan V.” Internal Combustion Engines” , 3rd Edition, Tata Mc graw- Hill, 2012
2. Ramalingam. K.K., "Thermal Engineering", 2nd Edition, Scitech Publications (India) Pvt. Ltd., 2009.
3. Rudramoorthy, R, “Thermal Engineering”, 3rd Edition, Tata McGraw-Hill, New Delhi,2003

21ME208	FLUID MECHANICS AND MACHINERY (Theory with Practical Course)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To describe the properties of fluids and Pressure measurement.
- To explain law of conservation in flow through pipes.
- To interpret the importance of dimensional analysis.
- To relate the importance of various types of flow in pumps.
- To discuss the importance of various types of flow in turbines.

UNIT I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity. Flow characteristics –pressure measurement - application of continuity equation, energy equation and momentum equation. Buoyancy.

UNIT II	FLOW THROUGH CIRCULAR CONDUITS	9

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

UNIT III	DIMENSIONAL ANALYSIS	9

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV	PUMPS	9

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle - work done by the impeller -Reciprocating pump- working principle.

UNIT V	TURBINES	9

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities.

TOTAL: 45 PERIODS

PRACTICAL COURSE **15**

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orificemeter.
2. Determination of the Coefficient of discharge of given Venturimeter.
3. Calculation of the rate of flow using Rotameter.
4. Determination of friction factor for a given set of pipes.
5. Conduct experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
6. Conduct experiments and drawing the characteristic curves of reciprocating pump.
7. Conduct experiments and drawing the characteristic curves of Gear pump.
8. Conduct experiments and drawing the characteristic curves of Pelton wheel.

9. Conduct experiments and drawing the characteristics curves of Francis turbine.
10. Conduct experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply mathematical knowledge to predict the properties and characteristics of a fluid.
CO2: Relate and correlate major and minor losses associated with pipe flow in piping network.
CO3: Solve the dimensional analysis.
CO4: Calculate the performance of pumps.
CO5: Illustrate the performance of turbines.

TEXT BOOKS:

1. Bansal, R. K., "Textbook of fluid mechanics and hydraulic machine: SI units" 10th Edition, Laxmi Publication, 2018.
2. White, Frank M., "Fluid Mechanics" 8th Edition, McGraw-Hill, 2017.
3. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", 22nd Edition, Standard Book House, 2019.

REFERENCES:

1. Kumar K. L., "Engineering Fluid Mechanics", 8th Revised Edition, Eurasia Publishing House(p) Ltd., 2014,
2. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", 8th Edition, John Wiley & Sons, 2011.
3. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", 9th Edition, McGraw Hill Publishing Co., 2017.

21ME209	MANUFACTURING TECHNOLOGY LABORATORY – II	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To demonstrate various gear cutting in milling machine
- To experiment gear cutting in hobbing and shaping machine
- To demonstrate various grinding operation in grinding machine
- To calculate various cutting forces in lathe and milling using instruments
- To use CNC part programming

LIST OF EXPERIMENTS

1. Spur gear cutting in milling machine
2. Helical Gear Cutting in milling machine
3. Gear generation in hobbing machine
4. Gear generation in gear shaping machine
5. Plain Surface grinding
6. Cylindrical grinding
7. Tool angle grinding with tool and Cutter Grinder
8. Measurement of cutting forces in Milling / Turning Process
9. CNC Part Programming

TOTAL: 60 PERIODS

At the end of the course, learners will be able to

CO1: Manipulate gear cutting operation in milling machine.
CO2: Manipulate gear cutting operation in shaping and gear hobbing machine.
CO3: Manipulate various operation in grinding machine.
CO4: Evaluate various cutting forces in lathe and milling machine.
CO5: Apply CNC part programing for given geometry.

21ME210	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To illustrate value timing-V diagram and performance of IC Engines.
- To demonstrate characteristics of fuels/Lubricates used in IC Engines.
- To illustrate of steam generator/ turbine.
- To demonstrate Load test on a single cylinder -Diesel engine.
- To illustrate Load test on multi-cylinder petrol engine

LIST OF EXPERIMENTS

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Performance Test on 4 – stroke Diesel Engine.
4. Heat Balance Test on 4 – stroke Diesel Engine.
5. 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.
8. Study on Steam Generators and Turbines.
9. Performance and Energy Balance Test on a Steam Generator.
10. Performance and Energy Balance Test on Steam Turbine.

TOTAL: 60 PERIODS

COURSE OUTCOME:

At the end of the course, learners will be able to

CO1: Sketch the various components and mechanisms of I. C. Engines.
CO2: Evaluate performance characteristics of single-cylinder petrol engines at different loads.
CO3: Demonstrate indicated power of individual cylinders of an engine by using the morse test.
CO4: Evaluate the tests Steam Turbine.
CO5: Evaluate the tests Steam generators.

21ME211	KINEMATICS AND DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- To calculate the mass moment of inertia.
- To relate the effect of gyroscope and governors.
- To sketch the cam profile for followers.
- To demonstrate the vibration effect for springs under loading condition.
- To calculate the critical speed for shaft with concentrated loads

LIST OF EXPERIMENTS

1. Determination of Mass Moment of Inertia using compound pendulum/ Bifilar Suspension/ Trifilar Suspension
2. Motorized gyroscope – Study of gyroscopic effect and couple.
3. Characteristics of watt / Porter / Proell/ Hartnell governor by fixing the mechanism properly to spindle shaft.
4. Cams – Cam profile drawing, Motion curves and study of jump phenomenon.
5. Free vibration of spring mass system.
6. Longitudinal vibration of helical spring.
7. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
8. Transverse vibrations of simply supported beam and Cantilever Beam.
9. Balancing of Rotating and Reciprocating masses.
10. Study of Damped Torsional vibration of single rotor system.
11. Study of undamped Torsional vibration of single rotor system.

TOTAL: 60 PERIODS

COURSE OUTCOME:

At the end of the course, learners will be able to

CO1: Calculate mass moment of inertia.
CO2: Interpret the effect of gyroscope and governors.
CO3: Sketch the cam profile for various applications.
CO4: Demonstrate the vibrations effect for spring mass system
CO5: Calculate the critical speed for shafts under different loading system

21EN202	ADVANCED READING AND WRITING LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. To use relevant strategies for reading critically and writing purposely.
2. To choose relevant skills required to study engineering topics.
3. To discriminate between general writing and technical writing.
4. To develop students' critical thinking skills.
5. To propose research ideas and develop their project in writing.

UNIT I	BASICS OF PARAGRAPH READING AND WRITING	6

Reading - Strategies for effective reading - Usage of glossaries and footnotes to aid reading Comprehension - Read and recognize different text types - Predicting content using photos and title; **Writing** - Plan before writing - Synopsis Preparation - Develop a paragraph: topic sentence, supporting sentences, concluding sentence -Write a descriptive paragraph

UNIT II	ORGANISATION OF WRITING	6

Reading - Read for details - Use of graphic organizers to review and aid comprehension **Writing** - State reasons and examples to support ideas in writing - Parallel paragraph - Write a paragraph with reasons and examples - Write an opinion paragraph

UNIT III	COMPONENTS OF LONGER TEXTS	6

Reading - Understanding pronoun reference and use of connectors in a passage - speed reading techniques; **Writing** - Hints Developing - Elements of a good essay -Types of essays – Descriptive, Narrative, Issue-based, Argumentative - Analytical.

UNIT IV	WRITING IN PERSONAL AND TECHNICAL CONTEXTS	6

Reading - Cohesion of ideas, Organization of Ideas; **Writing** - Email writing - Resumes - Writing Job application - Formats of project proposals.

UNIT V	LANGUAGE AT WORKPLACES	6

Reading - Critical reading and thinking - Reading and comprehending texts of different domains – Identify; **Writing** - Statement of Purpose - Letter of recommendation

	TOTAL: 30 PERIODS

OUTCOMES:

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

CO1: Strengthen the reading skills of students of engineering.

CO2: Enhance their writing skills with specific reference to technical writing.

CO3: Develop students' critical thinking skills.

CO4: Communicate well at workplaces

CO5: Provide more opportunities to develop their project and proposal writing skills.

TEXT BOOKS:

1. E. Suresh Kumar and et al. "Enriching Speaking and Writing Skills", 2nd Edition.Orient BlackSwan: Hyderabad, 2012
2. Debra Daise, CharlNorloff, and Paul Carne Reading and Writing (Level 4) Oxford University Press: Oxford, 2011
3. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press:Oxford, 2011

REFERENCES:

1. Davis, Jason and Rhonda LIss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006
2. Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge University Press: Cambridge, 2004
3. Petelin, Roslyn and Marsh Durham. The Professional Writing Guide: Knowing Well and Knowing Why. Business & Professional Publishing: Australia, 2004
4. Goatly, Andrew. Critical Reading and Writing. Routledge: United States of America, 2000

21ME301	DESIGN OF MACHINE ELEMENTS (Usage of PSG Design Data Book is permitted in the end semester examinations)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the concepts of stress in design of machine elements subjected to steady and variable loading
- To use design procedure to validate strength of shafts and couplings
- To execute the design procedure for spring and connecting rod to validate the strength based upon the application and requirements
- To demonstrate the design procedure for joints and suggest the suitable dimension for various mechanical applications
- To choose the appropriate bearings based on standard procedure for specific applications

UNIT I	STEADY STRESSES AND VARIABLE STRESSES	9

Factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances, Factor of safety - principle stresses for various load combinations, curved beams - Crane hook – Crane sling, Theories of failure - Design for variable loading

UNIT II	DESIGN OF SHAFTS AND COUPLINGS	9

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

UNIT III	ENERGY STORING ELEMENTS	9

Coil Springs: Tension Springs -Compression Springs - Optimization of helical springs - Leaf Springs – Design of Connecting Rods and crank shafts.

UNIT IV	TEMPORARY AND PERMANENT JOINTS	9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Welded joints, riveted joints for structures

UNIT V	DESIGN AND SELECTION OF BEARINGS	9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs - Selection of Rolling Contact bearings.
Case Studies on Machine Elements using Software (Not for an Examination)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explin the concepts of stress in design of machine elements subjected to steady and variable loading.
CO2: Use design procedure to validate strength of shafts and couplings.
CO3: Execute the design procedure for spring and connecting rod to validate the strength based upon the application and requirements.
CO4: Apply the design procedure for joints and suggest the suitable dimension for various mechanical applications
CO5: Demonstrate the appropriate bearings based on standard procedure for specific applications.

TEXT BOOKS:

1. Joseph Edward Shigley and Charles R. Misucke, "Mechanical Engineering Design", 10th Edition, Tata McGraw Hill, 2015.

2. Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016.
3. Sharma and Purohit, “Design of Machine Elements”, 4th Edition, PHI Learning, 2003.

REFERENCES:

1. Jalaludeen S, “Machine Design**,** Vol -1”, 4th Edition, Reprint Anuradha Publications, 2021
2. M.F. Spott, “Design of Machine Elements”, 8th Edition, Pearson Education, 2019
3. R.B. Patel, “Design of Machine Elements”,7th Edition, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
4. PSG, “Design Data Book”, Kalaikathir Achhangham Coimbtore, 2018.

21ME302	PRODUCTIVITY AND QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate them to know the evolution of Productivity and Quality Management.
- To use the tools productivity management.
- To apply the functions and principles of management.
- To discussion the application of the quality principles in an organization.
- To apply the tools for quality and productivity improvements.

UNIT I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	9

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

UNIT II	PRODUCTIVITY MANAGEMENT	9

Evolution of Industrial Engineering, Productivity definition, means of increasing productivity, **Method study**: Selection of jobs, recording tools and techniques – Flow chart, Process chart, Man-machine chart, two handed process chart, Process flow diagram, Process Flow Analysis, Analyzing, and Development of improved methods**. Work Measurement**: Time study equipment, performance rating, allowances, number of cycles to be studied, and determination of standard time. Work place design - Ergonomics.

UNIT III	PRINCIPLES AND CONCEPTS OF TOTAL QUALITY MANAGEMENT	9

Need for quality - Evolution of quality - Definitions of quality - Introduction Productivity metrics – Quality route to productivity - Dimensions of product and service quality - Basic concepts of TQM - Customer focus –Leadership -Employee involvement -Performance appraisal - Continuous process improvement -Supplier partnership TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements

UNIT IV	SUPPORTING TOOLS, ACTIVITIES AND TECHNIQUES IN TQM PROJECTS	9

The seven traditional tools of quality - New management tools -, - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types. Quality Function Deployment (QFD) - Taguchi quality loss function -

UNIT V	QUALITY AND PRODUCTIVITY SYSTEMS	9

JIT concepts and enablers - Kanban principles - evaluate inventory norm in the supply chain, Changeover time compression techniques, TPM - Concepts, improvement needs - Six sigma: Concepts, Methodology - The structure of ISO 9000 – 2015 series standards – Development of quality statement complying different classes - certification process.

TOTAL PERIOD	45

Course Outcomes:

At the end of the course, learners will be able to

CO1: Discuss the need for Productivity and Quality

CO2: Demonstrate the various productivity tools and techniques

CO3: Apply the various TQM principles in meeting the customer expectations from a product/service

CO4: Demonstrate various quality management tools, techniques and systems

CO5: Discuss the need for Implement the Productivity and Quality Management Systems in a

different organization environment

TEXT BOOKS

1. Harold Koontz & Heinz Weihrich, “Essentials of Management: An International, Innovation and Leadership Perspective”, 5th edition, McGraw Hill, 2015.
2. ILO, “Introduction to Work Study”, 4th Edition, Universal Publishing Corporation, Bombay, 1992.
3. Dale H. Besterfiled, et at., "Total quality Management", 5th Edition, Pearson Education Asia, Indian Reprint, 2018

REFERENCES

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, “Fundamentals of Management”, 7th Edition, Pearson Education, 2011.
2. Tripathy PC & Reddy PN, “Principles of Management”, 4th edition, Tata Mcgraw Hill, 1999
3. Panneerselvam R, "Production and Operations Management”, 3rd edition, PHI, New Delhi, 2006

21ME303	FLUID POWER AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To discuss the application of fluid power in process, construction and manufacturing Industries.
- To demonstrate the working of hydraulic actuators and control components
- To apply the hydraulic circuits and systems
- To demonstrate the working of pneumatic and electro pneumatic systems
- To apply a measurable degree of competence in the design, construction and operation of fluid power circuits

UNIT I	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids – Basics of Hydraulics – Pascal's Law – Principles of flow – Sources of Hydraulic power: Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps

UNIT II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols

UNIT III	HYDRAULIC CIRCUITS AND SYSTEMS	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V	TROUBLE SHOOTING AND APPLICATIONS	9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the Fluid power and operation of different types of pumps.

CO2: Summarize the features and functions of Hydraulic motors, actuators and Flow control

valves

CO3: Explain the different types of Hydraulic circuits and systems

CO4: Explain the working of different pneumatic circuits and systems

CO5: Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", 3rd edition, Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", 2nd edition, Tata McGraw-Hill, 2001.
3. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", 5th edition,Chand & Co, 2006.

REFERENCES:

1. Anthony Lal, "Oil hydraulics in the service of industry", 4th edition, Allied publishers, 1982.
2. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", 3rd edition,Prentice Hall, 1987.
3. Majumdar S.R., "Pneumatic systems – Principles and maintenance", 4th edition,Tata McGraw Hill, 1995

21ME304	HEAT AND MASS TRANSFER (Theory with Practical Course)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To solve the problems on conductive Heat transfer
- To demonstrate the problems on convective Heat Transfer.
- To solve the problems on radioactive Heat Transfer
- To calculate the Heat Exchanger parameters.
- To solve the problems on Mass Transfer.

UNIT I	CONDUCTION	9

Basic concepts – Mechanism of Heat Transfer - Fourier Law of Conduction - General Differential equation of Heat Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction–Conduction through Plane Wall, Cylindrical system – Composite Systems

UNIT II	CONVECTION	9

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders- Internal flow- Flow through pipes

UNIT III	RADIATION	9

Black Body Radiation – Grey body radiation - Shape Factor, Planes perpendicular to each other, Plane parallel to each other, Circular disc – Radiation Shields and its applications

UNIT IV	HEAT EXCHANGERS	9

Types of Heat Exchangers–Heat Exchanger Analysis –LMTD Method and NTU-Effectiveness–Overall Heat Transfer Coefficient–Fouling Factors- Boiling and Condensation.

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–

TOTAL: 45 PERIODS

PRACTICAL COURSE	15

LIST OF EXPERIMENTS:

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. 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.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Demonstrate the problems on conductive Heat transfer

CO2: Apply the problems on convective Heat Transfer.

CO3: Solve the problems on radioactive Heat Transfer

CO4: Calculate the Heat Exchanger parameters. CO5: Calculate the problems on Mass Transfer
TEXT BOOKS:
1. Cengel, Y.A., "Heat Transfer-A Practical Approach", 3rd Edition, McGraw-Hill, 2002. 2. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer", 4th Edition New Age International, 2017. 3. Incropera, Frank P. DeWitt, David P. Bergman, Theodore L, Lavine, Adrienne S , "Fundamentals of Heat and Mass Transfer", 3rd Edition, John Wiley and Sons,2011.
REFERENCES:
1. Yadav R "Heat and Mass Transfer" 4th Edition, Central Publishing House-Allahabad, 1992. 2. Nag P.K, "Heat Transfer", 3rd Edition, Tata McGraw-Hill, New Delhi, 2011. 3. Kothandaraman. C.P, "Fundamentals of Heat and Mass Transfer," 4th Edition New Age International, New Delhi, (Reprint 2015).

21ME305	METROLOGY AND MEASUREMENTS (Theory with Practical Course)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To demonstrate knowledge on various basic concepts of metrology.
- To examine Linear and Angular measurements.
- To experiment with advanced measuring equipment's.
- To apply knowledge on the form measurement techniques.
- To calculate of power, flow and temperature measurements.

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.

UNIT II	LINEAR AND ANGULAR MEASUREMENTS	9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar– Autocollimator – Applications

UNIT III	ADVANCES IN METROLOGY	9

Basic concept of lasers Advantages of lasers – 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.

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

	TOTAL: 45 PERIODS

PRACTICAL COURSE	15

LIST OF EXPERIMENTS:

1. Calibration and use of measuring instruments – Vernier caliper
2. Calibration and use of measuring instruments - Micrometer
3. Calibration and use of measuring instruments - Vernier height gauge
4. Calibration and use of measuring instruments – telescopic gauge
5. Measurement of angles using sine bar
6. Measurement of gear parameters – gear tooth vernier caliper
7. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
8. Measurement of torque and temperature

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1 -Summarize the Metrological basis, concept of measurement errors, uncertainty in measurements

CO2 - Explain the linear and angular measuring instruments and their applications

CO3 -Apply measurement strategies and diagnose various methods of measuring Mechanical parameters.

CO4 -Demonstrate effective methods of various form measurements

CO5 – Calculate power, flow and temperature using measuring instruments.

TEXT BOOKS:

1. Gupta. I.C., "Engineering Metrology", 3rd Edition Dhanpatrai Publications, 2005.
2. Jain R.K. "Engineering Metrology", 5th Edition, Khanna Publishers, 2018.
3. Manohar Mahajan, "A Textbook of Metrology", 4th edition Dhanpatrai Publications, 2021.

REFERENCES:

1. Alan S. Morris, "The essence of Measurement", 3rd Edition, Prentice Hall of India 1996.
2. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", 4th Edition, Pearson Education, 2014.
3. Charles Reginald Shotbolt, "Metrology for Engineers", 5th Edition, Cengage Learning EMEA, 1990.

21ME306	COMPUTER AIDED PRODUCT DEVELOPMENT (Theory with Practical Course)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To apply practical knowledge regarding conceptualization, design and development of a new product
- To use the basic concepts of product design, product features and its architecture
- To use basic knowledge in the common features a product has and how to incorporate them suitably in product.
- To discuss the purpose of inculcating basic design standards and design skills among the students.
- To apply basic features of product development

UNIT I	INTRODUCTION	9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behavior analysis. Understanding customer need – prompting customer understanding – involve customer in development and managing requirements – Plan and establish product specifications.

UNIT II	CONCEPT GENERATION AND SELECTION	9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III	PRODUCT ARCHITECTURE	9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV	INDUSTRIAL DESIGN	9

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools– Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – conceptualization – refinement – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT V	PRODUCT DEVELOPMENT	9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes –Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

LIST OF EXPERIMENTS:	15

1. Introduction to Engineering Drawing standards
2. Introduction to Geometric Dimensioning
3. Introduction to Limits, Fits and Tolerances
4. Preparation of production drawings and reading of part and assembly drawings
5. CAD drawing of Plummer Block
6. CAD drawing of couplings

7. CAD drawing of screw jack
TOTAL: 60 PERIODS
COURSE OUTCOMES:
At the end of the course, learners will be able to CO1: Demonstrate the concept of product development and its applications. CO2: Apply concept evaluation process. CO3: Demonstrate the suitable product architecture. CO4: Discuss the product planning process based on the customer need. CO5: Discuss product specification with cost, aesthetic and ergonomics aspects.
TEXT BOOKS:
1. Ulrich, Karl T and Steven D. Eppinger, "Product Design and Development", 6th Edition Irwin/McGraw-Hill, 2015. 2. N.Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing", 3rd Edition, Tata McGraw Hill, 2014. 3. Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013
REFERENCES:
1. David G. Ullman, "The Mechanical Design Process", 4th edition, Tata McGraw Hill , 2011 2. Orwin, Homewood, "Effective Product Design and Development", 1st Edition, Stephen Rosenthal, Business One, 1992. 3. Stuart Pugh, "Tool Design – Integrated Methods for successful Product Engineering", 1st Edition, Addison Wesley Publishing, 1991.

21ME307	DESIGN OF TRANSMISSION SYSTEM (Usage of P.S.G Design Data Book is permitted in the end semester examinations)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate the principles for designing the flexible elements in Transmission systems.
- To apply the design procedure for designing Spur and Helical gears
- To apply the design procedure for designing bevel and worm gears.
- To construct and calculate the multi-speed gear box.
- To illustrate the concepts for designing clutches and brakes.

UNIT I	DESIGN OF FLEXIBLE ELEMENTS	9

Introduction on transmission system - Design of Flat belt drive and Flat belt pulleys - Design of V belt drive - Design of roller chain drive - Design of wire ropes

UNIT II	SPUR AND HELICAL GEARS	9

Gear terminology - speed ratios and number of teeth-force analysis – stresses in gear teeth - dynamic effects – fatigue strength - 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. - Crossed helical and Herringbone gear - Cross helical, Terminology-helix angles

UNIT III	BEVEL AND WORM GEARS	9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Design of pair of straight bevel gears. Worm Gear: Merits and demerits- terminology, materials-forces and stresses, efficiency, Design of the worm gear pair-Heat generation in worm gear drive

UNIT IV	DESIGN OF GEAR BOXES	9

Gear Box – methods for obtaining different spindle speeds – Requirements of a speed reducer gear box – preferred numbers - Standard step ratio - Rules for optimum gear box design - Preparation of ray diagram and kinematic arrangement – Design of multi-speed gearbox

UNIT V	CLUTCHES AND BRAKES	9

Clutches - Function of clutch – Classification – Friction materials – Design Single plate and Multi plate clutches - axial clutch - internal expanding rim clutches. Brakes – Classification - Design of Single Block, Double Blake brake – Design of Band and Block Brake - Internal and external expanding shoe brakes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply principles and procedure for the design of flexible Transmission elements.

CO2: Interpret the standard procedure for the design Spur and Helical Gears.

CO3: Interpret the standard procedure for the design Bevel and Worm Gears.

CO4: Demonstrate procedure for designing a gear box

CO5: Illustrate the concepts for designing clutches and brakes.

TEXT BOOKS:
1. Bhandari V.B, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Education, New Delhi, 2017. 2. Richard G.Budynas and J.Keith Nisbett., "Shigley's Mechanical Engineering Design", 10th Edition (SIE), Tata McGraw-Hill Education, New Delhi, 2017. 3. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum‟s Outline), 2010
REFERENCES:
1. Sundararajamoorthy T.V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2018 2. R.S.Khurmi, "A text book of Machine Design", S.Chand & Co, New Delhi, 1st Edition 2015. 3. PSG College of Technology, "Design Data Book of Engineers", Kalaikathir Achchagam, 2018.

21ME308	FINITE ELEMENT ANALYSIS (Theory with Practical Course)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To demonstrate the concepts of Mathematical Modeling of Engineering problems.
- To examine the One Dimensional structural and thermal elements.
- To appraise structural and thermal elements using Two Dimensional scalar variable equations
- To appraise planar stresses using Two Dimensional Vector variable equations
- To examine the Isoparametric elements for its displacement

UNIT I	INTRODUCTION	9

Historical Background – 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 and heat transfer.

UNIT III	TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS	9

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

UNIT IV	TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS	9

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

UNIT V	ISOPARAMETRIC FORMULATION	9

Natural co-ordinate systems–Isoparametric elements – Shape functions – One and two dimensions – Serendipity elements–Numerical integration and Gaussian quadrature

TOTAL: 45 PERIODS

PRACTICAL COURSE	15

LIST OF EXPERIMENTS:

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.
4. Stress analysis of axisymmetric components
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress and heat transfer analysis of composite plates.
7. Modal analysis of Beams
8. Harmonic and transient analysis of simple beams

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1:	Illustrate the Engineering problems using the concept of Engineering Model
CO2:	Solve the One Dimensional structural and thermal elements.
CO3:	Solve the Two Dimensional scalar variable equations structural and thermal elements
CO4:	Solve planar stresses using Two Dimensional Vector variable equations
CO5:	Demonstrate Isoparametric element, shape function and Gaussian quadrature.

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", 1st Edition, Prentice-Hall of India Pvt. Ltd. New Delhi, 2007.
3. Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004

REFERENCES:

1. Logan, D.L., "A first course in Finite Element Method", 1st Edition, Thomson Asia Pvt. Ltd., 2002
2. 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.
3. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div,1990
4. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications",1st Edition, John Wiley & Sons, 2005(Indian Reprint 2013)

21ME309	MECHATRONICS and IoT (Theory with Practical Course)	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To apply knowledge about the elements and techniques involved in Mechatronics system.
- To demonstrate the architecture and operation of typical microprocessors and microcontrollers.
- To understand the concepts of Internet of Things and able to build IoT applications
- To apply knowledge gained about generic architecture of PLCs and its real-life industrial applications.
- To evaluate and select suitable actuators, sensors and controllers

UNIT I	MECHATRONICS, SENSORS AND TRANSDUCER	9

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors(Bimetallic Strips,RTD,Thremistor) – Light sensors(Photo diode, photo transistor, Photo resister)-Optical Encoder

UNIT II	MICROPROCESSOR AND MICROCONTROLLER	9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set– Block diagram of 8051 Microcontroller-Microprocessor vs. Microcontroller-Timing Diagram

UNIT III	IOT AND PROGRAMMABLE PERIPHERAL INTERFACE	9

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT – Architecture of 8255- Pin Configuration- Interfacing Keyboard, LED display - Traffic light Control interface.

UNIT IV	PROGRAMMABLE LOGIC CONTROLLER	9

Introduction – Basic structure –Architecture of PLC- Input and output processing – Logic Gates– Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC

UNIT V	ACTUATORS AND MECHATRONIC SYSTEM DESIGN	9

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 – Automatic car park barrier.

LIST OF EXPERIMENTS:	15

1. Experiment with the various types of transducers.
2. Assembly language programming of 8085 – Addition – Subtraction
3. Stepper motor interface.
4. Design and develop traffic management system.
5. Speed control of DC motor.
6. Experiment on hydraulic, pneumatic and electro-pneumatic circuits.

7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
8. Experiment on PLC and its applications.
9. Experiment the image processing technique.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Select various Sensors and Transducers in Mechatronics systems

CO2: Demonstrate 8085 Microprocessors and 8051 Micro controller.

CO3: Operate the fundamentals of IOT and Programmable Peripheral Interface.

CO4: Interpret programmable logic controller

CO5: Demonstrate various actuators and appraise mechatronics systems

TEXT BOOKS:

1. W.Bolton, "Mechatronics", 4th Edition, Prentice Hall, 2008.
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Prentice Hall, 2008.
3. A. McEwen and H. Cassimally, "Designing the Internet of Things", 1st Edition, Wiley, 2013.

REFERENCES:

1. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", 4th Edition, PWS publishing company, 2007.
2. Krishna Kant, "Microprocessors & Microcontrollers", 3rd Edition, Prentice Hall of India, 2013
3. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", 4th Edition, McGraw Hill International edition, 2012.

21ME310	DESIGN THINKING AND PROTOTYPE DEVELOPMENT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To apply the foundational knowledge to get hands on training in the fabrication of one or more components.
- To illustrate the various parts of the product.
- To relate the various operation and material selected for the product.
- To interpret the cost analysis of the product.
- To demonstrate the complete working model.

GUIDELINE 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: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the fundamental concepts of design the product.

CO2: Demonstrate the various parts of the product.

CO3: Relate various operation and material selected for the product.

CO4: Interpret the cost analysis of the product.

CO5: Show the applications of the complete working model.

21EN301	PROFESSIONAL COMMUNICATION LABORATORY *(Common to all B.E./B.Tech. Programmes)*	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To demonstrate communication skills that can lead to improved interpersonal relationships.
- To plan to set and achieve goals with focus.
- To organize themselves in work life to face the professional set up with confidence.
- To interpret ideas and participate in group discussion with positive attitude.
- To develop their confidence and help learners to attend interviews successfully.

UNIT I	COMMUNICATION AND PROFESSIONAL ETIQUETTES	6

Importance and Types of Communication Verbal communication -Presentation skills- Non-Verbal communication - Personal Appearance, Posture, Gestures, Facial Expressions, Eye Contact and Space Distancing - Professional Etiquette

UNIT II	GOAL SETTING AND MOTIVATION	6

Short term and Long term Goals- Strategies to set and achieve goals- Motivation

UNIT III	TIME AND STRESS MANAGEMENT	6

Importance of Time - Time Management Skills - Sources of Stress - Managing Stress - Analysis of the Case Studies on time and stress management

UNIT IV	GROUP DISCUSSIONS AND POSITIVE ATTITUDE	6

Group Discussions - Leadership Qualities - Decision Making - Problem Solving - Negotiation Skills - Positive Attitude

UNIT V	RESUME MAKING AND INTERVIEW SKILLS	6

Preparing Resume - E - Resume - Covering Letter – Job Application through email - Career Portfolio - Types of Interviews - Mock Interviews

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Demonstrate effective communication skills through presentations.

CO2: Utilize their knowledge of motivation in setting and achieving goals.

CO3: Examine time and stress management.

CO4: Formulate their ideas into an effective communication in formal contexts.

CO5: Develop a well-composed resume and face interviews confidently.

TEXTBOOKS:

1. Dhanavel S P, "English and Soft Skills", 1st Edition, Orient BlackSwan Ltd, Hyderabad, 2012.
2. Dr. Tobin Porterfield & Bob Graham, "The 55 Soft Skills That Guide Employee and Organizational Success," Mason – West Publishing House, 2018.
3. Prashant Sharma, "Soft Skills Personality Development for Life Success, "BPB Publications, New Delhi, January 2018.

REFERENCES:

1. M. Ashraf Rizvi, “Effective Technical Communication,” Tata McGraw Hill Education Pvt. Ltd. New Delhi, 2016.
2. Mohan Krishna & Meera Banerji, “Developing Communication Skills,” 1st Edition, Trinity Press, 2017.
3. N. Krishnaswami & T. Sriraman, “Creative English for Communication”, 3rd Edition, Laxmi Publications Private Limited, 2017.

21ME401	PROJECT WORK 1	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To develop knowledge to formulate a real-world problem.
- To apply the goal and evolve procedures
- To use different tools and techniques to arrive at a solution
- To relate the results analytically and experimentally
- To prepare a report and give a presentation

Student shall identify a minor problem related to the field of Mechanical Engineering and carry out a literature survey/case studies/data collection. Student is supposed to formulate Engineering solutions to the problem, methodology to test their hypothesis/solutions and validate it theoretically/practically, planned and executed within the stipulated time.

Observations, results and inference should be documented and presented as report in the prescribed format.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Identify an engineering problem using scientific tools

CO2: Analyse physical systems to address an engineering problem

CO3: Formulate objectives and timelines for executing a project

CO4: Apply multidisciplinary knowledge to develop sustainable solutions

CO5: Report solutions and their outcomes through documentation

21ME402	PROJECT WORK II	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES:

- To use the knowledge to formulate a real-world problem.
- To demonstrate the goal and evolve procedures
- To use different tools and techniques to arrive at a solution
- To choose the results analytically and experimentally
- To prepare a report and give a presentation

Student shall identify a major/critical problem related to the field of Mechanical Engineering and carry out a literature survey/case studies/data collection. Student supposed to formulate Engineering solutions to set objectives, methodology to test their hypothesis/solutions and validate it theoretically/practically, planned and executed within the stipulated time.

Observations, results and inferences should be documented and presented as report in the prescribed format.

TOTAL: 300 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Identify an engineering problem using scientific tools
CO2: Analyse physical systems to address an engineering problem
CO3: Formulate objectives and timelines for executing a project
CO4: Apply multidisciplinary knowledge to develop sustainable solutions
CO5: Report solutions and their outcomes through documentation

VERTICAL 1: PRODUCT AND PROCESS DEVELOPMENT

21PME01	DESIGN CONCEPTS IN ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the concepts of design process.
- To explain the design ability of reliable products to satisfy the customer needs.
- To apply the appropriate design techniques.
- To illustrate the process of material selection principles and design.
- To apply the concepts used in design for reliability.

UNIT I	DESIGN PROCESS	9

Importance of design - The Design Process - Morphology of Design - Design Drawings - Computer Aided Engineering - Designing of Standards - Concurrent Engineering - Product Life Cycle - Technological Forecasting - Market Identification - Competition Benchmarking.

UNIT II	DESIGN FOR CUSTOMER NEEDS	9

Identification of customer needs - customer requirements - Quality Function Deployment - Product Design Specifications - Human Factors in Design – Ergonomics, Aesthetics and Societal consideration – Product liability – Patenting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Design for ecological - future trends in interaction of engineering with society.

UNIT III	DESIGN TECHNIQUES	9

Creativity and Problem Solving – Creativity methods-Theory of Inventive Problem Solving (TRIZ) – Conceptual decomposition - Generating design concepts - Axiomatic Design – Evaluation methods-Embodiment Design - Product Architecture - Configuration Design - Parametric Design - Role of models in design - Mathematical Modelling – Simulation – Geometric Modelling

UNIT IV	MATERIAL SELECTION PROCESSING IN DESIGN	9

Material Selection Process - Economics - Cost Vs Performance - Weighted Property Index - Value Analysis - Role of Processing in Design - Classification of Manufacturing Process - Design for Manufacture - Design for Assembly - Residual Stresses - Fatigue, Fracture and Failure.

UNIT V	PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY	9

Probability – Distributions – Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability – Robust Design – Failure Mode and Effect Analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the principles of CAE/concurrent engineering/forecasting techniques for new product design and development

CO2: Describe the appropriate design strategies complying with established standards in devising systems for customer needs

CO3: Use the various design techniques through modelling/simulation and optimize design

CO4: Apply the appropriate material selection strategy for various design concepts.

CO5: Demonstrate the various design and analysis tools for improving the quality and reliability of products performance.

TEXT BOOKS:

1. Dieter, George E., Engineering Design - "A Materials and Processing Approach", 3rd Edition, McGraw Hill International Editions, Singapore, 2000.
2. Karl T. Ulrich and Steven D. Eppinger "Product Design and Development" 4th Edition, McGraw Hill Edition 2009.
3. Kevin Otto, and Kristin Wood, "Product Design – Techniques in Reverse Engineering and New Product Development", 1st Edition Pearson Education, 2000

REFERENCES:

1. Pahl, G, and Beitz, W.," Engineering Design – A systematic approach", 3rd Edition, English Springer 2007.
2. Suh, N.P., "The principles of Design", 1st Edition, Oxford University Press, NY. 1990.
3. Orwin, Homewood, "Effective Product Design and Development", 1st Edition, Stephen Rosenthal, Business One, 1992.

21PME02	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the importance of product life cycle management.
- To illustrate the functions of product life cycle management.
- To use PLM software for various module in development of product.
- To demonstrate product life cycle concepts in industrial applications.
- To interpret PLM customization with CAD, SLM and ERP.

UNIT I	INTRODUCTION TO PRODUCT LIFECYCLE MANAGEMENT	9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management, Product Data Management, Collaborative Product Definition Management, Collaborative Product Commerce.

UNIT II	FUNCTIONS AND FEATURES OF PRODUCT DATA MANAGEMENT	9

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

UNIT III	DETAILS OF MODULES IN APDM/PLM SOFTWARE	9

Collaborative Product Development, Mapping Requirements to specifications. Part Numbering, Engineering Vaulting, Product reuse, Engineering Change Management, Bill of Material and Process Consistency. Digital Mock up and Prototype development. Virtual testing and collateral.

UNIT IV	ROLE OF PLM IN INDUSTRIES	9

PLM selection and implementation - PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Complete the history, concepts and terminology of PLM
CO2: Illustrate the functions and features of PLM/PDM
CO3: Discover the different modules offered in commercial PLM/PDM tools.
CO4: Demonstrate the PLM/PDM approaches for industrial applications.
CO5: Apply the integration of PLM/PDM with legacy data base & ERP systems

TEXT BOOKS:

1. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", 3rd Edition, Springer Publisher, 2008.
2. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", 2nd Edition, Springer Publisher, 2011.
3. Michael Grieves, "Product Life Cycle Management", 2nd edition, Tata McGraw Hill, 2006.

REFERENCES:

1. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", 1st Edition, Artech House Publishers, 2003.
2. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", 1st Edition, Springer Publisher, 2007.
3. ArieKarniel and Yoram Reich, Managing the Dynamics of New Product Development Processes: A New Product Lifecycle Management Paradigm, 1st Edition, Springer, 2011.

21PME03	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate the basic concepts of CAD /CAM/CIM.
- To use the computers and software for preparing the process plan.
- To apply the group technology and cellular manufacturing concepts.
- To apply the concepts of FMS and AGV Systems.
- To demonstrate the basics of Industrial Robotics.

UNIT I	INTRODUCTION	9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing Control- Introduction to CAD/CAM –CIM concepts – Computerized elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation

UNIT II	PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING	9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control- Automated data collection - bar codes, optical character recognition, vision or image processing, radio frequency identification, magnetic identification - Brief on Manufacturing Resource Planning-II (MRP-II)

UNIT III	CELLULAR MANUFACTURING	9

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

UNIT IV	FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS)	9

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

UNIT V	INDUSTRIAL ROBOTICS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Describe the basis of Computer Integrated Manufacturing

CO2: Apply the fundamentals of process and production planning

CO3: Explain cellular manufacturing and group technology concepts

CO4: Explain the concepts of FMS and AGV Systems

CO5: Describe the working of Industrial Robotics in manufacturing systems

TEXT BOOKS:

1. Mikell.P. Groover "Automation, Production Systems and Computer Integrated manufacturing", 4th Edition, Pearson education ltd, 2016.
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2018.
3. James A. Rehg, H. W. Kraebber, "Computer Integrated Manufacturing", 3rd Edition, Pearson, 2004.

REFERENCES:

1. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" 1st Edition, Chapman & Hall, London, 1995.
2. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", 1st Edition, Prentice Hall India 1998.
3. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", 2nd Edition, Tata McGraw Hill Publishing Company, 2017.

21PME04	ADDITIVE MANUFACTURING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To illustrate the potential of additive manufacturing in different industrial sectors.
- To demonstrate the need, advantages and limitations of additive manufacturing (AM)
- To demonstrate the processes used in additive manufacturing for a range of materials and applications
- To construct the role of additive manufacturing in the design process and its ability to support Design and manufacturing
- To relate the challenges associated with AM and its data-processing tools

UNIT I	INTRODUCTION TO ADDITIVE MANUFACTURING	9

Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Applications, Advantages of AM and Types of materials for AM. Impact of AM on Product Development - Virtual Prototyping - Rapid Tooling – RP to AM.

UNIT II	REVERSE ENGINEERING AND CAD MODELLING	9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements & formats, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM.

UNIT III	LIQUID & SOLID-BASED ADDITIVE MANUFACTURING SYSTEMS	9

Working Principles, details of processes, products, materials, advantages, limitations and applications - Stereo lithography Apparatus - Solid Ground Curing - Fused deposition Modelling - Laminated Object Manufacturing.

UNIT IV	POWDER-BASED ADDITIVE MANUFACTURING SYSTEMS	9

Selective Laser Sintering: Principle, process, Indirect and direct SLS- powder structures, Materials, post-processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping: Processes, materials, products, advantages, limitations and applications

UNIT V	OTHER ADDITIVE MANUFACTURING SYSTEMS	9

Three-dimensional Printing (3DP): Principle, basic process, types of printing, process capabilities, material system. Solid-based, Liquid-based and powder-based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing, Ballistic Particle Manufacturing and Selective Laser Melting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Demonstrate additive manufacturing and its role in product development

CO2: Apply the CAE processes in additive manufacturing

CO3: Apply the various liquid and solid-based additive manufacturing techniques

CO4: Illustrate the different powder-based additive manufacturing techniques

CO5: Summarize other additive manufacturing techniques

TEXT BOOKS:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", 2nd Edition, World Scientific Publishers, 2010.
2. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", 1st Edition, Springer, 2010.
3. Amit Bandyopadhyay Susmita Bose, "Additive Manufacturing", 2nd Edition, CRC Press, Taylor & Francis Group, 2020

REFERENCES:

1. Gebhardt, A., "Rapid prototyping", 1st Edition, Hanser Gardener Publications, 2003.
2. Hilton, P.D. and Jacobs, P.F., "Rapid Tooling: Technologies and Industrial Applications", 1st Edition, CRC press, 2005.
3. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", 1st Edition, Springer, 2006.

21PME05	COMPOSITE MATERIALS IN PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Demonstrate the knowledge of composite materials and its types
- To Illustrate the difference between matrix and reinforcements
- To Summarize the fabrication techniques for polymer matrix composites
- To Summarize the fabrication techniques for metal matrix composites
- To Recognize the importance of novel composite materials in product development

UNIT I	INTRODUCTION TO COMPOSITES	9

Introduction: Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement and matrix.

UNIT II	REINFORCEMENTS AND INTERACTIONS	9

Types of reinforcements and their properties: Fibers: Carbon, Boron, Glass, Aramid, Al2O3, SiC - Role of interfaces: Wettability and Bonding, interface in Composites, Interactions and Types of bonding at the Interface, Tests for measuring Interfacial strength.

UNIT III	POLYMER MATRIX COMPOSITES	9

Fabrication of Polymeric Matrix Composites, hand layup processes – spray up processes – compression moulding – reinforced reaction injection moulding – resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Laminated Composites

UNIT IV	METAL MATRIX COMPOSITES	9

Fabrication of Metal Matrix Composites: powder metallurgy process – diffusion bonding – stir casting – squeeze casting, spray process, Liquid infiltration In-situ reactions

UNIT V	COMPOSITES IN PRODUCT DEVELOPMENT	9

Properties of Composites - Mechanical Properties, Density, Elastic constants - Applications of composites in various domains - applications of PMC and MMC in aerospace, automotive industries – Composites in Additive Manufacturing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Develop understanding of composite materials and its types
CO2: Comprehend knowledge on matrix, reinforcement and its interactions
CO3: Understand fundamentals and processing of polymer matrix composites
CO4: Understand fundamentals and processing of metal matrix composites
CO5: Identify the significance of composite materials in product development

TEXT BOOKS:

1. It Meng Low, Yu Dong, "Composite Materials - Manufacturing, Properties and Applications", 1st edition, Elsevier, 2021.

2. K. Srinivasan "Composite Material: Production Properties Testing", 5th edition, Narosa, 2020.
3. Mallick, P.K. and Newman, S., "Composite Materials Technology: Processes and Properties", 4th edition, Hansen Publisher, Munish, 1990

REFERENCES:

1. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", 3rd edition, Oxford University Press, 2006.
2. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", 4th edition, Maneel Dekker Inc, 1993.
3. Halpin, J.C., "Primer on Composite Materials, Analysis", 3rd edition, Technomic Publishing Co., 1984.

21PME06	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate the various concepts of ergonomics in the design of man – machine system.
- To use the basic knowledge in the application of ergonomic principles to design of industrial workplaces.
- To demonstrate the scope of occupational ergonomics.
- To demonstrate the environmental factor in design
- To explain the core concepts of ergonomics to evaluate and redesign the products.

UNIT I	INTRODUCTION	9

Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture – repetitive motion.

UNIT II	ANTHROPOMETRY	9

Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

UNIT III	DESIGN OF SYSTEMS	9

Displays – Controls – Workplace – Seating – Work process – Duration and rest periods – Hand tool design – Design of visual displays – Design for shift work.

UNIT IV	ENVIRONMENTAL FACTORS IN DESIGN	9

Temperature – Humidity – Noise – Illumination –Vibration – Measurement of illumination and contrast – use of photometers – Recommended illumination levels. The ageing eye – Use of indirect (reflected) lighting – cost efficiency of illumination – special purpose lighting for inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on performance

UNIT V	WORK PHYSIOLOGY	9

Provision of energy for muscular work – Role of oxygen physical exertion – Measurement of energy expenditure Respiration – Pulse rate and blood pressure during physical work – Physical work capacity and its evaluation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the various concepts of human factors engineering

CO2: Demonstrate the anthropometry principles and measures.

CO3: Sketch the tasks and workstations to fit employees.

CO4: Demonstrate the design consideration of the surroundings

CO5: Interpret the concepts of work physiology.

TEXT BOOKS:

1. Kroemer, K.H.E., "Fitting the Human: Introduction to Ergonomics", 7th Edition, CRC Press, 2017.
2. Martin Helander, "A guide to the ergonomics of manufacturing", 4th Edition, East West press, 2007.
3. Freivalds, A., "Neibel's Methods, Standards and Work Design", 13th Edition, McGraw Hill.2013

REFERENCES:

1. Bridger, R.S. "Introduction to Ergonomics", 1st Edition, McGraw Hill, 1995.
2. Micormic, J. "Human factors in Engineering and Design", 2nd Edition, McGraw Hill, 1992.
3. Wilson,J.R.Corlect EN, "Evaluation of Human work", A. practical Ergonomcis methodology, 1st Edition, Taylor and Francis, 1990.
4. Shackel, B.Richardson S, "Human Factors for Information usability", Cambridge University, 1st Edition, Cambridge University Press, 1991.

21PME07	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate the design principle for economical production.
- To explain the importance of form design in manufacture.
- To illustrate various machining parameter for assembly.
- To demonstrate the casting concepts for DFMA
- To interpret the knowledge of compliance analysis on assembly and environment design

UNIT I	INTRODUCTION	9

General design principles for manufacturability: strength and mechanical factors, mechanisms selection, evaluation method, Process capability: Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks.

UNIT II	FACTORS INFLUENCING FORM DESIGN	9

Working principle, Material, Manufacture, Design- Possible solutions, Materials choice, Influence of materials on form design, form design of Welded members, forgings and castings

UNIT III	COMPONENT DESIGN-I	9

Machining Consideration: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly

UNIT IV	COMPONENT DESIGN-II	9

Casting Consideration: Redesign of castings based on parting line considerations, Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA

UNIT V	DESIGN FOR THE ENVIRONMENT	9

Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the appropriate design for economical production.

CO2: Demonstrate the factors influencing form design.

CO3: Interpret various machining operation for economical production and assembly. CO4: Use the casting concepts to design component for DFMA. CO5: Use the compliance analysis for design of assembly and environment.
TEXT BOOKS:
1. Geoffry Boothroyd, Peter Dewhurst and W. A. Knight, "Product design for manufacture and assembly", 3rd Edition, CRC Press, 2. George E Deiter, "Engineering Design", 4th Edition, McGraw-Hill International, 2002. 3. Kevin Otto and Kristin Wood, "Production Design",5th edition, Person Education,
REFERENCES:
1. A. K. Chitale and R.C. Gupt ''Product design and Manufacturing", 3rd Edition, prentice-Hall of India, New Delhi, 2003 2. Surender Kumar, Goutham Sutradhar, ''Design and Manufacturing", 3rd Edition, Oxford & IBH Publishing co, Pvt Ltd, 1998. 3. Graedel T. Allen B, "Design for the Environment", 5th Edition, Angle Wood Cliff, Prentice Hall. Reason Pub.1996

VERTICAL 2: DIGITAL AND GREEN MANUFACTURING

21PME08	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To relate the need for unconventional machining processes and its classification
- To explain various thermal energy and electrical energy based unconventional machining processes
- To classify various chemical and electro-chemical energy based non-traditional machining processes
- To choose various nano abrasives based unconventional machining processes
- To show various recent trends based unconventional machining processes

UNIT I	INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES	9

Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT II	THERMAL AND ELECTRICAL ENERGY BASED PROCESSES	9

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipment-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing — Applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types – Beam control techniques – 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- equipment-Surface Roughness and MRR Electrical circuit-Process Parameters-ECG and ECH - 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, equipment, effect of process parameters, applications, advantages and limitations.

UNIT V	RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES	9

Recent developments in non-traditional machining processes, their working principles, equipment, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the mechanical energy based processes and its classification.

CO2: Identify the various thermal energy and electrical energy based processes.
CO3: Demonstrate the various chemical and electro-chemical energy based processes.
CO4: Choose various advanced nano finishing processes.
CO5: Identify the recent trends in non-traditional machining processes.

TEXT BOOKS:

1. Vijay. K. Jain "Advanced Machining Processes" 2nd Edition, Allied Publishers Pvt. Ltd., New Delhi, 2007
2. Pandey P.C. and Shan H.S. "Modern Machining Processes" 3rd Edition, Tata McGraw-Hill, New Delhi, 2007.
3. Paul De Garmo, J.T.Black, and Ronald. A.Kohser, "Material and Processes in Manufacturing" Prentice Hall of India Pvt. Ltd., 8th Edition, New Delhi, 2001.

REFERENCES:

1. Benedict. G.F. "Nontraditional Manufacturing Processes", 1st Edition, Marcel Dekker Inc., New York, 1987.
2. Mc Geough, "Advanced Methods of Machining", 2nd Edition, Chapman and Hall, London, 1998.
3. M. K. Singh, "Unconventional Machining processes", New Age International Publishers, 1st Edition, 2010.

21PME09	CASTING AND WELDING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To illustrate the quality test methods conducted on welded and cast components.
- To demonstrate the metallurgical aspects during the solidification of metal and alloys.
- To relate the challenges associated with various casting and moulding processes in manufacturing.
- To explain the behaviour of materials during welding, and the effect of process parameters in welding
- To demonstrate the various joining process used in manufacturing.

UNIT I	INTRODUCTION TO FOUNDRY CASTING	9

Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry - classification, factors that determine the selection of a casting alloy. Patterns: Definition, classification, materials for pattern, pattern allowances. Sand moulding: Types of base sand, requirements. Binder, Additives definition, need and types; preparation of sand moulds. Moulding machines- Jolt type, squeeze type and Sand slinger. Types of moulding process, Cores: Definition, need, types. Method of making cores, Concept of gating and risers, Functions and types.

UNIT II	MELTING & METAL MOLD CASTING METHODS	9

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace. Casting using metal moulds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.

UNIT III	SOLIDIFICATION & NON-FERROUS FOUNDRY CASTING	9

Solidification: Definition, nucleation, solidification variables. Directional solidification-need and methods. Degasification in liquid metals-sources of gas, degasification methods. Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process. Nonferrous foundry casting: Aluminium castings - advantages, limitations, melting of Aluminium using lift-out crucible furnace. Hardeners used, drowsing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set-up, procedure, uses, advantages and limitations.

UNIT IV	WELDING PROCESSES	9

Welding process: Definition, Principles, classification, application, advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW). Special types of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.

UNIT V	METALLURGICAL ASPECTS IN WELDING, SOLDERING, AND BRAZING	9

Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ),

Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses. Concept of electrodes, filler rod and fluxes. Welding defects- detection, causes & remedy. Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxyhydrogen welding, air-acetylene welding, Gas cutting, powder cutting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply casting process with knowledge of foundry and moulding machines.
CO2: Illustrate the various casting furnaces and different mould casting methods.
CO3: Describe the Solidification process and Casting of Non-Ferrous Metals.
CO4: Explain the different welding processes used in manufacturing
CO5: Illustrate the metallurgical aspects in welding, soldering and brazing process

TEXT BOOKS:

1. Anup Goel, "Metal Casting and Welding: Processes and Applications", Technical Publications, 1st edition, 2020
2. Richard W. Heine, Carl R. Loper Jr., Philip C. Rosenthal, "Principles of metal casting", Tata McGraw Hill Education Private Limited, 1st edition, 1976
3. Serope Kalpakjian, Steuen. R Sechmid, "Manufacturing Technology", 5th Edition, Pearson Education Asia, 2006

REFERENCES:

1. Dr. K. Radhakrishna, "Manufacturing Process-I", Sapna Book House, 5th Revised Edition 2009.
2. P.N.Rao, "Manufacturing Technology - Foundry, Forming and Welding", 3rd Edition, Tata McGraw Hill, 2003.
3. Roy A Lindberg, "Process and Materials of Manufacturing", 4th Edition, Pearson Edu. 2006
4. G.S. Sawhney, "Manufacturing Science", Vol I: Forming, Casting, Welding, 1st edition, Wiley, 2019

21PME10	NON DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To illustrate the overview of Non Destructive testing methods.
- To demonstrate the various surface NDE methods.
- To Use thermography and eddy current testing for NDE.
- To Use ultrasonic testing and acoustic emission concepts in NDE.
- To apply radiography testing method for evaluation.

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. 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 limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV	ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (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. 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, Computed Tomography

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate the fundamental concepts of NDT

CO2: Demonstrate the different methods of NDE

CO3: Use the concept of Thermography and Eddy current testing

CO4: Demonstrate the concept of Ultrasonic Testing and Acoustic Emission

CO5: Illustrate the concept of Radiography

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", 1st Edition, Narosa Publishing House, , 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised Edition, New Age International Publishers, 2010
3. Paul E Mix, "Introduction to Non-destructive testing: a training guide", 2nd Edition, Wiley, New Jersey, 2005

REFERENCES:

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", 1st Edition, McGraw Hill, New York 2001.

21PME11	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To experiment with failure micro mechanisms occurring for different service conditions.
- To illustrate the micro mechanism failure to optimize surface engineered microstructures.
- To illustrate appropriate testing approaches to evaluate service performance.
- To experiment with real life surface failure problems and determine the correct surface engineering solution by applying contact mechanics.
- To relate complex data and propose appropriate engineering solutions

UNIT I	FUNDAMENTALS OF SURFACE ENGINEERING	7

Introduction: Engineering components, surface dependent properties and failures, importance and scope of surface engineering; Surface and surface energy: Structure and types of interfaces, surface energy and related equations; Surface engineering: classification, definition, scope and general principles

UNIT II	CONVENTIONAL SURFACE ENGINEERING PRACTICES	12

Solid material removal: Cleaning, pickling, etching, grinding, polishing, buffing / puffing; Solid material addition: Electrodeposition / plating, Aluminizing, calorizing, diffusional coatings; Surface modification using liquid/molten bath: Cyaniding, liquid carburizing; Surface modification using gaseous medium: Nitriding carbonitriding

UNIT III	ADVANCED SURFACE ENGINEERING PRACTICES	12

Surface engineering by energy beams: General classification, scope and principles, types and intensity/energy deposition profile; Laser assisted microstructural modification, Ion beam assisted microstructure and compositional modification; Surface engineering by spray techniques: Flame spray and HVOF. Surface coatings and surface modifications: Evaporation - Sputter deposition of thin films & coatings - PVD coating processes, CVD and PECVD.

UNIT IV	CHARACTERIZATION OF COATINGS AND SURFACES	7

Measurement of coatings thickness; porosity & adhesion of surface coatings; Measurement of residual stress & stability; Surface microscopy & topography by scanning probe microscopy; Spectroscopic analysis of modified surfaces

UNIT V	FUNCTIONAL COATINGS AND APPLICATIONS	7

Functional and nano-structured coatings and their applications in photovoltaics, bio- and chemical sensors; Surface passivation of semiconductors & effect on electrical properties; Surface engineering of polymers and composites; Thin film technology for multilayers & superlattices for electronic, optical and magnetic devices; Modelling.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate the fundamental surface engineering techniques.

CO2: Demonstrate the conventional surface engineered structures.

CO3: Relate the advanced practices in surface engineering.

CO4: Experiment with characterization of coatings and surfaces.

CO5: Demonstrate the functional coatings and applications.

TEXT BOOKS:

1. Devis, J.R., "Surface Engineering for Corrosion & Wear Resistance", 1st Edition, CRC Press, 2001
2. M. Ohring, “The Materials Science of Thin Films”, 2nd Edition, Academic Press Inc, 2001.
3. Peter Martin, " Introduction to Surface Engineering and Functionally Engineered Materials", 1st Edition, John Willey, 2011

REFERENCES:

1. K.G. Budinski, “Surface Engineering a Wear Resistances”, 1st Edition, Prentice Hall, Englewood Cliffs, 1988.
2. M.G. Fontana, “Corrosion Engineering (classification of Corrosion)”, Mc. Graw Hill, 1st Edition, 1987.
3. John O. Milewski, “Additive Manufacturing of Metals”, Springer, 2017.

21PME12	INDUSTRIAL AUTOMATION SYSYTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To illustrate the basics of automation and its basic concepts
- To use the concepts of group technology
- To apply the concepts of flexible manufacturing system
- To explain the Industrial Robotics and Mechatronics System
- To demonstrate the knowledge of automated machinery and economy

UNIT I INTRODUCTION **9**

Automation and types, Automated Manufacturing System, Reasons for Automating, the USA Principle, Strategies for automation and process improvement, automation migration strategies, levels of automations, Types of Automations.

UNIT II GROUP TECHNOLOGY **9**

Part family, Part classification and coding, production flow analysis – OPITZ classification system, cellular manufacturing, quantitative analysis in cellular manufacturing. Rank Order Clustering Technique (ROC), Holier Method –I, II, Single Linkage Cluster Analysis Technique (SLCA). Application of group technology

UNIT III FLEXIBLE MANUFACTURING SYSTEM **9**

Types of flexibility, types of FMS, FMS components, FMS Components-Workstations, Material Handling and Storage Systems, Computer Control System, Human Recourses, FMS Applications and Benefits., Quantitative analysis of FMS, Sizing the FMS, System performance measure. Automated Material Handling & Storage: Functions, Types, Analysis of material handling equipment, Design of Conveyor & AGV systems. Problems. Development for total material handling system.

UNIT IV INDUSTRIAL ROBOTICS AND MECHATRONICS SYSTEM **9**

Introduction, Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Sensors in Robotics, Industrial Robot Applications, Robot Programming overview. Transducers, Sensors and Actuators: Classification, Principle of Operation, Selection Criteria, Signal Conditioning, Calibration

UNIT V AUTOMATED MACHINERY AND AUTOMATED ECONOMY **9**

Introductions, Automated transfer machine, automated transfer line, auto-storage and retrieval system, automated guided vehicles, automated material handling system, automated inspection system and CMM.

Plant Economy, feasibility of automation on economical sense, effect of automation on economy, feasibility of automation in Indian market, Scope of automation in Indian industries, Break Even point analysis for automation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Use the application of automated systems integration using CIM

CO2: Apply the automation by applying Group Technology concepts.

CO3: Demonstrate the concepts of FMS in automation.

CO4: Apply the working of different sensors and actuator and find application for industrial automation

CO5: Show the scope of Automation in Industries

TEXT BOOKS:

1. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover, 3rd Edition, P.H.I. 2015.
2. Frank Lamb, "Industrial Automation", 1st Edition , Mc Graw Hill, 2013.
3. Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang, "Computer Aided Manufacturing", 1st Edition , Pearson 2011.

REFERENCES:

1. Er. A. K. Gupta and S. K. Arora, "Industrial Automation and Robotics", University Science Press, 1st Edition ,Laxmi Publishing Pvt. Ltd, 2011.
2. R. K. Mittal and I. J. Nagrath, "Robotics and Control", 1st Edition , McGraw Hill Education (India) Private Limited, 2015.
3. Ronald L Krutz, "Industrial Automation and Control System Security Principles", 2nd Edition , International Society of Automation, 2012.

21PME13	GREEN SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the foundational knowledge associated with the green supply chain.
- To illustrate the implication of today's most pressing environmental issues.
- To relate the various green supply chain practices can actually save money, increases efficiency and reduce delivery time.
- To interpret the Closed-loop Supply Chain in green manufacturing.
- To demonstrate the practices in Green Logistics and Transportation.

UNIT I	INTRODUCTION	9

Introduction – Traditional Supply Chain and Green Supply Chain – Environmental Concern and Supply Chain – Closed-loop Supply Chain – Corporate Environmental Management – Green Supply Chain (GSCM): Definition, Basic Concepts – GSCM Practices.

UNIT II	ECO-DESIGN	9

Design for the Environment (DFE) or Eco-Design – Eco-Design and Supplier Relationships – Definitions of Eco-Design – Tools of Product Eco-Design – Involving suppliers in product ecodesign: Drivers, Challenges and Successful factors.

UNIT III	GREEN PURCHASING	9

Green Procurement and Purchasing – Definitions of green purchasing – Drivers of green purchasing – Green purchasing strategies – Green purchasing performance measurement –Green Supplier Development and Collaboration.

UNIT IV	GREEN MANUFACTURING	9

Green Manufacturing or Production: Evolution, Definitions – 4Re's: recycling, remanufacturing, reuse and reduction – Closed-loop Manufacturing – Life Cycle Analysis (LCA) – Lean Manufacturing for Green Manufacturing or Production.

UNIT V	GREEN LOGISTICS AND TRANSPORTATION	9

Green Logistics and Transportation – Definitions of Green Logistics – Critical drivers of Green Logistics – Green transportation and logistics practices – Environmental impacts of transportation and logistics – Closing the Loop:

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the fundamental concepts of Green Supply Chain.

CO2: Demonstrate the Eco design

CO3: Relate Green Procurement and Purchasing

CO4: Interpret Closed-loop Supply Chain.

CO5: Show the applications of Green Logistics and Transportation

TEXT BOOKS:

1. Joseph Sarkis, Yijie Dou, "Green Supply Chain Management: A Concise Introduction", 1st Edition, Routledge, 2017
2. Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis, Dimitris Folinas, "Green Supply

Chain Management", 1st Edition, Routledge, 2018.

3. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, "Designing and Managing the Supply Chain concepts, Strategies and Case studies", 3rd Edition, Tata McGraw Hill, New Delhi 2017.

REFERENCES:

1. Hsiao-Fan Wang, Surendra M. Gupta, "Green Supply Chain Management: Product Life Cycle Approach", 1st Edition, McGraw Hill publishing, 2011
2. Stuart Emmett, Vivek Sood, "Green Supply Chains: An Action Manifes by Stuart Emmett", 1st Edition, Wiley publications, 2010
3. Alan Harrison and Remko van Hoek, "Logistics Management and Strategy", 5th Edition, Pearson, 2014.

21OPH01	Modern Materials Characterization Techniques (*Common to all B.E. / B.Tech. Programmes*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To establish a sound grasp of knowledge on analyzing crystal structure
- To prepare the students to understand the basics of thermal analysis.
- To understand the concept of various electron microscopes.
- To discuss students with different spectroscopic techniques.
- To interpret knowledge on electrical characterization of materials.

UNIT I	X-RAY DIFFRACTION	9

Elastic and inelastic scattering - Bragg's law - basic powder diffraction - generation of X-rays - characteristic X ray spectrum - Moseley's law - methods to remove Kb radiation – detectors - factors affecting the intensity of diffraction peaks - phase identification using XRD.

UNIT II	THERMAL ANALYSIS	9

Introduction – Thermo gravimetric analysis (TGA) – Instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA) – cooling curves – differential scanning calorimetry (DSC) – Instrumentation – specific heat capacity measurements – determination of thermo mechanical parameters.

UNIT III	ELECTRON MICROSCOPY	9

Scanning electron microscope (SEM) – field emission scanning electron microscope (FESEM) – Energy dispersive X-ray analysis (EDAX) – high resolution transmission electron microscope (HRTEM): working, principle and instrumentation – sample preparation – scanning probe microscopy – atomic force microscopy: principle, working and instrumentation.

UNIT IV	SPECTROSCOPY	9

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, electron spin resonance (ESR) – nuclear magnetic resonance (NMR), electron spectroscopy for chemical analysis (ESMA) -proton induced X-ray emission spectroscopy (PIXE).

UNIT V	ELECTRICAL CHARACTERIZATION	9

Two probe and four probe methods – Vander Pauw method – Hall probe and measurement – scattering mechanism – C-V, I-V characteristics – Schottky barrier capacitance – impurity concentration –electrochemical C-V profiling- limitations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Comprehend the X-ray diffraction to identify the phase present in the analyzed crystal system.

CO2: Understand the importance of thermal analysis.

CO3: Express the knowledge in scanning electron microscope and transmission electron microscope.

CO4: Demonstrate a strong foundational knowledge in spectroscopy.

CO5: Understand the importance of electrical characterization.

TEXT BOOKS:

1. Elton N. Kaufmann, “Characterization of Materials”, Volume 1 & 2, Willey –Interscience, 2003.
2. E. Newbury, Patrick Echlin& Joseph Goldstein, “Scanning Electron Microscopy and X-Ray Microanalysis: A Text for Biologists, Materials Scientists, and Geologists (English)”, Springer 2011.
3. R.F. Egerton, “Physical Principles of Electron Microscopy-An Introduction to TEM, SEM and AEM”, Second edition, Springer, 2016.
4. Colin. N. Banwell, Elaine M. Cash, “Fundamentals of Molecular Spectroscopy”, 4th Edition, Tata McGraw Hill, Indian Edition, 2017.

REFERENCES:

1. B.D. Cullity, “Elements of X-ray Diffraction”, Addison-Wesley Publishing Company, Inc., 2013.
2. B.L. Sharma, R. K. Purohit, “Semiconductor Heterojunctions”, Pergamon, 2014.
3. Bert Voigtlander, “Atomic Force Microscopy”, 2nd Edition, Springer, 2019.
4. Joseph. I. Goldstein, Dale E. Newbury, Joseph R. Micheal, Nicholas W. M. Rictchie, John Henry J. Scott, David C. joy, Budhika G. Mendis, “Scanning Electron Microscopy and X-ray Microanalysis”, Willey, 2018.

VERTICAL 3: CLEAN AND GREEN ENERGY TECHNOLOGIES

21PME14	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the solar radiation and its environmental impact to power.
- To illustrate the various collectors used for storing solar energy.
- To illustrate the various applications in solar energy.
- To demonstrate the wind energy and biomass and its economic aspects.
- To illustrate geothermal energy with other energy sources.

UNIT I	PRINCIPLES OF SOLAR RADIATION	9

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extra-terrestrial 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	9

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT III	SOLAR ENERGY STORAGE AND APPLICATIONS	9

Methods of Sensible heat, latent heat and stratified storage systems. Solar applications - heating/cooling technique, solar ponds, photovoltaic energy conversion, solar distillation and drying.

UNIT IV	WIND ENERGY AND BIOMASS	9

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria - biomass: Principles of Bioconversion, Anaerobic/aerobic digestion, types of biogas digesters, gas yield, combustion characteristics of biogas, utilization for cooking, I.C. Engine operation and economic aspects.

UNIT V	GEOTHERMAL ENERGY	9

Resources, types of wells, methods of harnessing the energy, potential in India. Ocean energy: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques and their economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Discuss the physics of solar radiation.

CO2: Demonstrate the solar energy collectors and methodologies of storing solar energy.

CO3: Demonstrate the application of solar energy in a useful way.

CO4: Illustrate wind energy and biomass with its economic aspects.

CO5: Illustrate the other forms of energy sources like wind, biogas and geothermal energies.

TEXT BOOKS:

1. Rai G.D. "Non-Conventional Energy Sources", 2nd Edition, Khanna Publishers, 2015.

2. Twidell & Wier, “Renewable Energy Resources”, 3rd Edition, CRC Press (Taylor & Francis), 2015.
3. Kothari D.P, Singhal ., K.C., “Renewable energy sources and emerging technologies”, 2nd Edition, P.H.I, New Delhi, 2011

REFERENCES:

1. Tiwari and Ghosal, “Renewable energy resources”, 1st Edition, Narosa Publishing House, 2004
2. Ramesh R & Kumar K.U , “Renewable Energy Technologies”, 1st edition, Narosa Publishing House, 2004
3. Mittal K M, “Non-Conventional Energy Systems”, 1st Edition, Wheeler Publishing Co. Ltd, New Delhi, 2003

21PME15	BIOENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To use the energy conversion technologies related to biomass
- To demonstrate the properties of biomass and its energy products
- To illustrate the feasibility of power production from biomass sources
- To use of the biochemical conversion technologies
- To demonstrate the separation of various elements

UNIT I	INTRODUCTION	9

Biomass as energy source – Sources – Biomass conversion processes – Biological – Thermal – Chemical – Hybrid conversions – Application of biomass conversion products – Biomass properties for conversion process – Physical properties : Particle size, distribution, heat capacity and thermal conductivity – Thermal properties : Proximate,

UNIT II	TORREFACTION	9

Torrefaction – products obtained – properties of torrified biomass – Physical and chemical – composition changes – torrefaction as pre-treatment process – Pyrolysis – types – effects of process parameters – Product characterization techniques – oxidation stability – Bio-oil up gradation – applications – Liquefaction – direct and indirect methods – advanced liquefaction techniques.

UNIT III	BIOMASS GASIFICATION	9

Biomass gasification – chemistry – types of gasifiers – gasifier design : TDR, throughput, A/F ratio and equivalence ratio calculations – advanced gasification – fluidized bed gasifier – component design – cold fluidization tests – Electrical power production – Biomass combustion – types of combustors – Co-combustion and Co-firing – applications – Eutectic point of biomass ash.

UNIT IV	BIOCHEMICAL CONVERSION TECHNOLOGIES	9

Stirred Tank Reactors; Batch Fermentation and Microbial Growth; Continuous Fermentation and Kinetics; Aeration and Oxygen Transfer

UNIT V	BIOMASS SEPARATION	9

Centrifugation/Filtration for Biomass Separation; Distillation (bioethanol and biodiesel production); Membrane Processes (Ultrafiltration, microfiltration, Pervaporation (alcohol/water separations); Adsorptive Separations (zeolites and chromatography)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate the properties of biomass and energy conversion process

CO2: Explain the characteristics of products obtained from biomass pyrolysis

CO3: Relate the basics of biomass gasification with gasifier design

CO4: Assess the potential of electrical power production from biomass

CO5: Interpret the separation of gases.

TEXT BOOKS:

1. Sergio C. Capareda “Introduction to Biomass Energy Conversions”, CRC Press, 2nd edition Taylor and Francis Group, 2019.
2. Sergio C. Capareda “Introduction to Renewable Energy Conversions”, CRC Press, 1st edition Taylor and Francis Group, 2019.
3. Anju Dahiya, “Bioenergy: Biomass to Biofuels”, Academic press, 3rd edition Elsevier Publication, 2014.

REFERENCES:

1. Erik Dahlquist, “Biomass as Energy Source: Resources, systems and applications”, Sustainable Energy Developments series, CRC Press, 1st edition Taylor and Francis Group, 2012.
2. D.P.Kothari, K.C Singal and Rakesh Ranjan “Renewable Energy Sources and Emerging Technologies”, 1st edition PHI Learning Private Ltd, New Delhi, 2011.
3. Godfrey Boyle, “Renewable Energy power for a sustainable future”, 3rd Edition, Oxford University Press, 2012

21PME16	ENERGY STORAGE DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the various types of energy storage.
- To describe the various applications of energy storage systems.
- To discuss the importance of energy storage.
- To summarize the knowledge of fuel cell and its applications.
- To explain the areas of energy storage systems and its applications in contemporary systems.

UNIT I	INTRODUCTION TO ENERGY STORAGE SYSTEMS	9

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

UNIT II	THERMAL ENERGY STORAGE SYSTEMS	9

Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of Transys

UNIT III	ELECTRO CHEMICAL ENERGY CONVERSION SYSTEMS	9

Electro-chemical energy conversion and storage: Introduction to batteries, elements and operation of electrochemical cells, theoretical cell voltage and capacity, losses in cells; Battery classification, factors effecting battery performance, batteries for PV system.

UNIT IV	FUEL CELL AND ITS APPLICATIONS	9

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantage and drawback of each type.

UNIT V	APPLICATION OF ENERGY STORAGE SYSTEMS	9

Some areas of application of energy storage: Food preservation; Waste heat Recovery; Solar energy storage; Greenhouse heating; Power plant applications; Drying and heating for process industries.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Describe the basic principles to study about energy storage systems.

CO2: Discuss the performance parameters of various thermal energy storage systems.

CO3: Explain the various electro chemical energy conversion systems and its drawbacks.

CO4: Summarize the various fuel cell and its types.

CO5: Discuss the concept of energy storage systems for commercial applications.

TEXT BOOKS:

1. James Larminie and Andrew Dicks, "Fuel cell systems Explained", 1st edition,Wiley publications, 2003.
2. Ru-shiliu, Leizhang, Xueliang sun, "Electrochemical technologies for energy storage and

conversion", 3rd edition,Wiley publications, 2012.

3. Johannes Jensen & Bent Sorensen, "Fundamentals of Energy Storage", 3rd edition,John Wiley & Sons, 1984

REFERENCES:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, 3rd edition John Wiley & Sons 2002
2. Rai G.D. "Non-Conventional Energy Sources", 2nd edition Khanna Publishers, 2015.
3. D.P.Kothari, K.C Singal and Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", 2nd edition PHI Learning Private Ltd, New Delhi, 2011.

21PME17	SOLAR ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn and study the solar radiation and various solar collectors
- To study the various solar thermal energy technologies and their applications
- To learn about various solar PV cell materials and conversion techniques
- To learn various Solar SPV systems designs and their applications
- To know about various solar passive building techniques for cooling and heating

UNIT I	SOLAR RADIATION AND MEASUREMENT	9

Energy from Sun – Solar Constant –Sun earth relationship – Spectral distribution of Extraterrestrial Radiation – Variation of Extraterrestrial Radiation – Solar angles–Sun path diagrams– Solar Time and its equation –Air mass ratio – Radiation reaching Earth's surface – Measurement and estimation on horizontal and tilted surfaces –Measurement devices for Solar Radiation

UNIT II	SOLAR COLLECTORS	9

Flat plate collector thermal analysis – Testing methods-Evacuated tubular collectors –Concentrating collectors – Classification- Design and performance parameters-Tracking systems- Compound parabolic concentrators – Parabolictrough concentrators-Concentrators with point focus-Heliostats– performance of the collectors

UNIT III	SOLAR PV FUNDAMENTALS	9

Semiconductor – properties – energy levels – basic equations of semiconductor devices physics. Solar cells – p-n junction: homo and hetro junctions – metal-semiconductor interface – dark and illumination characteristics – figure of merits of solar cell – efficiency limits – variation of efficiency with b and-gap and temperature-efficiency measurements-high efficiency cells–Solar thermoPhotovoltaic..

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 systems.

UNIT V	SOLAR PASSIVE ARCHITECTURE	9

Thermal comfort – bioclimatic classification – passive heating concepts: direct heat gain – indirect heat gain – isolated gain and sun spaces- passive cooling concepts: evaporative cooling-Radiative cooling-application of wind, water and earth for cooling; shading-paints and cavity Walls for co

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate solar radiation and its measurement

CO2: Identify various solar thermal energy technologies and their applications

CO3: Compare various solar PV cell materials and interpret factors influencing of conversion efficiency

CO4: Infer various SPV systems designs and their applications

CO5: Evaluate various solar passive building techniques for cooling and heating applications

TEXT BOOK

1. Chetan Singh Solanki, Solar Photo voltatics – Fundamentals, Technologies and Applications, 3rd PHI Learning Private limited, 2015.

2. John A.Duffie, William A.Beckman, Solar Engineering of Thermal Processes, 5th Edition, John Wiley & Sons, 2020.

3. Lovegrove K.,Stein W., Concentrating Solar Power Technology, Wood head Publishing Series in Energy, Elsevier, 1st Edition,2012

REFERENCES:

1. Solar Energy International, Photovoltaic–Design and Installation Manual, 1st Edition, New Society Publishers, 2004.

2. Sukhatme SP, Naya kJK, Solar Energy–Principle of Thermal Storage and collection, 4th Edition, Tata McGraw Hill, 2017.

3. Garg H P, Prakash J, Solar Energy – Fundamentals and Applications, 1st Edition, Tata McGraw Hill,2017.

21PME18	ENERGY CONSERVATION IN INDUSTRIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To discuss the types of fuels used in Industries and their characteristics
- To explain the techniques adopted for performance evaluation of thermal utilities
- To describe the working principle employed in VCRS and VAM systems
- To summarize technical parameters considered in electricity billing and the losses associated with a motor.
- To explain the techniques available for energy conservation in electrical utilities

UNIT I	INTRODUCTION	9

Introduction: Energy –Power –Past & Present Scenario Of World; National Energy Consumption Data –Environmental Aspects Associated With Energy Utilization –..

UNIT II	ENERGY CONSERVATION IN THERMAL UTILITIES	9

Thermal Systems: Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters –Efficiency Computation and Encon Measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT III	ENERGY CONSERVATION IN OHER UTILITIES	9

Energy Conservation In Major Utilities: Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration And Air Conditioning Systems –Cooling Towers –D.G. Sets..

UNIT IV	ENERGY AUDITING	9

Energy Auditing: Need, Types, Methodology And Barriers. Role Of Energy Managers. Instruments For Energy Auditing

UNIT V	ENERGY ECONOMICS	9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concepts

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the stoichiometric air for fuel and suggest measures for efficient combustion

CO2: Describe the cause for underperformance of thermal utilities and suggest suitable remedial measures

CO3: Summarize the factors affecting the COP of a VCR and VAR system

CO4: Describe the performance of induction motors and transformers

CO5: Exaplin energy conservation avenues of thermal and electrical utilities

TEXT BOOKS:

1. L.C.Witte, P.S.Schmidt, D.R.Brown, "Industrial Energy Management and Utilization" 1st edition,Hemisphere Publication, Washington, 1987.
2. Eastop.T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, 1st edition,Logman Scientific &Technical, ISBN-0-582-03184, 1990.
3. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy

Management", 7th Edition, The Fairmont Press Inc., 2012.

REFERENCES:

1. W.C.turner, "Energy Management Handbook"Wiley,1st edition,NewYork,1982
2. W.R. Murphy and G. McKay "Energy Management" 1st edition Butter worths, London1987
3. Energy Manager Training Manual (4Volumes) available at http://www.emea.org/gbook1.asp,a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India. 2004.

21PME19	EQUIPMENT FOR POLLUTION CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain knowledge and understanding of causes and effects of air pollution and their controlling mechanisms.
- To describe knowledge on the principle and design of control of Indoor.
- To discuss a design of control of Particulate Contaminants
- To demonstrate a model for controlling Gaseous Contaminants
- To summarize knowledge in air pollutant and its emerging trends. .

UNIT I	INTRODUCTION	9

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards

UNIT II	METEOROLOGY	9

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

UNIT III	CONTROL OF PARTICULATE CONTAMINANTS	9

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle, Design and performance equations of Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations.

UNIT IV	CONTROL OF GASEOUS CONTAMINANTS	9

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations.

UNIT V	INDOOR AIR QUALITY MANAGEMENT	9

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Summarize knowledge and understanding of causes and effects of air pollution and their controlling mechanisms.

CO2: Explain knowledge on the principle and design of control of Indoor.

CO3:Demonstrate a design of control of Particulate Contaminants

CO4:Discuss a model for controlling Gaseous Contaminants

CO5:Explain the knowledge in air pollutant and its emerging trends

TEXT BOOKS:

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, 3rd Edition, springer science + science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", 3rd Edition, Waveland press, Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", 1st Edition, Allied Publishers (P) Ltd., India 2002.

REFERENCES:

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", 3rd Edition, Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", 1st edition, Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", 3rd Edition John Wiley and Sons, Inc, 2000.

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21PME20	ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To discuss the need, methodology, documentation and usefulness of environmental impact assessment
- To explain the knowledge related to the broad field of environmental risk assessment, important processes that control contaminant transport
- To demonstrate the environmental impact assessment documentation process.
- To summarize the environment management plan, ethical and quality aspects of environmental impact assessment.
- To discuss the hazard identification and management technique.

UNIT I	INTRODUCTION	8

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. – Types and limitations of EIA –.EIA process- screening – scoping - setting – analysis – mitigation. Cross sectorial issues and terms of reference in EIA – Public Participation in EIA-EIA Consultant Accreditation.

UNIT II	IMPACT INDENTIFICATION AND PREDICTION	10

Matrices – Networks – Checklists –Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA. Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological — Cumulative Impact Assessment

UNIT III	SOCIAL IMPACT ASSESSMENT AND EIA DOCUMENTATION	8

Social impact assessment - Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts. Communities in transition Documentation of EIA findings – planning – organization of information and visual display materials.

UNIT IV	ENVIRONMENTAL MANAGEMENT PLAN	7

EIA Report preparation. Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment- Case Studies

UNIT V	ENVIRONMENTAL RISK ASSESSMENT AND MANAGEMENT	12

Environmental risk assessment framework-Hazard identification -Dose Response Evaluation – Exposure Assessment – Exposure Factors, Tools for Environmental Risk Assessment– HAZOP and FEMA methods – Event tree and fault tree analysis – Multimedia and multipath way exposure modeling of contaminant- Risk Characterization Risk communication - Emergency Preparedness Plans –Design of risk management programs

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Describe the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.

CO2: Explain the cost benefit analysis of environmental impact assessment

CO3: Discuss the concept of environmental impact assessment documentation for proper findings.

CO4: Summarize the environment management plan.

CO5: Explain the methods of risk assessment and management.

TEXT BOOKS:

1. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 2012.
2. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, 3rd edition,Wiley-Interscience, New Jersey. 2003
3. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook",3rdedition, McGraw Hill Inc., New York, 1996.

REFERENCES:

1. Canter, L.W., "Environmental Impact Assessment", and McGraw Hill, 1st edition, New York. 1996
2. Cutter, S.L., "Environmental Risk and Hazards", 2ndedition,Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
3. Raghavan K. V., Khan A, "Methodologies in Hazard Identification and Risk Assessment, 1st Edition, Institution of Chemical Engineers by CLRI, 1997.

VERTICAL 4 - LOGISTICS AND SUPPLY CHAIN MANAGEMENT

21PME21	LOGISTICS IN MANUFACTURING, SUPPLY CHAIN AND DISTRIBUTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the foundational knowledge in logistics.
- To relate the various logistics strategies.
- To illustrate operations in supply chain.
- To interpret the functions of distribution.
- To demonstrate the planning in Distribution flows.

UNIT I	INTRODUCTION LOGISTICS	9

Introduction – Scope of logistics in business, Logistics and Supply Chain Management, Core and support activities of logistics; Logistical integration hierarchy; Integrated Logistics; Operating objectives; Barriers internal integration; Logistical performance cycles; Supply chain relationships – Channel participants, Channel structure, Basic functions, Risk, power and leadership.

UNIT II	LOGISTICS SYSTEM DESIGN	9

Logistics reengineering, Logistical environmental assessment, Time based logistics, Anticipatory and Response based strategies, Alternative strategies, Logistical operational arrangements, Time based control techniques; Integration theory – Location structure, Transportation economies, Inventory economies, Formulating logistics strategy.

UNIT III	CONCEPTS OF SUPPLY CHAIN	9

Service and manufacturing supply chain dynamics - Evolution of supply chain management - Multiple views and flows - Service supply chains -Manufacturing supply chains - Measures of supply chain performance - Bullwhip effect.

UNIT IV	DISTRIBUTION	9

Role of Distribution in Supply chain, Distribution channels – Functions, resources, Operations in Distribution, Designing Distribution network models - its features - advantages and disadvantages

UNIT V	PLANNING	9

Distribution network planning, Distribution network decisions, Distribution requirement planning (DRP)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Demonstrate the various functions of logistics

CO2: Explain the various types of logistics strategies
CO3: Apply the operations in supply chain to increase the productivity
CO4: Explain the importance of distribution in supply chain.
CO5: Show the applications of planning in Distribution

TEXT BOOKS:

1. Sunil Chopra, Peter Meindl, "Supply Chain Management: Strategy, Planning, and Operation", 6th edition, Pearson, 2014.
2. Raghuram and N. Rangaraj, "Logistics and Supply chain Management Cases and Concepts", 1st Edition, Macmillan Business Books, 2000.
3. John J. Coyle, Edward J. Bardi and C. John Langley Jr., "The Management of Business Logistics - A supply chain Perspective", 10th Edition, Thomson Business Information, 2016.

REFERENCES:

1. Paul Schönsleben, "Integral Logistics Management: Planning and Control of Comprehensive Supply", 2nd Edition, CRC Press Company, 2016.
2. David Frederick Ross, "Distribution Planning and Control: Managing in the Era of Supply Chain last edition", Springer, 2015.
3. Shaw, "G-P Forges Strong Customer Bonds Using Supply Chain Expertise, Innovative Marketing," Pulp & Paper, October 77:10 (2003), 26-30.

21PME22	MATERIALS MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the significance of Materials Management
- To demonstrate meaning of ABC Analysis.
- To illustrate characteristics of coding System.
- To interpret the functions of Purchase Department
- To demonstrate objectives of Negotiation.

UNIT I	MATERIALS MANAGEMENT: AN INTRODUCTION	9

Introduction, Meaning and Scope of Materials Management , Objectives of Materials Management Significance of Materials Management, Materials Management in Other Areas of Management Functions -Materials Management and Design/Development, Materials Management and Production , Materials Management and Sales , Materials Management and Finance & Accounting

UNIT II	ABC ANALYSIS	9

Meaning of ABC Analysis, Objective of ABC Analysis, Advantages of ABC Analysis, Limitations of ABC Analysis and Simple Numerical of ABC Analysis

UNIT III	CODIFICATION AND STANDARDIZATION	9

Basis of Codification - Codification by Group Classification and characteristics of a Good Coding System, Types of Coding, Standardization and Its Benefit.

UNIT IV	PURCHASING MANAGEMENT	9

Introduction, Meaning of Purchase Management, objectives of scientific purchasing, functions of Purchasing department- Responsibilities of the Purchase department and Duties of Purchasing Department, Purchase Parameters, Kardex System, Purchasing Policy and Procedure.

UNIT V	NEGOTIATION	9

Introduction, meaning of Negotiation, objectives of Negotiation, Techniques of Negotiation Negotiator - Qualities of a Good Negotiator, Tactics and Strategies in Negotiation - Factors Influencing Tactics, Preparation for Negotiation, Phases of Negotiation Request for Quotation (RFQ)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the various the Functions of Purchase Department

CO2: Relate various meaning of ABC Analysis.

CO3: Relate the characteristics of coding System and its benefits.

CO4: Interpret the functions and responsibilities of Purchase Department.

CO5: Explain the objectives of Negotiation and its factors.

TEXT BOOKS:

1. Stephen N. Chapman, Tony Arnold. J R, "Introduction to Materials Management" 8th Edition, Pearson, 2007.
2. Gopalkrishanan. P, Sundaresan. M, "Materials Management: An Integrated Approach". 1st Edition, PHI Learning Pvt. Ltd, 2004.
3. J K. Shridhar Bhat, "Production and Materials Management", 1st Edition, Himalaya Publishing House, 2008

REFERENCES:

1. Chary. S.N, "Production and Operations Management", 6th Edition, Tata McGraw Hill, 2019
2. Evrim Ursavas Guldogan, "Port Operations and Container Terminal Management: with applications", 6th Edition, Springer, 2011.
3. Arnold, Champman and Ramakrishnan, "Introduction to Materials Management", 5th Edition, Pearson Education, 2007.

21PME23	ENTERPRISE RESOURCE PLANNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To show the basic concepts of ERP
- To illustrate ERP implementation in organization
- To use various ERP modules
- To discover the market potential of ERP
- To apply ERP concepts in real time case studies

UNIT I	MRP AND INTRODUCTION TO ERP	9

Introduction - overview of MRP I and MRP II, capacity requirements planning, history of ERP, evolution of ERP, comparison of ERP with traditional systems, benefits of ERP, need for ERP, overview of modules in ERP.

UNIT II	ERP IMPLEMENTATION	9

Traditional approach to information system design, new approach to system development; ERP Implementation: Requirement analysis, alternatives, life cycle, implementation methodology; Selection of an ERP package for suitability for manufacturing, hidden costs; Case studies.

UNIT III	BUSINESS MODULES IN ERP	9

Accounts, production planning, human resources, plant maintenance, materials management, quality management, sales and distribution, ware house and supply chain; Case studies.

UNIT IV	ERP MARKET	9

Market place, dynamics, SAP R3, SAP HANA Baan Company, Oracle Corporation, People Soft, JD Edwards World Solutions Co, System Software Associates, Inc. (SSA); QAD; A Comparative Assessment and Selection of ERP Packages and Modules.

UNIT V	ERP CASE STUDIES	9

HRM, finance and costing, production planning, materials management, sales and distribution, integration of modules.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to
CO1: To illustrate basic concepts of ERP and MRP.
CO2 : To demonstrate the ERP implementation process
CO3 : Categorize the ERP modules based on its application.
CO4 :To show the real world utilization of various ERP Packages

CO5 :To illustrate ERP with real time problems
TEXT BOOKS:
1. Vinod Kumar Garg and Venkitakrishnan N K, “Enterprise Resource Planning Concepts and Practice”, 1st Edition, PHI, 2010. 2. Alexis Leon, "ERP Demystified", 2nd Edition, Tata McGraw Hill, India, 2008. 3. Joseph A Brady, Ellen F Monk, Bret Wagner, “Concepts in Enterprise Resource Planning”, 2nd Edition, Thompson Course Technology, 2010.
REFERENCES:
1. Rahul V. Altekar, “Enterprise Resource Planning”, 4th Edition Tata McGraw Hill, 2010. 2. David L OLSON, "Managerial Issues of ERP Systems", 1st Edition, Tata-McGraw Hill, India, 2004. 3. Mary Summer, “Enterprise Resource Planning”, 2nd Edition, Pearson Education, 2005.

21PME24	WAREHOUSING AUTOMATION AND CONTAINER LOGISTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the foundational knowledge in warehousing receiving and issuing.
- To relate the various warehouse types.
- To illustrate operations in warehouse.
- To apply the foundational knowledge in container management.
- To illustrate operations in containers.

UNIT I	RECEIVING AND ISSUING	9

Receiving- Logistics support for Inward Transportation, Unloading, Inspection, Acceptance and Recording; Storing: Space allocation, Facilitation to stocking, Guarding & Recording; Risk bearing- Processing- Grading and branding – Disinfecting services.

Issuing: Order preparation, Picking, Dispatching/ Delivery & Recording Handling, Transportation & Storage of ISO Containers– Utility and Advantages of warehouses- Problems and issues in receiving processes.

UNIT II	WAREHOUSE TYPES	9

Warehouse Types: Own Warehouses- Hired Warehouses- Private Warehouses- Public Warehouses- Government Warehouses- Bonded Warehouses- Co-operative Warehouses- Distribution Warehouses- Fulfilment/ Consolidation Warehouses .Warehouses Providing Value Added Services- Cross Docking and Trans-loading Warehouses- Break Bulk Warehouses- Storage Warehouses- Refrigerated Warehouses Characteristics of ideal warehouses- Warehouse Layout- Principles and Facilities Types.

UNIT III	OPERATIONS IN WAREHOUSE	9

Internal Operations: Measures and metrics of warehouse operations- Logistics in the warehouse- Localization of materials in a warehouse- Identification and classification of Materials and products in the warehouse- Managing the material/products turns in warehouse (FIFO/LIFO) – Problems and issues in shipment processes. Warehousing Equipment: Material Handling equipment and Systems Safety Matting, Industrial Safety Equipment- Storage types and storage unit management

UNIT IV	MULTIMODAL TRANSPORT	9

Container, Types of containers- Multimodal Transport- Advantages- Freight Rate Structure & Shipping Regulations, Principal factors impacting ocean freight rates- International Commercial Terms- Multimodal Transport Network System- Advanced system in Container

management - Sea Freight Container details- Customs connection & Multimodal Transport in International Trade Maritime Frauds. Container crimes. ICT in Multimodal transport.		
UNIT V	**CONTAINER TERMINOLOGY**	**9**
Container characteristics- ISO standards- Types and purpose- Container terminology-Container integrity and security. Container packing. Container seals and securing-Techniques-Container ownership and management- Owning vs. Leasing- Storage, maintenance and repair. Container ship types, sizes and characteristics-Layout and design of a modern Containership- Lack of deck obstructions, speed. The economics of container ship operations owning vs. Chartering – Operating costs.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the various functions of Warehouse.

CO2: Relate various types of warehouses and their advantages

CO3: Relate the metrics of warehouse operations.

CO4: Apply the various functions in containers.

CO5: Show the various applications procedures in containers.

TEXT BOOKS:

1. David J. Piasecki, "Inventory Accuracy: People, Processes, & Technology", 1st Edition, OPS publication, 2003.
2. Jeroen.P. Van Den Berg, "Integral Warehouse Management: Management", 1st Edition, Create space Independent Pub 2007.
3. Max Muller "Essentials of Inventory Management", 3rd Edition, AMACOM, 2009.

REFERENCES:

1. Dr. Hariharan K. V, "Container & Multimodal Transport Management", 1st Edition, Shroff Publishers and Distributors Pvt. Ltd, 2002.
2. Kap Hwan Kim, Hans-Otto Günther, "Container Terminals and Cargo Systems: Design, Operations Management, and Logistics Control Issues", 1st Edition, Springer, 2010.
3. Urgen Sorgen Frei, "Port Business", 2nd Edition, BoD Books, 2000.

21PME25	MATERIAL HANDLING EQUIPMENT, REPAIR AND MAINTENANCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To choose the material handling system for various engineering application
- To prepare the various material handling equipment and systems for the case
- To construct suitable system for the industrial requirement
- To apply the knowledge of maintenance procedures for material handling devices.
- To construct maintenance management system for based on requirement.

UNIT I	PRINCIPLES OF MATERIAL HANDLING	9

Classifications of the materials handling equipment, their characteristics and application, principles, packaging and storage of materials, operation analysis and study of travel diagrams and flow process charts. Preparation of a new proposal for an integrated materials handling system. Protective devices handling of fluids and multiphase systems. Handling of refrigerated cargo.

UNIT II	VARIOUS MATERIAL HANDLING EQUIPMENT AND SYSTEMS	9

Theory and construction of the various parts of Mechanical Handling devices, wire ropes and chains, hooks, shackles, grabs, ladles and lifting electromagnets, sheaves, sprockets and drums, runners and rails, buffers and limit switches.

UNIT III	DESIGN OF MATERIAL HANDLING EQUIPMENT	9

Design of simple mechanical handling devices, viz., screw jacks, pulley blocks, winches, hoists and capstans, wind lasses. Need, Comparison with conventional systems, Equipment like industrial robots and automatically guided vehicles

UNIT IV	REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT	9

Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT V	MAINTENANCE FOR MATERIAL HANDLING EQUIPMENT	9

Repair methods for Material handling equipment - Equipment records –Job order systems - Use of computers in maintenance.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate the material handling system for the application

CO2: Choose the various material handling equipment and systems

CO3: Construct suitable mechanical handling system for the requirement

CO4: Discover the repair methods for material handling devices CO5: Prepare maintenance management system for industrial case studies
TEXT BOOKS:
1. James Apple, Material Handling System Design, 1st Edition, John Wiley, 2009 2. Siddhartha Ray, Introduction to Materials Handling, 2nd Edition, New Age International Pvt Ltd Publishers, 2017 3. Venkataraman .K "Maintenance Engineering and Management", 1st Edition, PHI Learning, Pvt Ltd., 2007.
REFERENCES:
1. Immer J. R., Material Handling, 1st Edition, Tata McGraw Hill Publication, 1953 2. Materials Handling Equipment - N. Rudenco, MIR Publisher, 2nd Revised Edition, 1997. 3. Srivastava S.K., "Industrial Maintenance Management", S. Chand and Co., 2nd Edition 2002.

21PME26	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the process planning concepts for selecting proper equipment and tools.
- To explain the various process planning activities.
- To prepare the cost estimation for various products after process planning.
- To calculate the product cost of job done by various manufacturing methods.
- To manipulate the machining time for various operations carried out in different machines.

UNIT I	INTRODUCTION TO PROCESS PLANNING	10

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

UNIT II	PROCESS PLANNING ACTIVITIES	10

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

UNIT III	INTRODUCTION TO COST ESTIMATION	8

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labour cost, material cost- allocation of overhead charges- Calculation of depreciation cost.

UNIT IV	PRODUCTION COST ESTIMATION	8

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 OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the process planning concepts and appropriate selection of equipment and tools for various industrial products.

CO2: Interpret the process planning activity chart.

CO3: calculate the various types of cost in the development of product.

CO4: Manipulate the costs of forging, welding and casting process to make or buy the product.

CO5: Calculate the machining time for various machining operations.

TEXT BOOKS:

1. Peter scallan, “Process planning, Design/Manufacture Interface”, 1st edition, Elsevier science technology Books, 2003.
2. Panneerselvam. R and Sivasankaran. P, “Process Planning and Cost Estimation”, 1st edition, PHI Learning, 2015.
3. T.R. Banga and S.C. Sharma “A Text-Book of Mechanical Estimating & Costing”, 17th Edition, Khanna Publishers, New Delhi, 2018.

REFERENCES:

1. Khanna. R.B, "Production and operations management", 2nd Edition, PHI Learning, 2015.
2. Adithan.M, “Process Planning and Cost Estimation”, 2nd Edition, New Age International Publisher, 2013.
3. Chary S. N., “Production & Operations Management”, 5th edition , Tata McGraw Hill, 2012

21PME27	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate concepts of production planning and control.
- To apply the principles of work study.
- To apply the principles of product planning and process planning.
- To prepare the various production scheduling and dispatching techniques.
- To explain the recent trends of PPC.

UNIT I	INTRODUCTION	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.

UNIT II	WORK STUDY	9

Method study, Basic procedure – Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study - Work measurement - Techniques of work measurement - Time study – Performance rating – Activity sampling - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III	PRODUCT PLANNING AND PROCESSPLANNING	9

Product planning - Extending the original product information - Value analysis - Problems in lack of product planning - Process planning and routing-Pre requisite information needed for process planning - Steps in process planning - Quantity determination in batch production - Machine capacity, Line balancing-Analysis of process capabilities in a multi-product system.

UNIT IV	PRODUCTION SCHEDULING	9

Production Control Systems - Loading and scheduling - Master scheduling - Scheduling rules - Gantt charts -Perpetual loading - Basic scheduling problems - Flow production scheduling - Batch production scheduling - Product sequencing - Material requirement planning – Dispatching - Progress reporting and expediting -Manufacturing lead time - Master production

schedule along with lead time and MRP		
UNIT V	**INVENTORY CONTROL AND RECENT TRENDS IN PPC**	**9**
Inventory control - Purpose of holding stock - Effect of demand on inventories – Ordering procedures. Two bin system - Periodic review system – Fixed order quantity system - Ordering cycle system - Determination of economic order quantity and economic lot size - ABC analysis - Recorder procedure - Elements of JIT - Fundamentals of MRP II and ERP**.**		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the various components and function of production planning and control.

CO2: Apply the principles of work study and time study activities.

CO3: Use the principles of product planning and process planning.

CO4: Prepare various production scheduling and dispatching techniques.

CO5: Describe the recent trends like Manufacturing Requirement Planning (MRP-II) & Enterprise Resource Planning (ERP).

TEXT BOOKS:

1. Martand Telsang, "Industrial Engineering and Production Management", 3rd Edition, S. Chand, 2018.
2. Panneerselvam, R., "Production and Operations Management", 3rd Edition, Prentice Hall of India, New Delhi,2012
3. Chary S. N., "Production & Operations Management", 5th Edition, Tata McGraw Hill, 2012.

REFERENCES:

1. Samuel Eilon, "Elements of Production Planning and Control", 3rd Edition, , Macmillan 2007.
2. Elwood S. Buffa and Rakesh K. Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley and Sons, 2011.
3. Jain K. C, Aggarwal L. N., "Production Planning Control and Industrial Management", 6th Edition, Khanna Publishers, 2004.

VERTICAL 5: THERMAL POWER PROCESSES AND EQUIPMENT

21PME28	THERMAL POWER ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the concepts of thermodynamics law.
- To demonstrate various air standard cycles.
- To illustrate the function of thermal power plant.
- To apply various process of waste heat recovery systems.
- To interpret various types of Cogeneration.

UNIT I	FUNDAMENTAL OF THERMODYNAMICS	9

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. Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries.

UNIT II	AIR STANDARD CYCLES	9

Air Standard Cycles - Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison – Rankine, reheat and regenerative cycle

UNIT III	THERMAL POWER PLANT AND ITS PARTS	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.

UNIT IV	WASTE HEAT RECOVERY SYSTEMS	9

Source and utilisation of residual heat. Heat pipes, Heat pumps, Recuperative and Regenerative heat exchangers-parallel flow- counter flow and cross flow heat exchangers. Economic Aspects. Advantages and limitations of heat recovery systems

UNIT V	COGENERATION	9

Cogeneration Principles, Types – Topping and Bottoming cycles - Advantages and limitations - Cycle Analysis, Applications of Cogeneration in Sugar, Paper, Steel and Glass industries. Economics of Cogeneration

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Solve the concepts of thermodynamics law

CO2: Interpret the air standard cycles.

CO3: Analyze the function of thermal power plant

CO4: Analyze the process of waste heat recovery systems

CO5: Calculate the various types of Cogeneration

TEXT BOOKS:

1. Kothandaraman.C.P, Domkundwar. S,Domkundwar. A.V., "A course in thermal

Engineering", 5th Edition, Dhanpat Rai & sons , 2016
2. Rajput. R. K., "Thermal Engineering" 6th Edition, S.Chand Publishers, 2017.
3. Rudramoorthy, R, "Thermal Engineering", 3rd Edition, Tata McGraw-Hill, New Delhi,2003

REFERENCES:

1. Ganesan V. "Internal Combustion Engines" , 3rd Edition, Tata Mcgraw-Hill 2012
2. Ramalingam. K.K., "Thermal Engineering", 4th Edition, Scitech Publications Pvt. Ltd., 2009.
3. Sarkar, B.K, "Thermal Engineering" 6th Edition, Tata McGraw-Hill Publishers, 2007.

21PME29	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To illustrate the construction and working principle of various parts of an automobile.
- To demonstrate the engine auxiliary system.
- To demonstrate the transmission systems in vehicle.
- To show the steering, brakes and suspension systems.
- To show assembling and dismantling of engine parts and transmission system.

UNIT I	VEHICLE STRUCTURE AND ENGINES	9

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

UNIT II	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type), 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, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive

UNIT IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

UNIT V	RECENT TRENDS IN AUTOMOTIVE SYSTEMS	9

Multi Point Fuel Injection, Common Rail Diesel Injection, Automatic Transmission, Continuously variable transmission - GDA Engine and HVT engine Electric and Hybrid Vehicles, Fuel Cell.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the construction and working principle of various parts of an automobile.
CO2: Discuss the engine auxiliary system.
CO3: Demonstrate the transmission systems in vehicle.
CO4: Discuss the steering, brakes and suspension systems.
CO5: Demonstrate assembling and dismantling of engine parts and transmission system.

TEXT BOOKS:

1. Ganesan, V., Internal Combustion Engines, 3rd Edition, Tata McGraw-Hill, New Delhi, 2012.
2. Kirpal Singh, Automobile Engineering- Vol. I and II, 4th Edition, Standard Publishers, New Delhi, 2011.
3. Ramalingam. K .K, Automobile Engineering, 6th Edition, Scitech publications,2011

REFERENCES:

1. Kamaraju Ramakrishna, Automobile Engineering, 5th Edition, PHI Learning pvt. Ltd., New delhi2012.
2. Mathur M.L. and Sharma. 'A Course in Internal Combustion Engines', 2nd Edition R.P. Dhanpat Rai Publications, 2009.
3. K. M. Gupta, Automobile Engineering- Vol I and II, 1st Edition,Umesh Publications, 2007

21PME30	ADVANCED INTERNAL COMBUSTION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To illustrate various functions of SI engines.
- To demonstrate various functions of CI engines.
- To explain the pollution formations and their control
- To demonstrate various alternate fuels and their properties.
- To illustrate various recent development in IC engines.

UNIT I	SPARK IGNITION ENGINES	9

Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers

UNIT II	COMPRESSION IGNITION ENGINES	9

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behavior – Spray structure and spray penetration – Air motion - Introduction to Turbocharging.

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	ALTERNATIVE FUELS	9

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.

UNIT V	RECENT TRENDS	9

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOx Adsorbers - On-board Diagnostics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Demonstrate various functions of SI engines.

CO2: Illustrate various functions of CI engines.

CO3: Illustrate the pollution formations and their control

CO4: Explain various alternate fuels and their properties

CO5: Demonstrate various recent development in IC engines.

TEXT BOOKS:

1. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", 6th Edition, SciTech

Publications, 2002.
2. Ganesan, "Internal Combustion Engines", 2nd Edition, TMH, 2002.
3. John Heywood, “Internal Combustion engines”,3rd Edition, McGraw Hill, 1988.

REFERENCES:

1. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines" 4th Edition,Dhanpat Rai & Sons 2007.
2. Duffy Smith, "Auto Fuel Systems", 2nd Edition, The Good Heart Willcox Company, Inc., 1987.
3. Eric Chowenitz, "Automobile Electronics", 4th Edition, SAE Publications, 1995

21PME31	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To illustrate the principles of operations in different Refrigeration & Air conditioning systems
- To discuss vapour compression refrigeration system
- To demonstrate the various refrigeration system
- To solve psychrometric process and systems
- To describe knowledge on design aspects of Refrigeration & Air conditioning systems

UNIT I	INTRODUCTION	9

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

UNIT II	VAPOUR COMPRESSION REFRIGERATION SYSTEM	9

Vapour 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. Equipment's: 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 OUTCOMES:

At the end of the course, learners will be able to

CO1: Illustrate the different properties of the refrigerants

CO2: Demonstrate the concepts of vapor compression refrigeration system.

CO3: Demonstrate the concepts of various refrigeration systems.
CO4: Manipulate the psychrometric properties and processes.
CO5: Demonstrate the load estimation of air conditioning system

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.
2. Manohar Prasad, “Refrigeration and Air Conditioning”, 3rd Edition, New age international (P) limited, New Delhi, 2021.
3. R.S.Khurmi & J.K Gupta, “Refrigeration and Air Conditioning” Revised Edition, S. Chand Publication, 2019

REFERENCES:

1. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", 2nd Edition, McGraw Hill, New Delhi.
2. P.L.Ballaney, “. Refrigeration and Air Conditioning” Khanna publishers,1st Edition, New Delhi, 1972.
3. Andrew D. Althouse, Carl h. Turnquist and Alfred F. Bracciano, “Modern Refrigeration and Air Conditioning” 2nd Edition, The goodheart-willcox company, INC, 2012

21PME32	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the concept of isentropic condition for solving the problems in variable flow ducts.
- To calculate heat transfer and friction in constant area ducts.
- To apply the normal and oblique shock concept for finding various parameters.
- To apply basic knowledge in jet propulsion.
- To demonstrate the basic principle of cryogenics and rocket propulsion

UNIT I	BASIC CONCEPTS AND ISENTROPIC FLOWS	9

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

UNIT II	FLOW THROUGH DUCTS	9

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

UNIT III	NORMAL AND OBLIQUE SHOCKS	9

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications.

UNIT IV	JET PROPULSION	9

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

UNIT V	SPACE PROPULSION	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Interpret the concept of compressible flows in variable area ducts.

CO2: Apply the concept of compressible flows in constant area ducts.

CO3: Examine the effect of compression and expansion waves in compressible flow.

CO4: Use the concept of gas dynamics in Jet Propulsion.

CO5: Apply the concept of gas dynamics in Space Propulsion

TEXT BOOKS:

1. Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2012.
2. Yahya, S.M. "Fundamentals of Compressible Flow", 3rd Edition, New Age International

(P) Limited, New Delhi, 2002.
3. Sutton. G.P., "Rocket Propulsion Elements", 5th Edition, John Wiley, New York, 2010.

REFERENCES:

1. Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory",1st Edition Longman Group Ltd.,1980
2. Ganesan. V., "Gas Turbines", 3rd Edition, Tata McGraw Hill Publishing Co., New Delhi, 2010.
3. Shapiro. A.H.," Dynamics and Thermodynamics of Compressible fluid Flow", 2nd Edition, John Wiley, New York, 1953.
4. Zucrow. N.J., "Principles of Jet Propulsion and Gas Turbines", 1st Edition, John Wiley, New York, 1970.

21PME33	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To demonstrate the overview of thermal power plants
- To illustrate diesel, gas turbine and combined cycle power plants.
- To interpret nuclear power plant
- To interpret various renewable energies
- To calculate the power tariff and load factors

UNIT I	COAL BASED THERMAL POWER PLANTS	10

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. Binary Cycles and Cogeneration systems.

UNIT II	DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS	10

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	7

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	10

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

UNIT V	ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS	8

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 OUTCOMES:

At the end of the course, learners will be able to

CO1: Examine the function and the parts of the coal based Thermal Power plant.

CO2: Demonstrate the power plants based on gas power cycles.

CO3: Examine the Nuclear Reactors in Nuclear power plant.

CO4: Illustrate power from Renewable energy sources.

CO5: Report the energy, economic and Environmental issues of power plant.

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", 3rd Edition, Tata McGraw – Hill Publishing Company Ltd., 2008
2. El-Wakil. M.M., "Power Plant Technology", 1st Edition Tata McGraw – Hill Publishing Company Ltd., 2010.
3. Arora and Domkundwar, “Power plant engineering” 8th Edition, Dhanpat rai & co. pvt. Ltd. 2016

REFERENCES:

1. Black & Veatch, Springer, "Power Plant Engineering", 1st Edition,1996.
2. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
3. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.

21OCH02	MATERIALS CHEMISTRY *(Common to all B.E / B.Tech. Programmes)*	L 3	T 0	P 0	C 3

COURSE OBJECTIVES:

- To describe the working principles of adhesives and lubricants.
- To realize the characteristics of explosives and propellants.
- To recognize the significant applications of glasses and abrasives.
- To apprehend the importance of smart materials.
- To summarize the applications of sensor materials.

UNIT-I	ADHESIVES AND LUBRICANTS	9

Adhesives-Introduction and classification - bonding process of adhesives- physical and chemical factors influencing adhesive action -development of adhesive strength-**lubricants**-classification - mechanism of lubrication- properties of lubricating oils-viscosity- redwood viscometer method-flash and fire point-determination -cloud and pour point-determination –oiliness.

UNIT-II	EXPLOSIVES AND PROPELLANTS	9

Explosives-Introduction and classification –characteristics- precautions during storage- blasting fuses – preparation of important explosives (TNT, GTN and RDX) - uses of explosives- -**Rocket Propellants**– classification, essential characteristics of rocket propellant.

UNIT III	GLASSES AND ABRASIVES	9

Glasses-Introduction- manufacture of glass- special types of glasses (safety glasses, optical glasses, toughened glasses and laminated glasses) - **Abrasives** -classification - characteristics and applications – manufacture of abrasive paper and cloth.

UNIT IV	SMART MATERIALS	9

Introduction to smart materials – properties – components – classification – piezoelectric materials – electrostrictive materials – magnetostrictive materials – rheological materials – thermo responsive materials – electrochromic materials – fullerenes – biomimetic materials – smart gels – shape memory alloys – industrial applications.

UNIT V	SENSOR MATERIAL	9

Introduction to sensor material - classification and physico –chemical properties of sensor-sensing mechanism-chemical and electrochemical sensors for environmental pollution monitoring-sensor-characterisation, calibration sensor reliability, aging test-failure mechanisms and their evaluation and stability study-biosensor instrumentation- transducers-industrial applications.

45 PERIODS

COURSE OUTCOMES : At the end of the course, learners will be able to

CO 1: Understand the working principle of adhesives and lubricants.
CO 2: Identify the characteristics of explosives and propellants.
CO 3: Apprehend the applications glasses and abrasives.
CO 4: Interpret the characteristics of smart materials and relevant applications.
CO 5: Relate the importance of sensor materials.

Text Book:

1. Jain and Jain, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Company, New Delhi, 17th Edition, 2019.
2. Malini.S, Anantha Raju K.S, Chemistry of Engineering Materials, CBS Publishers & Distributors pvt ltd, New Delhi,1st Edition,2022.
3. Rajendran V, Materials Science, McGraw Hill Publishing Company limited, New Delhi, 3rd Edition, 2017.

Reference Books:

1 .S.S. Dara and S.S. Umare, A Text Book of Engineering Chemistry, S Chand Publishers and Company limited, New Delhi, 6th Edition, 2019.
2.Harry. R. Allcock, Introduction to Materials Chemistry, Wiley publication, U.S, 2nd Edition, 2019.
3.C.V. Agarwal, C. Parameswara Murthy, Andra Naidu, BS Publications, Hyderabad, 9th Edition, 2018.

VERTICAL 6: INDUSTRIAL SYSTEM ENGINEERING

21PME34	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To predict the importance of knowledge in management
- To demonstrate the process of planning in an organization.
- To illustrate functions of an industry.
- To use different motivational techniques and leadership skills in the organization.
- To use the various controlling techniques and tools in the organization.

UNIT I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	9

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

UNIT II	PLANNING	9

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

UNIT III	ORGANISING	9

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

UNIT IV	DIRECTING	9

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

UNIT V	CONTROLLING	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the foundational knowledge in management.
CO2: Relate the various planning.
CO3: Illustrate various functions of organization.
CO4: Interpret the functions of motivation.
CO5: Demonstrate the practices in budget and reporting.

TEXT BOOKS:

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Stephen P. Robbins & Mary Coulter, "Management", 10th Edition, Prentice Hall (India) Pvt. Ltd., 2009.
3. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 7th Edition, Pearson Education, 2011.

REFERENCES:

1. Robert Kreitner & Mamata Mohapatra, "Management", 1st Edition, Biztrantra, 2008.
2. Harold Koontz & Heinz Weihrich, "Essentials of Management", 1st Edition, Tata McGraw Hill, 1998.
3. Tripathy PC & Reddy PN, "Principles of Management", 1st Edition, Tata McGraw Hill, 1999

21PME35	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the foundational knowledge in Total Quality Management.
- To relate the various TQM Principles.
- To illustrate various TQM Tools and Techniques I.
- To interpret the functions of TQM Tools and Techniques II.
- To demonstrate the practices in Quality Management System.

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 OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the quality management philosophies and Framework.

CO2: Demonstrate the need of customer expectations, employee involvement and Supplier Partnership.

CO3: Illustrate TQM tools and Techniques to improve the product and process Quality

CO4: Use the modern tools to improve quality of the product.

CO5: Explain the Management Standards and certification process.

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Revised 3rd Edition, Pearson Education Asia, Indian Reprint, 2013.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3. Oakland J S, “TQM - Text with Cases”, 3rd Edition, Butterworth - Heinemann Ltd., Oxford, 2012.

REFERENCES:

1. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", 1st Edition,PrenticeHall (India) Pvt. Ltd., 2006.
2. Suganthi.L and Anand Samuel, "Total Quality Management", 2nd Edition, Prentice Hall (India) Pvt. Ltd.,2006.
3. Ramachandran S, “Total Quality Management”, 3rd Edition, Air Walk Publications, 2014.
4. ISO9001-2015 standards

21PME36	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To use various Lean Manufacturing tools
- To execute various lean tools for improving production
- To show the concepts to reduce the process time
- To implement the process of Six Sigma
- To use the suitable Lean Tools for various cases

UNIT I	INTRODUCTION TO LEAN MANUFACTURING	9

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.

UNIT II	CELLULAR MANUFACTURING, JIT, TPM	9

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

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

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

UNIT IV	SIX SIGMA	9

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

UNIT V	CASE STUDIES	9

Various case studies of implementation of lean manufacturing at industries.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply various Lean Manufacturing tools to eliminate wastes.

CO2: Apply various lean manufacturing tools for productivity improvements.

CO3: Demonstrate the concepts to reduce the process time

CO4: Apply the process of Six Sigma in industries.

CO5: Use the suitable Lean Tools for the identified cases and justify

TEXT BOOKS:

1. Ronald G. Askin & Jeffrey B. Goldberg, "Design and Analysis of Lean Production Systems", 1st Edition, John Wiley & Sons, 2003.
2. D. Reinertsen, "The Principles of Product Development Flow", 1st Edition, Second Generation Lean Product Development, Celeritas Publishing, 2009.
3. M. Rother, J. Shook, "Learning to See , Lean" 1st Edition, Enterprise Institute, 2009.

REFERENCES:

1. Mikell Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th edition, Pearson, 2014.
2. Rother M. and Shook J, "Learning to See: Value Stream Mapping to Add Value and

Eliminate MUDA", Lean Enterprise Institute, 1st Edition, 1999.
3. J.K. Liker, "The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer", 1st Edition, McGraw Hill, 2004.

21PME37	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply safety ideas to impart basic safety skills.
- To relate the concepts of safety analysis and its control measures.
- To discover the occupational health hazards and its risk in workplace.
- To interpret the safety, Health and Environmental regulations.
- To relate safety management system and apply in industrial case studies.

UNIT I	OPERATIONAL SAFETY	9

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II	SAFETY APPRAISAL AND ANALYSIS	9

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III	OCCUPATIONAL HEALTH	9

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV	SAFETY AND HEALTH REGULATIONS	9

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V	SAFETY MANAGEMENT	9

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Interpret operational safety in industrial process
CO2: Calculate safety risk by executing safety appraisal using HAZOP
CO3: Discover the occupational health hazards presents in the workplace
CO4: Relate the safety and health regulations in workplace
CO5: Choose safety system to run an industry with utmost safety precautions

TEXT BOOKS:

1. John V Grimaldi, Safety Management, Richard D. Irwin; 5th Edition, 2003
2. Krishnan N.V, "Safety in Industry", 1st Edition, Jaico Publisher House, 1996
3. Deshmukh L M , "Industrial Safety Management", 2nd Edition, McGraw Hill Education India, 2017

REFERENCES:

1. John.V .Grimaldi and Rollin. H Simonds, "Safety Management", 1st Edition, All India traveller book seller, New Delhi – 1989
2. Singh, U.K and Dewan, J.M., "Safety, Security and Risk Management", 1st Edition, APH publishing company, New Delhi, 1996
3. Occupational Safety Manual, NIOSH, 1985

21PME38	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the basic concepts of Industry 4.0
- To relate the concepts of evolution of Industry 4.0
- To construct the concepts of IIOT
- To discover the real time application of Industry 4.0
- To prepare the Business opportunities and challenges in Industry 4.0

UNIT I	INTRODUCTION TO INDUSTRY 4.0	9

The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - The Journey so far: Developments in USA, Europe, China and other countries - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

UNIT II	ROAD TO INDUSTRY 4.0	9

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics

UNIT III	IIOT	9

Fourth Revolution – Sustainability assessment of Manufacturing Industry – Lean Production system – Smart and connected business perspective – smart factories – cyber-physical systems – collaboration platform and PLM

UNIT IV	APPLICATIONS	9

Inventory Management and Quality Control – Plant security and safety – Facility management – oil, chemical and Pharmaceutical Industry – Milk processing and packaging industries

UNIT V	BUSINESS ISSUES IN INDUSTRY 4.0	9

Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era – Strategies for competing in an Industry 4.0 world

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to
CO1: Show the basics of Industrial Revolution
CO2: Interpret the basic concepts of Industry 4.0
CO3: Relate the Concepts of Industrial IOT in various sectors
CO4: Demonstrate the applications of Industrial IOT
CO5: Solve the Business issues in Industry 4.0

TEXT BOOKS:

1. The Fourth Industrial Revolution‖ by Klaus Schwab, World Economic Forum 2nd Edition
2. Arsheep Bahga and Vijay Madisetti, “Internet of Things: A Hands-On Approach”, 8th Edition, University Press.
3. NOC: "Introduction to Industry 4.0 and Industrial Internet of Things” 3rd Edition

REFERENCES:

1. Jean-Claude André, “Industry 4.0”, 3rd Edition, Wiley- ISTE, 2019.
2. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, “Handbook of Industry 4.0 and SMART Systems”, 2nd Edition, Taylor and Francis, 2020.
3. Miller M, “The internet of things: How smart TVs, smart cars, smart homes, and smart cities are changing the world”, 3rd Edition, Pearson Education, 2015.

21PME39	PROFESSIONAL ETHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply the importance of Human Values.
- To relate the various theories related to ethical behaviour.
- To illustrate various role and responsibility in technological development through experimentation.
- To explain the functions of professionals rights.
- To demonstrate the practices in Global Issues.

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 OUTCOMES:

At the end of the course, learners will be able to

CO1: Apply the foundational knowledge in Human Values.

CO2: Relate the various Engineering Ethics.

CO3: Illustrate various Engineering as Social Experimentation.

CO4: Interpret the functions of Safety, Responsibilities and Rights.

CO5: Apply the knowledge of human values and social values to contemporary ethical values and global issues.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, 4th Edition, Tata McGraw Hill, New Delhi, 2017.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, 1st Edition, Prentice Hall of India, New Delhi, 2004.
3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, 1st Edition, Oxford University Press, Oxford, 2001.

REFERENCES:

1. Charles B. Fleddermann, “Engineering Ethics”, 2nd Edition, Pearson Prentice Hall, New Jersey, 2004.
2. John R Boatright, “Ethics and the Conduct of Business”, 1st Edition, Pearson Education, New Delhi, 2003.
3. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility”, 1st Edition, Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013

21PME40	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop basic entrepreneurial skills.
- To demonstrate strengthen entrepreneurial motivation
- To illustrate the business efficiently and effectively
- To relate financing and accounting
- To support the entrepreneurs policy

UNIT I	ENTREPRENEURSHIP	9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Entrepreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth

UNIT II	MOTIVATION	9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III	BUSINESS	9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies

UNIT IV	FINANCING AND ACCOUNTING	9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V	SUPPORT TO ENTREPRENEURS	9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Explain the entrepreneurial skills and factors
CO2: Illustrate the need of motivation for Entrepreneur
CO3: Describe the requirement to run the business efficiently and effectively
CO4: Estimate the sources of Finance and Loan
CO5: Express to support the entrepreneurs policy

TEXT BOOKS:

1. Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi,
2. Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9th Edition, Cengage
3. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.

REFERENCES:

1. Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis" 2nd Edition, Dream tech, 2005.

2. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
3. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.

21PME41	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To solve Linear Programming techniques.
- To solve about the transportation models and network models
- To solve about Assignment models and Inventory control
- To solve basic Project management techniques
- To solve Game theory problems and queuing models

UNIT I	CONCEPTS OF OPERATIONS RESEARCH AND LINEAR PROGRAMMING TECHNIQUES	9

Operations research and decision making, types of mathematical models and their construction; Formulation of linear programming problem, applications and limitations: Graphical method, Simplex method, Big–M method, Two–phase method.

UNIT II	TRANSPORTATION MODELS AND NETWORK MODELS	9

Least cost method, North West corner rule, Vogel's approximation method, Modified distribution method optimization models, degeneracy in transportation model, unbalanced and maximization models.

UNIT III	ASSIGNMENT MODELS AND INVENTORY CONTROL	9

Assignment models: Hungarian algorithm, unbalanced assignment problems, maximization case in assignment problems, traveling salesman problem. Inventory models with penalty, shortage and quantity discount, safety stock, inventory models with probability, lead time, demand, multi item deterministic model.

UNIT IV	PROJECT MANAGEMENT BY CPM AND PERT	9

Constructing project network, network computations in CPM and PERT, cost crashing, resource levelling.

UNIT V	GAME THEORYAND QUEUING MODELS	9

Game theory: Theory of games, competitive games, rules for game theory, mixed strategies, two person zero sum game, n person zero sum game, graphical method. ; Queuing models: The M/M/1 queue, The M/M/m queue, batch arrival queuing system, queues with breakdowns

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to

CO1: Construct the LPP and solve by Graphical method

CO2: Solve the Transportation and Network models

CO3: Solve the Assignment and Inventory models

CO4: Construct the project network using CPM and PERT

CO5: Solve by using Game theory and Queuing models

TEXT BOOKS:

1. Hillier and Libeberman, "Operations Research", 3rd Edition, Holden Day, 2005
2. Taha H.A., "Operations Research", 6th Edition, Prentice Hall of India, 2003.
3. Tulsian and Pasdey V., "Quantitative Techniques", 4th Edition, Pearson Asia, 2002.

REFERENCES:

1. Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, 4th Edition, John Wiley, 2009.
2. Budnick F.S., “Principles of Operations Research for Management”, 3rd Edition, Richard D Irwin, 1990.
3. Philip D.T. and Ravindran A., “Operations Research”, 2nd Edition, John Wiley, 1992.
4. Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, 4th Edition, Wiley Eastern, 1994.