COIMBATORE INSTITUTE OF TECHNOLOGY

(Govt. Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641014

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF MECHANICAL ENGINEERING

CURRICULUM & SYLLABI

Under Choice Based Credit System

(For the students admitted during the academic year 2023-24 and onwards)

COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014

(An Autonomous Institution affiliated to ANNA UNIVERSITY, CHENNAI)

DEPARTMENT OF MECHANICAL ENGINEERING

REGULATIONS 2023 CHOICE BASED CREDIT SYSTEM

B. E. MECHANICAL ENGINEERING

VISION

To become one of the best mechanical engineering departments in the country within the next decade, in preparing engineers capable of working innovatively and creatively towards a better world.

MISSION

- Impart sound knowledge through effective teaching-learning methods.
- Prepare students to address current and impending challenges facing the country.
- Create and nurture an environment for fostering innovation and research.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO 1: Acquire fundamental knowledge and expertise necessary for successful professional practice in mechanical engineering and allied fields, and for higher studies.

PEO 2: Attain and demonstrate essential technical skills to identify, analyze and solve complex problems and design issues in mechanical engineering.

PEO 3: Possess a professional attitude as an individual or a team member with consideration for societal, ethical and environmental factors, and display motivation for life-long learning.

PROGRAM OUTCOMES (POs)

1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2 **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principle of mathematics, natural sciences, and engineering sciences.

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

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

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

6 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Apply principles of mechanical engineering and physical sciences to model, analyze, design and select appropriate materials and manufacturing processes to create engineering solutions (products, systems, or processes) during their Mini-Project and Thesis Project Work.

PSO2: Work with contemporary technologies through multi-pronged opportunities such as industry linked One Credit Courses, In-plant Training, and Internships together with a Fast-tracked curriculum.

PSO3: Participate in team hackathons and develop critical thinking skills via hands-on-experience in research experiments to become an entrepreneur or initiate a start-up.

MAPPING OF PROGRAMME EDUCATIONAL OUTCOMES WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC COUTCOMES

PEOs	PROGRAMME OUTCOMES (PO)												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	2	2	2	-	-	1	3	1	3	2	1
2	2	3	3	3	3	2	2	1	1	2	3	2	3	2	3
3	-	1	3	1	-	3	3	3	3	3	3	3	2	2	3

COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014
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DEPARTMENT OF MECHANICAL ENGINEERING
REGULATIONS 2023 - CHOICE BASED CREDIT SYSTEM

B. E. MECHANICAL ENGINEERING

CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23FYH111	Technical English	HSC	2	2	0	4	4
2	23FYM112	Matrices, Calculus and Differential Equations	BSC	3	1	0	4	4
3	23FYP112	Physics for Mechanical Engineers I	BSC	2	1	0	3	3
4	23FYC112	Chemistry for Mechanical Engineers	BSC	3	0	0	3	3
5	23ME131	C - Programming and Problem-Solving	ESC	2	0	2	4	3
PRACTICALS								
6	23FPC121	Basic Sciences Laboratory I	BSC	0	0	2	2	1
7	23ME121	Engineering Graphics for Mechanical Engineers I	ESC	0	0	4	4	2
8	23ME122	Engineering Practices laboratory	ESC	0	0	2	2	1
MANDATORY COURSE								
9	23FYH121	Heritage of Tamils/ Tamizhar Marabu	HSC	1	0	0	1	1
10	23MC101	Induction Program	MC	-	-	-		0
11	23MC102	Soft Skills	EEC	-	-	-		0
			TOTAL	**13**	**4**	**10**	**27**	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23FYH211	Professional English / Foreign language	HSC	3	0	0	3	3
2	23FYM212	Fourier Series, Transforms, Difference and Vector Calculus	BSC	3	1	0	4	4
3	23FYP211	Physics for Mechanical Engineers II	BSC	2	1	0	3	3
4	23ME211	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3

5	23ME212	Materials and Metallurgy	PCC	3	0	0	3	3
PRACTICALS								
6	23FPC222	Basic Sciences Laboratory II	BSC	0	0	2	2	1
7	23ME221	Engineering Graphics for Mechanical Engineers II	ESC	0	0	4	4	2
8	23FYH221	English Communication Competency Laboratory	HSC	0	0	4	4	2
MANDATORY COURSE								
9	23CC	Co-Curricular Activities	MC					1
10	23FYC221	Environmental Science and Engineering	MC	1	0	0	1	1
11	23FYH222	Tamils and Technology / Tamizharum Thozhilnutpamum	MC					1
TOTAL				**15**	**2**	**10**	**27**	**24**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23M312	Complex Variables and Partial Differential Equations	BSC	3	1	0	4	4
2	23ME311	Engineering Mechanics	ESC	3	1	0	4	4
3	23ME312	Engineering Thermodynamics	ESC	3	1	0	4	4
4	23ME313	Manufacturing Processes I	PCC	3	0	0	3	3
5	23ME314	Metrology and Quality Control	PCC	3	0	0	3	3
PRACTICALS								
6	23ME321	Computer Aided Machine Drawing I	PCC	0	0	4	4	2
7	23ME322	Metrology Laboratory	PCC	0	0	2	2	1
8	23ME323	Moulding and Welding Laboratory	PCC	0	0	2	2	1
MANDATORY COURSE								
9	23MC301	Induction Program	MC					0
10	23MC321	Human Values and Professional Ethics	MC					1
11	23MC322	Design Thinking	EEC					1
		TOTAL		**15**	**3**	**8**	**26**	**24**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Applied Thermodynamics	PCC	3	1	0	4	4
2		Electrical Machines and Drives	ESC	2	0	2	4	3

3		Fluid Mechanics and Machinery	PCC	3	1	0	4	4
4		Manufacturing Processes II	PCC	3	0	0	3	3
5		Strength of Materials	ESC	3	1	0	4	4
PRACTICALS								
6		Computer Aided Machine drawing II	PCC	0	0	2	2	1
7		Fluid Mechanics and Machinery Laboratory	PCC	0	0	2	2	1
8		Material Characterization and Testing Laboratory	PCC	0	0	2	2	1
MANDATORY COURSE								
9		Value Added Course 1	EEC					1
10		Community Service and Engineering	MC					0
			TOTAL	**14**	**3**	**8**	**25**	**22**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Design of Machine Elements	PCC	3	1	0	4	4
2		Heat Transfer	PCC	3	1	0	4	4
3		Kinematics of Machinery	PCC	3	1	0	4	4
4		Professional Elective I	PEC	3	0	0	3	3
5		Professional Elective II	PEC	3	0	0	3	3
PRACTICALS								
6		Applied Thermodynamics Laboratory	PCC	0	0	2	2	1
7		Finite Element Analysis Laboratory	PCC	0	0	2	2	1
8		Lathe and Special Machines Laboratory	PCC	0	0	2	2	1
9		In plant training	EEC	0	0	0	0	1
MANDATORY COURSE								
10		Value Added Course - 2	EEC					1
11		Seminar and Technical Writing	EEC					1
			TOTAL	**15**	**3**	**6**	**24**	**24**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Computer Integrated Manufacturing	PCC	3	0	0	3	3
2		Design of Transmission Systems	PCC	3	1	0	4	4
3		Dynamics of Machinery	PCC	3	1	0	4	4

4		Professional Elective III	PEC	3	0	0	3	3
5		Professional Elective IV	PEC	3	0	0	3	3
PRACTICALS								
6		Computer Aided Manufacturing Laboratory	PCC	0	0	2	2	1
7		Dynamics Laboratory	PCC	0	0	2	2	1
8		Heat Transfer Laboratory	PCC	0	0	2	2	1
9		Mini Project	EEC	0	0	4	4	2
MANDATORY COURSE								
10		Hackathon	EEC					1
			TOTAL	**15**	**2**	**10**	**27**	**23**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Control Systems and Mechatronics	PCC	3	1	0	4	4
2		Fluid Power Control Systems	PCC	3	0	0	3	3
3		Operations Research	PCC	3	1	0	4	4
4		Professional Elective V	PEC	3	0	0	3	3
5		Professional Elective VI	PEC	3	0	0	3	3
PRACTICALS								
6		Fluid Power Laboratory	PCC	0	0	2	2	1
7		Mechatronics Laboratory	PCC	0	0	2	2	1
8		Advanced Manufacturing Laboratory	EEC	0	0	2	2	1
			TOTAL	**15**	**2**	**6**	**23**	**20**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Professional Elective - VII / Open Elective - I	PEC/OEC	3	0	0	3	3
2		Professional Elective - VIII / Open Elective - II	PEC/OEC	3	0	0	3	3
PRACTICALS								
3		Project Work	EEC	0	0	12	12	6
			TOTAL	**6**	**0**	**12**	**18**	**12**

LIST OF PROFESSIONAL ELECTIVE COURSES

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	23ME	Advanced Machining Processes	PEC	3	0	0	3	3
2.	23ME	Alternative Energy Conversion Technologies	PEC	3	0	0	3	3
3.	23ME	Automotive Technology	PEC	3	0	0	3	3
4.	23ME	Composite Materials	PEC	3	0	0	3	3
5.	23ME	Computer Aided Design	PEC	3	0	0	3	3
6.	23ME	Design of Jigs and Fixtures	PEC	3	0	0	3	3
7.	23ME	Energy Conservation and Waste Heat Recovery	PEC	3	0	0	3	3
8.	23ME	Engineering Economics and Management	PEC	3	0	0	3	3
9.	23ME	Engineering Optimization	PEC	3	0	0	3	3
10.	23ME	Environment Sustainability and Impact Assessment	PEC	3	0	0	3	3
11.	23ME	Finite Element Analysis	PEC	3	0	0	3	3
12.	23ME	Gas Dynamics and Jet Propulsion	PEC	3	0	0	3	3
13.	23ME	Internal Combustion Engines	PEC	3	0	0	3	3
14.	23ME	Lean and Agile Manufacturing	PEC	3	0	0	3	3
15.	23ME	Manufacturing Cost Estimation	PEC	3	0	0	3	3
16.	23ME	Measurements and Controls	PEC	3	0	0	3	3
17.	23ME	Powder Metallurgy	PEC	3	0	0	3	3
18.	23ME	Power Plant Engineering	PEC	3	0	0	3	3
19.	23ME	Precision Manufacturing	PEC	3	0	0	3	3
20.	23ME	Production Planning and Control	PEC	3	0	0	3	3
21.	23ME	Refrigeration and Air Conditioning	PEC	3	0	0	3	3
22.	23ME	Robotics	PEC	3	0	0	3	3
23.	23ME	Total Quality Management	PEC	3	0	0	3	3
24.	23ME	Tribology	PEC	3	0	0	3	3
25.	23ME	Work System Design	PEC	3	0	0	3	3

LIST OF VALUE ADDED COURSES

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	23ME	3-D Scanning Technology	EEC	1	0	0	1	1
2.	23ME	Advanced Industrial Automation Systems	EEC	1	0	0	1	1
3.	23ME	Aircraft Maintenance	EEC	1	0	0	1	1
4.	23ME	Biology for Engineers	EEC	1	0	0	1	1
5.	23ME	Constitution of India	EEC	1	0	0	1	1
6.	23ME	E-Commerce Security	EEC	1	0	0	1	1
7.	23ME	Foundry Practice and Procedures	EEC	1	0	0	1	1
8.	23ME	Innovation and Entrepreneurship	EEC	1	0	0	1	1
9.	23ME	Inspection and Quality Control in Manufacturing	EEC	1	0	0	1	1
10.	23ME	MATLAB Programming	EEC	1	0	0	1	1
11.	23ME	Non Destructive Evaluation	EEC	1	0	0	1	1
12.	23ME	Recent Trends in Quality	EEC	1	0	0	1	1
13.	23ME	Design of Electric Vehicle (Four Wheeler)	EEC	1	0	0	1	1
14.	23ME	Heating Ventilation and Air-Conditioning System Design	EEC	1	0	0	1	1
15.	23ME	Geometric Dimensioning and Tolerancing in Design	EEC	1	0	0	1	1
16.	23ME	Advanced Solid State Joining Processes	EEC	1	0	0	1	1

LIST OF VERTICALS

S. NO.	VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6	VERTICAL 7 (MINOR)
	MATERIALS AND DESIGN ENGINEERING	**COMPUTATIONAL ENGINEERING**	**ROBOTICS AND AUTOMATION**	**FLUID AND THERMAL SCIENCES**	**MANUFACTURING AND MANAGEMENT**	**PRODUCT AND PROCESS DEVELOPMENT**	**MECHANICAL TECHNOLOGY**
1	Biomaterials	Computational Fluid Dynamics and Heat Transfer	Digital Manufacturing and IoT	Advanced Heat Transfer	Manufacturing Sciences	Additive Manufacturing	Fundamentals of Engineering Mechanics
2	Design Concepts in Engineering	Computational Solid Mechanics	Drives and Actuators for Robotics	Advanced Fluid Mechanics	Plastic Processing Techniques	Creativity and Innovation in Entrepreneurship	Fundamentals of Thermal Sciences
3	Design for Manufacturing and Assembly	Machine Learning for Intelligent Systems	Embedded Systems and Programming	Cryogenics	Surface Engineering	Design For X	Basic Manufacturing Processes
4	Experimental Stress Analysis	Python Programming	Industry 4.0	Design and Optimization of Thermal Equipment	Advanced Statistics and Data Analytics	Ergonomics in Design	Energy Conversion Technologies
5	Smart Materials	Theory on Computation and Visualization	Sensors and Instrumentation	Design of Heat Exchangers	Quality Control and Reliability Engineering	New Product Development	Industrial Safety
6	Tool Engineering and Design	Computational Bio-Mechanics	Smart Mobility and Intelligent Vehicles	Turbo Machines	Supply Chain Management	Product Life Cycle Management	Electric and Hybrid Vehicle Technology

LIST OF OPEN ELECTIVE COURSES OFFERED FOR THE STUDENTS OF OTHER UG PROGRAMMES

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C	UG PROGRAMME
1.		Design of Experiments	OE	3	0	0	3	3	All branches
2.		Engineering Polymers, Composites and Allied Manufacturing Processes	OE	3	0	0	3	3	Chemical & Civil
3.		Business Process Re-Engineering	OE	3	0	0	3	3	All branches
4		Industrial Management	OE	3	0	0	3	3	All branches
5		Reverse Engineering	OE	3	0	0	3	3	All branches
6		Nano Technology	OE	3	0	0	3	3	All branches

SUMMARY

Category; BSC – Basic sciences, HSC– Humanities and Social Sciences, ESC–Engineering sciences, PCC –Professional Core, PEC- Professional Elective, OEC-Open Elective Course, EEC –Employability Enhancement Course, MC – Mandatory Course

B.E. MECHANICAL ENGINEERING										
Sl. No.	Subject Area	Credits per Semester								Credits Total
		I	II	III	IV	V	VI	VII	VIII	
1	HSC	5	5							10
2	BSC	11	8	4						23
3	ESC	6	5	8	7					26
4	PCC		3	10	14	15	14	13		69
5	PEC					6	6	6		18
6	OEC								6	6
7	EEC			1	1	3	3	1	6	15
8	MC		3	1						4
TOTAL CREDITS										171

SEMESTER I

23FYH111	TECHNICAL ENGLISH	L	T	P	C
		2	2	0	4

MODULE I FOCUS ON LANGUAGE: GRAMMAR & VOCABULARY 6+6

Embedded Sentence – Numerical Adjectives - Subject Verb Agreement – If Conditionals – Active Passive Voice – Reported Speech - Idiomatic Expressions - Business and Job Related Vocabulary - Relative Clause – Pronouns – Adjectives - Degrees of Comparison - Technical Vocabulary – Avoidance of Jargon - Collocations - Formal and Informal Vocabulary – Verbal Analogy - Tenses - Prepositions – Articles – Homophones and Homonyms - One Word Substitutes –Linking Words.

MODULE II TECHNICAL COMMUNICATION 6+6

Importance of Technical Communication - Objective & Characteristics of Technical Communication – General and Technical Communication – Process of Communication - Levels of Communication – Flow of Communication –Visual Aids in Technical Communication - Barriers to Communication: Noise – Classification of Barriers –Non-verbal Communication: Kinesics – Proxemics- Chronemics.

MODULE III READING & LISTENING 6+6

Reading Comprehension Techniques: Understanding Technical Articles – Skimming and Scanning – Summarizing–- Intensive & Extensive Reading- Note Making – SQ3R Reading Technique - Meaning and Art of Listening-Importance of Listening & Empathy in Communication – Reasons for Poor Listening – Traits of a good listener – Listening to Technical Talks – Listening to TED/INK Talks.

MODULE IV WRITING 6+6

Paragraph Writing – Interpreting Charts and Graphs – Instructions – Checklists – Recommendations – Describing a Process – Extended Definitions – Essay Writing – Report Writing – Minutes of the Meetings -Email Writing - Essay Writing - Job Application Letters.

MODULE V SPEAKING 6+6

Introducing Oneself- Asking for and Giving Directions – Seeking Clarification – Speaking about a Process – Introduction to Technical Presentation – Mechanics of Presentation – Achieving Confidence, Clarity & Fluency – Vocal Cues - Barriers to Speaking – Types of Speaking – Persuasive Speaking – Public Speaking.

TOTAL (30+30): 60 PERIODS

COURSE OUTCOMES

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

CO1: Categorize the barriers to communication and formulate solutions using appropriate vocabulary.
CO2: Apply the rules of the grammar and construct grammatically correct sentences.
CO3: Comprehend the nuances of Technical Communication.
CO4: Make inferences and interpret texts using reading and listening strategies.
CO5: Perceive the mechanics of business writing and presentation skills.
CO6: Develop LSRW skills to excel in workplace communication.

TEXT BOOKS:

1. Praveen Sam D & Shoba K N, “A Course in Technical English” Cambridge University Press,

2020.
2. Meenakshi Raman, Sangeeta Sharma, “Technical Communication – Principles and Practice”, Oxford University Press, New Delhi, 2015.

REFERENCES:

1. Sudharshana N. P & Savitha C, “English for Engineers”, CUP, 2018
2. Lourdes Joavani Rayen & Shoba K N, “Communicative English”, CUP, 2018.
3. Steve Hart, Aravind R. Nair & Veena Bhambhani, “Embark – English for Undergraduates”, CUP, 2016
4. Jack C Richerds, “Interchange - 2”, CUP, Fourth Edition, Chennai, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1									2	3		1			
2									2	3		1			
3									2	3		1			
4									2	3		1			
5									2	3		1			
6									2	3		1			
AVG.									2	3		1			

1-low, 2-medium, 3-high

SEMESTER I

23FYM112	MATRICES, CALCULUS AND DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

MODULE I MATRICES **9+3**

Eigenvalues and Eigenvectors - Cayley Hamilton theorem (statement only) - Applications to find the inverse and higher power of a matrix – Diagonalization by an orthogonal transformation – Transformation of quadratic forms to canonical forms.

MODULE II DIFFERENTIAL CALCULUS **9+3**

Partial derivatives- Total derivative - Taylor's series - Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

MODULE III MULTIPLE INTEGRALS **9+3**

Double integrals – Change of order of integration – Jacobians - Evaluation in polar coordinates – Area enclosed by plane curves – Triple integrals in Cartesian coordinates– Volume of solids.

MODULE IV ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Second and higher order ordinary differential equations with constant coefficients - Method of variation of parameters - Legendre linear homogeneous ordinary differential equations - Solution of simultaneous ordinary differential equations with constant coefficients.

MODULE V NUMERICAL SOLUTION OF SIMULTANEOUS AND ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Numerical Solution of algebraic and transcendental equations by Newton-Raphson method – Solution of Linear simultaneous equations by Gauss Elimination method - Gauss Seidel method - Numerical solution of first order ordinary differential equation: Taylor's Series Method – Modified Euler's method - Fourth order Runge- Kutta method - Milne's predictor and corrector method.

TOTAL(45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Evaluate eigenvalues, eigenvectors, diagonalize the matrix and transform quadratic forms to canonical forms**.**

CO2: Perform partial derivatives and maxima and minima of multi variable functions.

CO3: Compute the area of regions and volume of solids using double and triple integrals.

CO4: Apply the concepts of ordinary differential equations in modelling and solving engineering problems.

CO5: Solve the system of equations and first order differential equations using numerical methods.

TEXT BOOKS:

1. B. S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, 2012.
2. B. V. Ramana, "Higher Engineering Mathematics", Kindle Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES:

1. Srimanta Pal and Suboth. C. Bhunia, Engineering Mathematics, Oxford University Press, New Delhi, 2015.

2. Erwin Kreyszig, “Advanced Engineering Mathematics”, 9th Edition (2014), John Wiley& Sons.
3. T. Veerarajan, “Engineering Mathematics (For First Year)”, (2006), McGraw Hill Education.
4. P. Sivaramakrishnadas, C. Vijayakumari, “Engineering Mathematics”, 1st Edition (2017), Pearson Education
5. T. Veerarajan, T. Ramachandran, “Numerical Methods”, 1st Edition (2018), McGraw Hill Education.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2											1		
2	3	2		1									1		
3	3	3											1		
4	3	3											1		
5	3	3	1	1									1		
AVG.	3	2.6	0.2	0.4									1		

1-low, 2-medium, 3-high

SEMESTER I

23FYP112	PHYSICS FOR MECHANICAL ENGINEERS I	L	T	P	C
		2	1	0	3

MODULE I KINEMATICS **6+3**

Rest and Motion-Motion in a straight line, plane and space-Change of frame- Newton's Laws of motion-First law of motion-Second law of motion-Working with Newton's first and second Law-Newton's third law of motion - Pseudo forces-constraint equation- Centre of Mass- Centre of Mass of Continuous Bodies- Motion of the Centre of Mass.

MODULE II ROTATIONAL MECHANICS **6+3**

Moment of Inertia-Theorems on Moment of Inertia-Rotation of a rigid body-Rotational dynamics-Torque of a force about the axis of rotation-Bodies in equilibrium-Angular momentum-Conservation of angular momentum-Angular impulse-Kinetic energy of a Rigid body rotating about a given axis-Work done by a torque-Combined rotation and translation.

MODULE III MECHANICAL PROPERTIES OF SOLIDS **6+3**

Modulus of Elasticity – types-Poisson's ratio-Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength (mechanical and thermal) - torsional stress and deformations – twisting couple - Introduction to ductility- malleability- hardness- toughness.

MODULE IV HARMONIC OSCILLATIONS **6+3**

Oscillatory Motion - Simple Harmonic Motion (SHM) - expression for velocity, acceleration and energy of the particle executing SHM-Simple and Torsional Pendulum - Composition of two simple harmonic motions-Damped oscillations-underdamped, critically damped and over damped oscillations-Forced Oscillations-Resonance.

MODULE V INTRODUCTION TO FLUID MECHANICS **6+3**

Fluid definition - Properties - Newtonian and Non-Newtonian Fluids – Compressibility - Surface tension - Fluid pressure and Pascal's law - Manometry - Buoyancy and Archimedes Principle - Fluid kinematics, Fluid Dynamics and Classification of Fluid Flow (descriptive treatment).

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Study the fundamentals of Newtonian mechanics including kinematics, relative motion, work and constraints.

CO2: Understand the basic concepts of rotational dynamics such as moment of inertia, torque, angular momentum, rotation about fixed axis, combined translation and rotation.

CO3: Analyze the mechanical properties of solids subjected to stress, strain and its various effects.

CO4: Elaborate the aspects of waves and oscillations and to analyze the phenomenon of forced, damped, driven and harmonic oscillations.

CO5: Define and classify a fluid, explain fluid properties such as viscosity, pressure, compressibility, surface tension.

CO6: Explain Pascal's law and Archimedes' Principle and solve simple problems in fluid statics, distinguish between fluid kinematics and fluid dynamics, and classify fluid flow.

TEXT BOOKS:

1. "Concept of Physics Part – I" by H.C Verma, Bharati Bhawan, 2022.
2. "Engineering Physics" Ist Edition by Bhattacharya, D.K. & Poonam, Oxford University Press, 2015.

REFERENCES:

1. "Basic Mechanics" by Bhattacharya. B," New Age International (P) Ltd, 2012.
2. "Engineering Mechanics: Principles of Statics and Dynamics" by R C Hibbeler," Pearson Education; 2006.
3. White "Fluid Mechanics", F.M, 9th Edition Tata McGraw Hill, 2022.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	1			1	1		1	2	1	1
2	3	2	1	1	1	1			1	1		1	2	1	1
3	2	3	1	1	1	1			1	1		1	2	1	1
4	3	1	1	1	1	1			1	1		1	2	1	1
5	2	2	1	1	1	1			1	1		1	2	1	1
6	2	1	1	1	1	1			1	1		1	2	1	1
Avg..	2.5	1.8	1	1	1	1			1	1		1	2	1	1

1-low, 2-medium, 3-high

SEMESTER I

23FYC112	CHEMISTRY FOR MECHANICAL ENGINEERS	L	T	P	C
		3	0	0	3

MODULE I HIGH POLYMERS AND INDUSTRIAL PLASTICS **9**

Polymerization: - Introduction- Plastics as engineering materials: Thermoplastics and Thermosetting plastics - Preparation, properties, and applications of polyethene, PVC, Bakelite Teflon and polycarbonates Elastomers: - Natural rubber- compounding and vulcanization – Synthetic rubbers: Buna S, Buna N, Thiokol and polyurethanes – Applications of elastomers. Composite materials & Fiber reinforced plastics. Biodegradable polymer – conducting polymers.

MODULE II FUEL TECHNOLOGY **9**

Fuels – Introduction – Classification – Calorific value – HCV and LCV – Dulong's formula – Bomb calorimeter – Numerical problems - Liquid fuels – Petroleum- Refining – Cracking – Synthetic petrol –Petrol knocking – Diesel knocking – Octane and Cetane ratings – Anti-knock agents – Power alcohol – Bio-diesel – Gaseous fuels – Natural gas, LPG and CNG. Rocket fuels.

MODULE III ELECTROCHEMICAL ENERGY SYSTEM **9**

Batteries- characteristics-construction and working of Lechlanche, lead-acid, nickel-cadmium, and lithium-ion batteries- supercapacitors. Batteries for automobiles, satellites, torpedos, computer standby supplies. Fuel cell- theory, working principle and applications of proton exchange membrane, direct methanol fuel cells and solid oxide fuel cells.

MODULE IV CHEMISTRY OF ADVANCED MATERIALS **9**

Nanomaterials: Introduction and classification of nanomaterials; preparation of nanomaterials - Sol-gel and Chemical vapour deposition method; applications of nanomaterials (industrial and medicinal). Carbon nanotubes (CNTs) - applications. Lubricants: classification- properties, mechanism of lubrication- additives and improvers. Solid lubricants (graphite and MoS_2). Refractories: characteristics – classification – alumina, magnesite, and zirconia bricks- applications.

MODULE V CORROSION AND PROTECTIVE COATINGS **9**

Introduction- Causes and effects of corrosion; Types of corrosion- chemical (oxidation corrosion) and electrochemical corrosion, factor affecting corrosion- Corrosion control methods - cathodic protection - sacrificial anodic protection and impressed current cathodic protection; protective coatings - galvanizing and tinning, electroplating (Cu plating) and electroless plating (Ni plating) - advantages and applications of electroplating/electroless plating.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Formulate and develop polymeric compounds used in various engineering materials for futuristic engineering applications.

CO2: Predict various types of fuels and design considerations of burners and control of emissions in combustion.

CO3: Relate the knowledge in operating principles of various types of batteries, including fuel cells and fabricate the same for sustainable development.

CO4: Apply the knowledge of advanced materials to find solutions for material science and engineering including nanotechnology.

CO5: Analyze the basic principles of corrosion and apply the suitable methods to control corrosion.

CO6: Apply the fundamental knowledge of advanced materials to energy and environmental applications.

TEXT BOOKS:

1. Engineering Chemsitry by P.C. Jain & M. Jain: Dhanpat Rai Publishing Company (P) Ltd, New Delhi. 17th Edition.
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Company Ltd., 46th Edition (2013).

REFERENCES:

1. Engineering Chemistry, by S. S. Dara, S. Chand & Company Ltd, New Delhi. 12th Edition. 2010.
2. Nano: The essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, Tata Mc Graw-Hill Publishing Company Limited, New Delhi, 2008
3. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Company Ltd., 46th Edition (2013).

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3										2		
2	3	3	3										2		
3	3		3				3						2		
4	3		3										2		
5	3	3	3										2		
6	3		3										2		
Avg..	**3**	**1.5**	**3**				**0.5**						**2**		

1-low, 2-medium, 3-high

SEMESTER I

23ME131	C - PROGRAMMING AND PROBLEM-SOLVING	L	T	P	C
		2	0	2	3

MODULE I INTRODUCTION TO PROGRAMMING 6

Introduction to programming paradigms Concept of algorithms – Flow Charts – Data Flow diagrams etc., Bits bytes – kilo – mega and gigabytes. Concepts of character representation – Number Systems & Binary Arithmetic.

MODULE II PROGRAMMING USING C 8+10

C data types – int, char, float – C expressions – arithmetic operation – relational and logic operations – C assignment statements – extension of assignment of the operations – C primitive input output using get char and put char – exposure to the scanf and printf functions – C Statements – Decision making within a program, Conditions - if statement, if-else statement, Switch statement, structured Programming.

PRACTICALS:

- Operators
- Decision Statements

MODULE III ITERATIONS AND SUBPROGRAMS 8+10

Concept of loops, examples of loops in C using for, while and do-while. One-dimensional arrays and examples of iterative programs using arrays, 2-d arrays use in matrix computations. Concept of Sub-programming, functions, Example of functions.

PRACTICALS:

- Control statements
- Functions
- Arrays

MODULE IV POINTERS, STRINGS, STRUCTURE & UNIONS 8+10

Pointers, relationship between arrays and pointers, Argument passing using pointers Array of pointers. Passing arrays as arguments. Strings and C string library. Structure and Unions. Defining C structures, passing strings as arguments, Programming examples using pointers.

PRACTICALS:

- Pointers
- Strings
- Structure

TOTAL (30+30): 60 PERIODS

COURSE OUTCOMES

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

CO1: Understand the fundamentals of programming and be able to write algorithms and flowcharts.

CO2: Implement different programming constructs, such as input/output statements and conditionals.

CO3: Develop modular applications using arrays and functions.

CO4: Define and use of pointers, and strings with simple applications.
CO5: Define and use of structure and union with applications.

TEXT BOOKS:

1. ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCES:

1. E. Balagurusamy, “Programming with ANSI-C”, 4TH Edition,2008, Tata McGraw Hill
2. Venugopal K. R and Prasad S. R, “Mastering ‘C’”, 3rd Edition, 2008, Tata McGraw Hill.
3. Raja Raman, “Computer Programming in C”, Prentice Hall of India, 1995.
4. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3						2			1	2		
2	3	1	3						2			1	2		
3	3	1	3						2			1	2		
4	3	1	3						2			1	2		
5	3	1	3						2			1	2		
AVG.	3	1	3						2			1	2		

1 - low, 2 - medium, 3 - high

SEMESTER I

23FPC121	BASIC SCIENCES LABORATORY I	L	T	P	C
		0	0	2	1

Part A - PHYSICS LABORATORY- I - LIST OF EXPERIMENTS

1. Torsional Pendulum-Rigidity Modulus.
2. Air Wedge-Thickness of thin wire.
3. Magnetic field along the axis of a current carrying coil.
4. Calibration of Voltmeter and Ammeter.
5. Figure of Merit of Galvanometer.

Part B - CHEMISTRY LABORATORY- I - LIST OF EXPERIMENTS

1. Estimation of Nickel Using Murexide Indicator Direct Method.
2. Determination of strength of given HCl using NaOH by pH measurement.
3. Determination of alkalinity of water.
4. Determination of equivalent conductance of a strong electrolyte.
5. Estimation of dissolved oxygen in water sample.

TOTAL: 30 PERIODS

Part A – PHYSICS LABORATORY I

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: The students will be able to determine the rigidity modulus of the material of the wire using torsional pendulum and will be able to find the thickness of a foil or thin wire by forming air wedge.

CO2: The students will be able to estimate the magnetic induction along the axis of a current carrying coil and will be able to determine the figure of merit of a table galvanometer and calibrate the given ammeter and voltmeter using a potentiometer.

CO3: The students will be able to find out the band gap energy of given semiconductor by studying voltage current characteristics.

CO-PO & PSO MAPPING

CO	PO1	PO 2	PO 3	PO4	POS	PO6	PO7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1		2				1	1						
2	2	1		2				1	1						
3	2	1		2				1	1						
AVG.	2	1		2				1	1						

1-low, 2-medium, 3-high

Part B - CHEMISTRY LABORATORY I

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1: Apply the principle involved in complexometric titration.

CO2: Use the principle involved in pH meter and determine the concentration of acid and base by exact neutralization.

CO3: Estimate the alkalinity of water sample and use the same for assessing the quality of water.

CO4: Handle analytical tools such as conductometer and pH meter.

CO5: Estimate dissolved oxygen present in water and assess the usage of water in boiler.

CO-PO & PSO MAPPING
(CHEMISTRY)

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1		1										1	
2	1	1		1										1	
3	1	1		1										1	
4	1	1		1										1	
5	1	1		1										1	
AVG.	1	1		1										1	

1 - low, 2 - medium, 3 - high

SEMESTER I

23ME121	ENGINEERING GRAPHICS FOR MECHANICAL ENGINEERS I	L	T	P	C
		0	0	4	2

MODULE I LETTERING AND DIMENSIONING

Principles of Engineering Graphics and their significance, usage of drawing instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning - Scales - Plain, Diagonal and Vernier scales. Introduction to AutoCAD (2D drafting) – draw, edit, dimensions, layers and template.

MODULE II CONSTRUCTION OF CONICS

Basic Geometrical constructions, Curves used in engineering practices - Conics – Construction of ellipse, parabola and hyperbola by directrix and rectangle method.

MODULE III CONSTRUCTION OF CYCLOIDS AND HELIX

Construction of cycloids – Construction of helix, spirals and involutes.

MODULE IV ORTHOGRAPHIC PROJECTION OF POINTS AND LINES

Introduction to orthographic Projections, Projection of points- Projections of lines - inclined to both planes (rotating line method), traces of lines.

MODULE V PROJECTIONS OF PLANES

Projections of planes - planes parallel to one of the reference planes - planes inclined to one reference plane and perpendicular to the other – inclined to both the planes - auxiliary projection.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Demonstrate the knowledge of BIS and ISO standards in engineering drafting.
CO2: Construct curves used in engineering practices.
CO3: Use computer aided tools to create technical drawing.
CO4: Interpret Orthographic projections of a given object.
CO5: Imagine and visualize details of engineering objects.

TEXT BOOKS:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.

REFERENCES:

1. **B**asant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edit ion, 2019.
2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., “Fundamentals of Engineering Drawing

with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2		2				1	1		2	1		
2	1	2	2		2				1	1		2	1		1
3	2		2		2				1	2		2	1		1
4	1		2		2				1	1		2	1		
5	1		2		2				1	3		3	1		1
AVG.	1.2	0.8	2		2				1	1.6		2.2	1		0.6

1 - low, 2 - medium, 3 - high

SEMESTER I

23ME122	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Perform planning and marking on a given wooden piece using carpentry tools
2. Preparation of wooden half- lap joint from the given silver oak wood
3. Perform filing and marking on a given mild steel sheet using fitting tools
4. Preparation of square joint from the given mild steel sheet
5. Perform shearing on a given GI sheet using sheet metal tools
6. Preparation of single seam panned - down joint from GI sheet
7. Preparation of double seam knocked - up joint from GI sheet
8. Perform external threading and prepare basic pipe connections on given PVC pipe using plumbing tools
9. Preparation of saddle connection to a house service line
10. Study of BIS symbols and applications of various electrical components
11. Preparation of a wiring circuit for a single lamp controlled by a single switch
12. Preparation of wiring circuit for dim and bright connection

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Gain practical experience in using various carpentry tools.

CO2: Utilize fitting techniques for household and industrial installations.

CO3: Prepare basic sheet metal components using appropriate tools.

CO4: Implement knowledge of pipeline connections in both residential and industrial buildings.

CO5: Apply fundamental electrical engineering skills to house wiring projects.

Reference Books:

1. Engineering Practices Laboratory Manual, CIT, 2023.

CO – PO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3					1						2	2	3	
2	3					1						2	2	3	
3	3					1						2	2	3	
4	3					1						2	2	3	
5	3					1						2	2	3	
AVG.	3					1						2	2	3	

SEMESTER II

23FYH211	PROFESSIONAL ENGLISH	L	T	P	C
		3	0	0	3

MODULE I FOCUS ON LANGUAGE: ENGLISH GRAMMAR & VOCABULARY **9**

Word Formation: Prefixes & Suffixes - Modal Verbs – Verb Preposition Combinations – Confusing Words – Abbreviations and Acronyms – Relative Clause – Pronouns – Cause and Effect Expressions – Purpose and Function – Conjunction - Common Errors and Redundancies-Contracted form of Verbs- Sentence Types and Clauses.

MODULE II READING **9**

Sequencing of Sentences – Cloze Reading – Reading Charts, Tables, Schedules and Graphs – Reading Newspaper Reports – Reading Advertisements – Reading Online content – Reading Official Letters and Profiles.

MODULE III WRITING **9**

Types of Paragraphs – Description – Describing Structures –Paragraph Construction - Paragraph Patterns – Kinds of Paragraph - Business Letters – Describing a Product– Proposal Writing –Memos –Gadget Review - Steps to Effective Précis Writing - Dialogue Writing – Writing Blogs.

MODULE IV LISTENING **9**

Types of Listening – Barriers of Effective Listening – Intensive Listening- Listening to Public Announcements – Listening to News Bulletins and Weather Forecasts – Listening to Speeches.

MODULE V SPEAKING **9**

Meetings - Negotiations: Types of Negotiation – Six Basic Steps of Negotiations – Informal and formal Negotiations - Expressing Preferences - Retelling an Incident – Controlling Nervousness & Stage Fright- Visual Aids in Presentation -Small Talk& Social Conversations - Making Enquires – Expressing Gratitude and Apologizing - Making Suggestions – Making Requests and Seeking Permission.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Interpret technical texts and construct grammatically correct sentences.
CO2: Comprehend the correct usage of Grammar and Vocabulary.
CO3: Read accurately to support comprehension.
CO4: Perceive the techniques of professional writing.
CO5: Develop Listening, Negotiation, and Presentation skills.
CO6: Demonstrate fluency and exhibit effective listening and writing skills.

TEXT BOOKS:

1. Steve Hart, Aravind R. Nair &Veena Bhambhani, “Embark – English for Undergraduates”, Cambridge University Press, 2016.
2. Meenakshi Raman, Sangeeta Sharma, “Technical Communication – Principles and Practice”, Oxford University Press, New Delhi, 2015.

REFERENCES:

1. Praveen Sam D & Shoba K N , “A Course in Technical English” Cambridge University Press, 2020.
2. Sudharshana N. P & Savitha C, “English for Engineers”, Cambridge University Press, 2018.
3. Lourdes JoavaniRayen&Shoba K N, “Communicative English”, Cambridge University Press, 2018.
4. Jack C Richerds, “Interchange - 2”, Cambridge University Press, Fourth Edition, Chennai, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1									2	3		1			
2									2	3		1			
3									2	3		1			
4									2	3		1			
5									2	3		1			
6									2	3		1			
AVG.									2	3		1			

1-low, 2-medium, 3-high

SEMESTER II

23FYH211	BASIC GERMAN	L	T	P	C
		3	0	0	3

MODULE I EINFUHRUNG **9**

BegrUung - Name - Vorname - Familienname - Anrede

MODULE II THEMA **9**

Hallo !Wiegeht's? – Begegnungen - Guten Tag, ichsuche…, - ImSupermarkt - Arbeit und Freizeit - Familie und Haushalt.

MODULE III GRAMMATIK-I **9**

des Verbs : Aussage, W - Frage und - Ja/Nein - Frage; Artikel die der das. - W - Frage; Konjugation in Prasens.

MODULE IV GRAMMATIK-II **9**

Nominativ : bestimmter, unbestimmter und negative Artikel - Akkusativ : unbestimmterundnegativerArtikel - Adjektive : Akkusativ-Erganzung.

MODULE V GRAMMATIK-III **9**

ArtikelalsPronomen Dative - Erganzung :Personalpronomen und Ortsangaben; ImperativModalverben; Ortsangaben; Richtungsangaben; Zeitangaben; OrdinalzahlenPossessiv - Artikel; trennbare und nicht trennbareVerben; Wechselprapositionen.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the fundamental concepts of the Language.
CO2: Perceive the basic grammatical rules.
CO3: Speak to communicate ideas.
CO4: Write simple narration and description.
CO5: Demonstrate confidence in Social Interactions

TEXT BOOKS:

1. Studio d A1: Kurs - und Ubungsbuch (Deutsch alsFremdsprache) CornelsenVerlag

REFERENCES:

1. Tangarmaktuell1 :Kursbuch + Arbeitsbuch (Deutsch alsFremdsprache) Max HueberVerlag

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1															
2															
3															
4															
5															
AVG.															

1-low, 2-medium, 3-high

SEMESTER II

23FYH211	BASIC FRENCH	L	T	P	C
		3	0	0	3

MODULE I **9**

Faire connaissance - inviter etrépondre à une invitation - décrire les personnes- articles définisetindéfinis - genre etnombre des nomset des adjectifs- interrogation et négation - conjugaison du présent. Paris monuments et lieux publics - la vie de quatreparisiens de professions différentes.

MODULE II **9**

Exprimer l' ordreetl'obligation demander et commander - evaluer et apprécier- féliciter et remercier - articles partitifs -adjectifsdémonstratifs et possessifsprépositions et adverbes de quantité et de l'imperatif verbespronominaux - unerégiondeFrance la Bourgogne - vie quotidienne à la compagne.

MODULE III **9**

Raconteretrapporter - donner son avis - se plaindreetréprimander - expliqueret justifier - pronomscompléments -futurproche - passé composé et imparfait. Plusieursrégions de France –différentsunivers sociaux.

MODULE IV **9**

Ferrous materials Demander l'autorisation - interdire - formuler des projects - discuteretdébattre. Pronoms< en >et< y > - pronomsrelatifs et superlatifs - conjugaison du futur

MODULE V **9**

présentcontinu et passé récent.La vie administrative, etrégionale - problems economiques et écologiques - traditions et modernité

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the fundamental concepts of the Language
CO2: Perceive the basic grammatical rules
CO3: Speak to communicate ideas.
CO4: Write simple narration and description.
CO5: Demonstrate confidence in Social Interactions

TEXT BOOKS:

1. Le Nouveau Sans Frontières - Philippe Dominique, Jacky GirardetMichèleVerdelhan, Michel Verdelhan

REFERENCES:

1. Dondo Modern French Course ---MathurinDondo

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1															
2															
3															
4															
5															
AVG.															

1-low, 2-medium, 3-high

SEMESTER II

23FYM212	FOURIER SERIES, TRANSFORMS, DIFFERENCE AND VECTOR CALCULUS	L	T	P	C
		3	1	0	4

MODULE I FOURIER SERIES **9+3**

Dirichlet's conditions - Full range Fourier series - Half range Fourier series - Complex form of Fourier series - Parseval's identity - Harmonic analysis.

MODULE II LAPLACE TRANSFORMS **9+3**

Transform of elementary functions - Transform of unit step, Dirac delta and periodic functions - Initial and final value theorems – Inverse Laplace transforms - Convolution theorem -Solution of linear second order ordinary differential equations with constant coefficients.

MODULE III Z- TRANSFORMS AND FOURIER TRANSFORMS **9+3**

Z-transforms - Properties (without proof) – Simple Problems - Inverse -transforms using partial fraction method- Definition of difference equation - Solution of difference equation with constant coefficients.

Fourier integral theorem (without proof) - Infinite Fourier transforms – Properties (without proof) - Infinite Fourier sine and cosine transforms - Parseval's identity.

MODULE IV DIFFERENCE CALCULUS **9+3**

Operators and their interrelations – Interpolations - Newton’s forward, Newton’s backward and Lagrange’s method – Numerical differentiation and integration- Trapezoidal rule - Simpson’s 1/3 rule - Simpson’s 3/8 rule.

MODULE V VECTOR CALCULUS **9+3**

Vector differentiation – Gradient, divergence and curl - Directional derivative – Solenoidal and Irrotational vector fields - Vector integration – Line, surface and volume integrals - Green's, Gauss and Stoke's theorems (statement only) –Simple applications involving cube and rectangular parallelepiped.

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Calculate both real and complex forms of Fourier series for solving boundary value problems.

CO2: Solve ordinary differential equations with initial and boundary conditions using Laplace transforms.

CO3: Apply Z- transforms to solve difference equations, calculate Fourier transforms and inverse transforms of functions and use them in follow-up courses of various engineering fields.

CO4: Apply difference calculus ideas in solving numerical differentiation and integration problems.

CO5: Assimilate ideas of vector differentiation, evaluate line, surface and volume integrals along with the classical theorems involving them.

TEXT BOOKS:

1. B.S. Grewal, “Higher Engineering Mathematics”, 42nd Edition, Khanna Publishers, 2012.
2. B.V.Ramana, “Higher Engineering Mathematics”, Kindle Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCES:

1. Srimanta Pal and Suboth. C. Bhunia, Engineering Mathematics, Oxford University Press,

New Delhi, 2015.
2. Erwin Kreyszig, “Advanced Engineering Mathematics”, 9th Edition (2014), JohnWiley& Sons.
3. T. Veerarajan, “Transforms and Partial Differential Equations”, (2016), McGraw Hill Education.
4. P. Sivaramakrishnadas, C. Vijayakumari, “Engineering Mathematics”, 1st Edition (2017), Pearson Education.
5. T. Veerarajan, T. Ramachandran, “Numerical Methods”, 1st Edition (2018), McGraw Hill Education.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2										1		
2	3	2	1										1		
3	3	2	1										1		
4	3	2		1									1		
5	3	2											1		
AVG.	3	2	0.8	0.2									1		

1-low, 2-medium, 3-high

SEMESTER II

23FYP211	PHYSICS FOR MECHANICAL ENGINEERS II	L	T	P	C
		2	1	0	3

MODULE I BASIC CONCEPTS OF THERMODYNAMICS 6+3

Basic Concepts–Macroscopic & Microscopic approach, Concept of Continuum, Thermodynamic system & control volume, Thermodynamic properties, quasi-static process, Thermodynamic Equilibrium. Temperature – Zeroth law of thermodynamics – Temperature scales – Statement of I law of thermodynamics – limitation of I law of Thermodynamics – Perpetual motion machine (PMM) of I kind - Kelvin Planck's and Clausius Statements of II law of thermodynamics.

MODULE II INTRODUCTION TO HEAT TRANSFER 6+3

Heat Transfer - Modes - Fourier's law of heat conduction - Newton's law of cooling - Stefan Boltzmann law – black body and gray body emission - Simple Problems – steady state conduction through plane wall – composite plane walls.

MODULE III QUANTUM MECHANICS 6+3

Black body radiation – Planck's theory (qualitative) – Compton Effect– wave particle duality – concept of wave function and its physical significance – Schrodinger wave equation- scanning electron microscope and transmission electron microscope.

MODULE IV LASER AND FIBER OPTICS 6+3

Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index,

To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.

and mode) – fiber optic communication system-fibre optic sensors: pressure and displacement.

MODULE V NOVEL ENGINEERING MATERIALS 6+3

Nano materials – Quantum size effect – Importance of Nano structured materials and Nano particles - Preparation of nano materials- ball milling method – sputtering, plasma, pulsed laser ablation - properties and applications. Shape memory alloys, principle, working and applications. Metallic glasses, preparation, properties and applications.

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Distinguish between macroscopic and microscopic approaches and define thermodynamic system and surrounding, properties; and classify thermodynamic system and properties.

CO2: State the Zeroth, First and Second laws of Thermodynamics and solve simple problems.

CO3: Explain and identify modes of heat transfer and solve simple problems.

CO4 Discuss basic quantum mechanics for solving relevant physical phenomena such as electron microscope and its application.

CO5: Explain physical principles of operation of lasers and optical fibers and illustrate their industrial applications.

CO6: Correlate properties of nanostructures with their size, shape and surface characteristics and

to explain the properties and applications of metallic glasses and shape memory alloys.

TEXT BOOKS:

1. "A Text Book of Engineering Thermodynamics" 5th Edition by R.K.Rajput, Laxmi Publications, 2016.
2. "A Textbook of Engineering Physics" by Avadhanulu M.N, Kshirsagar P.G, Arun Murthy. T.V.S, S.Chand & Company Ltd., New Delhi, 2018.

REFERENCES:

1. "Fundamentals of Engineering Thermodynamics" 8th Edition by M. J. Moran and H. N. Shapiro, Wiley, New York, 2014.
2. "Introduction to Engineering Materials" by Agarwal B.K., Tata McGraw-Hill Publishing Company, New Delhi, 2017.
3. "Solid State Physics" by Pillai. S.O, New Academic Science, 2022.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	1			1	1		1	2	1	1
2	3	2	1	1	1	1			1	1		1	2	1	1
3	3	3	1	1	1	1			1	1		1	2	1	1
4	3	1	1	1	1	1			1	1		1	2	1	1
5	2	2	1	1	1	1			1	1		1	2	1	1
6	3	2	1	1	1	1			1	1		1	2	1	1
Avg..	2.8	2	1	1	1	1			1	1		1	2	1	1

1-low, 2-medium, 3-high

SEMESTER II

23ME211	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I ELECTROMECHANICAL ENERGY CONVERSION DEVICES **9**

Induction Machines: Principles of operation of three phase induction motors –construction of squirrel cage and slip ring motors- comparison and applications - Principle of operation of single-phase induction motor – capacitor start motor – capacitor start and run motor -domestic centrifugal pump motor working.

MODULE II ELECTRICAL INSTALLATION **9**

Types of wiring system –single and three phase system – series and parallel connections - wiring accessories – Earthing – fluorescent tubes – CFL – Sodium vapor lamp – LED Bulbs – Simple domestic wiring layouts – staircase wiring – IE rules– Electrical safety -Tariff Calculation – Example – Protective devices (MCB, fuse, ELCB, HRC) – selection of wires.

MODULE III DISPLAY AND RECORDING DEVICES **9**

Cathode Ray Oscilloscope working and applications- Digital Storage Oscilloscope – Signal Generator – Function Generator– LED – LCD – Dot Matrix Displays– Digital Multi meter.

MODULE IV COMMUNICATION NETWORK AND PROTOCOLS **9**

Electromagnetic spectrum – Reference model – Network Types: LAN, WAN, MAN –Network Media: Coaxial, Twisted Pair, Fiber optic – Fiber optic cable precautions – Network Topologies: Ring, Star, Mesh – Bluetooth – Cellular Networks – Introduction to PLC: Block diagram. Programming. [Simple ON /OFF and timer logic ladder programming for motor start / stop applications), Zigbee networking techniques

MODULE V CASE STUDY **9**

Uninterrupted Power Supply –Block Diagram - Selection of UPS Rating – Selection of Batteries - simple UPS design for domestic as Case study. Public Address System – Microphone types – Loud speaker types.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Demonstrate the working of electrical motors using the electromechanical energy conversion concepts.

CO2: Apply the rules of the grammar and construct grammatically correct sentences. Acquire knowledge of domestic electrical wiring, accessories and smart digital energy meter for hybrid power source and compute energy bill for domestic and industrial consumers.

CO3: Illustrate public and industrial network communication, topology and protocols.

CO4: Demonstrate the industry automation with SCADA and DAS.

CO5: Design an energy backup and energy storage devices for domestic.

TEXT BOOKS:

1. Metha V. K., “Principles of Electrical Engineering”, S. Chand & Company Ltd., New Delhi, 2001.

2. Mittle V.M., " Basic Electrical Engineering", Tata McGraw Hill, New Delhi, 2001

REFERENCES:

1. Ian G. Warnock, "Programmable Controllers Operation and Application", Prentice Hall International, U.K 1992
2. Gary S. Rogers, "An Introduction to Wireless Technology", Pearson Education, 2012.
3. K. Sawhney, "A Course in Electrical and Electronic Measurements", Dhanapat Rai and Sons, New Delhi, 2004

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2											1		
2	3	2		1									1		
3	3	3											1		
4	3	3											1		
5	3	3	1	1									1		
AVG.	3	2.6	0.2	0.4									1		

1-low, 2-medium, 3-high

SEMESTER II

23ME212	MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

MODULE I CRYSTAL STRUCTURE AND IMPERFECTIONS **9**

Unit cells, Metallic crystal structures – Density computation, Polymorphism and Allotropy. Imperfection in solids: Point, line, surface and volume defects.

Dislocations and strengthening mechanisms – characteristics of dislocation - slip systems – dislocation by twinning. Grain size reduction – solid solution strengthening and strain hardening – recovery, recrystallization and grain growth.

MODULE II ALLOYS AND PHASE DIAGRAMS **9**

Constitution of alloys and phase diagrams - constitution of alloys - solid solutions - substitutional and interstitial. Phase diagrams, isomorphous, eutectic, peritectic, and eutectoid and peritectoid reactions. Iron-carbon equilibrium diagram. Classification of steel and cast iron - microstructure, properties and application.

MODULE III HEAT TREATMENT **9**

Heat Treatment - full annealing, stress relief, recrystallisation and spheroidizing - normalising, hardening and tempering of steel. Isothermal transformation diagrams - cooling curves superimposed on CCR diagram. Hardenability - Jominy end quench test - austempering, martempering.

Case hardening, Carburizing, nitriding, cyaniding, carbonitriding, flame and induction hardening - Ageing.

MODULE IV FERROUS AND NON-FERROUS MATERIALS **9**

Ferrous materials: Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - Stainless and tool steels - HSLA. Grey, white, malleable, spheroidal, graphite, alloy castiron, Maraging steels, bearing alloys.

Non-Ferrous materials: Copper and its alloys, Aluminium and its alloys, Nickel and its alloys, titanium and its alloys, super alloys: Ni based, Fe based and Co based.

Composite Materials: Metal matrix composites, preparation, properties and applications.

Selection of materials - Ashby's material property chart.

MODULE V NON-METALLIC MATERIALS **9**

Non-metallic materials - polymers, types of polymer, commodity and engineering polymers. Properties and applications of PE, 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 Al_2O_3, SiC, Si_3N_4, PSZ etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Identify crystal structures and their defects for a given material, and select a suitable strengthening mechanism and predict behaviour of given alloy.

CO2: Interpret the binary phase diagrams, to arrive at the relationship between thermodynamic

variables and microstructures.

CO3: Suggest suitable heat treatment process for ferrous alloys based on its applications.
CO4: Identify appropriate ferrous/nonferrous material for a given applications.
CO5: Identify suitable non-metallic material for a given application.

TEXT BOOKS:

1. W. D. Callister, Materials Science and Engineering-An Introduction, 6th Edition, Wiley India, 2018.
2. Agarwal B.K., Introduction to Engineering Materials, Tata McGraw-Hill Publishing Company, New Delhi, 25th reprint, 2018.

REFERENCES:

1. Avner S. H., "Introduction to Physical Metallurgy", Tata McGraw-Hill Publishing Company, New Delhi, 2nd Edition, 2017.
2. Lakhtin Y., Weinstein N., "Engineering Physical Metallurgy", University Press of the Pacific, 2017.
3. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice - Hall of India, 2018.
4. V. Raghavan, “Material Science and Engineering’, Prentice Hall of India Private Limited, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1											3		
2	2	2		2									2		
3	3	2		2									2		
4	3	2	2										2		
5	3	2	2	2									2		
AVG.	2.8	1.8	2.0	2.0									2.2		

1-low, 2-medium, 3-high

SEMESTER II

23FPC222	BASIC SCIENCES LABORATORY II	L	T	P	C
		0	0	2	1

Part A – PHYSICS LABORATORY - II LIST OF EXPERIMENTS

1. Young's Modulus-Cantilever
2. Laser –determination of wavelength and particle size
3. Study of the charging and discharging of a Capacitor
4. Determination of Specific Resistance – Potentiometer
5. Study of I-V characteristics of solar cell and determination of its efficiency.

Part B – CHEMISTRY LABORATORY - II LIST OF EXPERIMENTS

1. Determination of sodium in water samples by flame photometry.
2. Estimation of iron in water sample by spectrophotometry.
3. Determination of corrosion rate of steel in acid media by weight loss method
4. Estimation of acid in a mixture by conductometry.
5. Estimation of ferrous ion by potentiometric titration

TOTAL: 30 PERIODS

Part A - PHYSICS LABORATORY - II

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: The students will be able to estimate the Young's modulus of the material of a bar by cantilever method and will be able to calculate the wavelength of the laser light by using transmission grating.

CO2: The students will be able to study the charging and discharging characteristics of a capacitor and will determine the capacitance of the given capacitor and they will also be able to construct and verify basic logic gates.

CO3: The students will be able to determine the specific resistance of the material of the wire using potentiometer and will be able to determine the efficiency of a silicon solar cell and study its and characteristics.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1		2				1	1						
2	2	1		2				1	1						
3	2	1		2				1	1						
AVG.	2	1		2				1	1						

1-low, 2-medium, 3-high

Part B - CHEMISTRY LABORATORY - II

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1: Use the principle involved in flame photometry and determine the various alkali and alkaline earth metals.

CO2: Apply the principle involved in spectrophotometry and determine the amount of various metals present in water samples.

CO3: Determine the mixture of acids and assess the advantage of conductometric titration.

CO4: Apply the weight loss method to determine the rate of corrosion in engineering applications.

CO5: Apply the principle involved in potentiometry and understand the redox titration which could be useful for the energy applications.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1		1										1	
2	1	1		1										1	
3	1	1		1										1	
4	1	1		1										1	
5	1	1		1										1	
AVG.	1	1		1										1	

1 - low, 2 - medium, 3 - high

SEMESTER II

23ME221	ENGINEERING GRAPHICS FOR MECHANICAL ENGINEERS II	L	T	P	C
		0	0	4	2

MODULE I PROJECTION OF SOLIDS

Projection of Solids - Types of solids, projections of solids in simple positions - axis perpendicular to the Horizontal Plane (HP) - axis perpendicular to the Vertical Plane (VP) - axis parallel to both the HP and the VP - axis inclined to HP, axis inclined to VP and axis inclined to both HP and VP.

MODULE II CONVENTIONS & SECTION OF SOLIDS

Conventions for materials, hole types, internal and external threads, thread types, undercuts, grooves, chamfers, fillet radii and keyways. Conventions of various machine components. Sections – Regular solids – Prism, Cylinder, Pyramid, Cone - types of sectional views, sectioning.

MODULE III INTERSECTIONS OF SOLIDS

Intersections of Solids – Cylinder and cylinder – with and without offset, inclined and perpendicular, Cylinder and cone.

MODULE IV DEVELOPMENT OF SURFACES

Method of development – Right Regular solids – Prism, Pyramid, Cylinder and Cone.

MODULE V ISOMETRIC AND PERSPECTIVE PROJECTION

Principles of Isometric Projection, Isometric scale, Isometric views of simple solids - Conversion of Isometric views to Orthographic views and Vice-versa. Perspective projection - Terminology and Principles of perspective projection. Methods of perspective projection of various objects.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Draw regular solids using computer aided tools.

CO2: Draw, read and interpret sectional views of regular solid objects.

CO3: Visualize the solid objects obtained by combination of two or more solid objects.

CO4: Draw and Interpret isometric view of objects.

CO5: Communicate ideas through technical drawings.

TEXT BOOKS:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.

REFERENCES:

1. **B**asant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edit ion, 2019.
2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production,

Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	3		2				1	1		2	1		
2	1	2	3		2				1	1		2	1		1
3	1		2		2				1	1		2	1		
4	1		2		2				1	2		2	1		
5	1		3		2				1	3		3	1		1
AVG.	1	0.8	2.6		2				1	1.6		2.2	1		0.4

1 - low, 2 - medium, 3 - high

SEMESTER II

23FYH221	ENGLISH COMMUNICATION COMPETENCY LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

1. Speech Sounds
2. Vocabulary
3. Reading Comprehension
4. Listening Practice - I
5. Dialogue Writing
6. Conversational Exercise - I
7. Focus on Language
8. Creative Writing
9. Conversational Exercise –II
10. Listening Practice - II
11. Greeting; Thanking
12. Complaining, Apologizing; Congratulating
13. Asking; Giving Directions
14. Alphabet Series; Letter Series Word Formation
15. Para Jumbles
16. Synonyms and Antonyms
17. Sentence Completion; Correction
18. Presentation Skills
19. Group Discussion
20. Interview Skills

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1:Solve timed objective questions on logical reasoning and verbal ability.

CO2:Use appropriate functional expressions and converse effectively.

CO3:Assimilate meaning and comprehend text.

CO4:Perceive the nuances of Presentation, Interview and Group Discussion skills.

CO5:Generate language structures accurately and speak fluently.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1									2	3		1			
2									2	3		1			
3									2	3		1			
4									2	3		1			
5									2	3		1			
AVG.									2	3		1			

1 - low, 2 - medium, 3 - high

SEMESTER II

23FYC221	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		1	0	0	1

MODULE I NATURAL RESOURCES **3**

Forest resources: Use and over-exploitation and deforestation. Water resources: Use and over- utilization of surface and ground water. Dams - benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

MODULE II ENVIRONMENTAL POLLUTION **3**

Sources, causes, effects and management of air pollution and water pollution, soil pollution and radioactive pollution. Solid waste Management.

MODULE III ECOSYSTEM AND BIODIVERSITY **3**

Concept of an ecosystem- structure and functions- food chain and food webs. Biodiversity-types, Importance and values of biodiversity, India as a mega diversity nation, hot spots of biodiversity, Threats to biodiversity, conservation of biodiversity.

MODULE IV GREEN CHEMISTRY **3**

Significance of green chemistry-basic components of green chemistry. Industrial application of green chemistry-green fuels-e-green propellants and bio catalysts.

MODULE V GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT **3**

Water conservation, Rain water harvesting, Climate change, Ozone depletion, Acid rain, Greenhouse effect, and global warming. Disaster management- Earthquakes, Floods, Landslides, and cyclones.

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO1: Apply the concept of natural resources.

CO2: Implement remedial measures to control environmental pollution.

CO3: Discuss the concept of conserving the biodiversity.

CO4: Apply the components of green chemistry in the environment.

CO5: Develop remedies for global environmental issues.

TEXT BOOKS

1. S.S.Dara, “Text book of Environmental Chemistry and Pollution Control”, S.Chand & Company Ltd, New Delhi, 2011.
2. R. Rajagopalan, “Environmental Studies”, Oxford University Press New Delhi, 2015.

REFERENCES:

1. Anubha Kaushik & C.P, Kaushik, “Environmental Science and Engineering”, New Age International Publishers, 2nd Edition, 2006.
2. Benny joseph, “Environmental Studies”, Tata McGraw-Hill Publishing company Limited, New Delhi, 2018.
3. Surinder Deswal & Dr.Anupama Deswal, “A Basic course in Environmental Studies”, Dhanpat Rai & Co (P) Ltd, New Delhi, 2013.

CO-PO & PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1							3					1			
2							3					1			
3							3					1			
4							3					1			
5							3					1			
AVG.							3					1			

1-low, 2-medium, 3-high

SEMESTER III

23M312	COMPLEX VARIABLES AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

MODULE I ANALYTIC FUNCTIONS (9+3)

Function of a complex variable - Analytic functions - Properties - Construction of an analytic Function - Conformal mapping by elementary functions w = z + b, cz, 1/z and z2 - Bilinear transformation.

MODULE II COMPLEX INTEGRATION (9+3)

Cauchy's integral theorem and Cauchy's integral formula - Series expansions - Classification of singularities - Cauchy's residue theorem- Evaluation of real definite integrals by contour integration.

MODULE III PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Formation of partial differential equations – Solutions of first-order non-linear partial differential equations(standard types) - Lagrange's linear equations –Second and higher-order homogeneous linear equations with constant coefficients.

MODULE IV BOUNDARY VALUE PROBLEMS (9+3)

Method of separation of variables - One-dimensional heat flow equations with steady state and unsteady state solutions - Two-dimensional steady state heat equation in Cartesian coordinates.

MODULE V NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (9+3)

Difference Quotients – Graphical Representation of Partial quotients – Classification – One-dimensional heat equation: Explicit method - Bender Schmidt recurrence formula – Implicit Method -Crank Nicholson Difference Formula - Elliptic Equations by Liebmann's Iteration Process.

TOTAL (L= 45, T = 15) = 60 PERIODS

COURSE OUTCOMES

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

CO1: Represent and solve simple analytical functions using complex variables
CO2: Apply Cauchy's theorem and integral formulae to evaluate complex contour integrals
CO3: Construct and solve simple partial differential equations
CO4: Apply the method of separation of variables and solve the heat equation in Cartesian Coordinates
CO5: Numerically solve Partial Differential Equations

TEXT BOOKS:

1. B.S. Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, 2020.
2. B.V.Ramana, "Higher Engineering Mathematics", Kindle Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2018.

REFERENCE BOOKS:

1. Srimanta Pal and Suboth. C. Bhunia, Engineering Mathematics, Oxford University Press, New Delhi, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition John Wiley & Sons, 2017.
3. T. Veerarajan, "Transforms and Partial Differential Equations", McGraw Hill Education. 2016.

4. P. Sivaramakrishnadas, C. Vijayakumari, “Engineering Mathematics”, 1st Edition, Pearson Education, 2017.
5. T. Veerarajan, T. Ramachandran, “Numerical Methods”, 1st Edition, McGraw Hill Education, 2018.

Further Reading:

NPTEL

1. https://onlinecourses.nptel.ac.in/noc23_ma89/preview
2. https://onlinecourses.nptel.ac.in/noc23_ma94/preview

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2											1		
2	3	2		1									1		
3	3	3											1		
4	3	3											1		
5	3	3	1	1									1		
Avg..	3	2.6	0.2	0.4									1		

1-low, 2-medium, 3-high

SEMESTER III

23ME311	ENGINEERING MECHANICS	L	T	P	C
		3	1	0	4

MODULE I STATICS OF PARTICLES **9 + 3**

Principles of statics, Statics of Particles –System of forces, Moment of force, Varignon's Theorem, Couple, Transfer of Force to Parallel position, Composition of Concurrent coplanar forces, Equilibriant of a force System, Composition of Coplanar non- concurrent force system, x and Y intercepts of resultant, Newton's First Law of Motion, Types of forces on a body, free body diagram.

MODULE II RIGID BODY EQUILIBRIUM **9+ 3**

Rigid body equilibrium in space – Equation for equilibrium. Application of energy method for equilibrium, stability of equilibrium. Analysis of force and moments of the system – Analysis of trusses- Method of section and joints, beams – simply supported, cantilever, overhanging beams.

MODULE III SYSTEM OF PARTICLES **9 + 3**

First moment of mass/area of simple geometry using first principles – Centre of gravity – by moments, three-dimensional bodies – symmetrical – Unsymmetrical sections – solid bodies – bodies with cut holes. Centre of Mass of composite sections. Moment of Inertia – methods, by integration, polar moment of inertia, radius of gyration, - Parallel and perpendicular axis theorem - Moment of Inertia for geometries, composite sections, thin plates.

MODULE IV FRICTION **(9 + 3)**

Types of friction, static, dynamic, and angle of friction, Systems with friction – the Laws of Dry Friction, Coefficients of Friction. Applications of frictions – ladder friction, wedge friction, screw friction (relationship between effort and weight during lift and lowering), efficiency of screw jack.

MODULE V KINEMATICS OF PARTICLES **(9 + 3)**

Analysis of translatory and rotary motions, Displacement- Velocity- Acceleration for motion in a straight line- Projectile- Horizontal range, maximum height, velocity, direction of motion, and time of flight. Collision- Elastic and Inelastic, Newton's law of collision, Loss of kinetic energy during collision, direct and indirect impact of a body with a fixed plane

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Apply mathematics, science, and engineering principles to solve complex engineering problems, specifically in the analysis of forces within statically determinate structures.

CO2: Apply advanced analytical skills to assess the influence of forces on rigid bodies in equilibrium, showcasing a high level of proficiency in structural analysis

CO3: Apply and analyze mathematical techniques to compute the center of gravity and moment of inertia for both simple and composite geometries

CO4: Learn the fundamentals of friction and forces, and skillfully apply concepts related to frictional forces on contact surfaces in various engineering systems and mathematically resolve engineering problems

CO5: Adopt the principles of mechanics, to analyze the motion of particles in different conditions for various practical situations

Text Books:

1. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I – Statics, Vol II, - Dynamics, 12th Edition, Tata McGraw Hill, 2019.
2. Vela Murali, “Engineering Mechanics-Statics and Dynamics”, Oxford University Press, 2018

Reference Books:

1. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 14th Edition, 2017
2. S. S. Bhavikkatti, Engineering Mechanics, New age international, 2019.

Further Reading:

NPTEL

1. https://nptel.ac.in/courses/112/106/112106286/
2. https://nptel.ac.in/courses/112103109

Online Materials

1. https://www.digimat.in/nptel/courses/video/112106180/
2. https://examupdates.in/engineering-mechanics-notes/#engineering-mechanics-pdf-1st-year-notes-pdf
3. https://sctevtodisha.nic.in/wp-content/uploads/2021/03/Engineering-Mechanics-1st-yr-LM.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2			1	1				1	2	1	2
2	3	3	3	1	1	1						2	3	1	3
3	3	2	2	1	1		1	1			1	1	3	3	3
4	3	2	3		1	1		1		1		1	3		2
5	3	3	3	3	2	1	2	1	1	1	1	1	2	2	2
Avg..	3.0	2.6	2.8	1.8	1.3	1.0	1.0	1.0		1.0	1.0	1.2	2.6	1.7	2.4

1-low, 2-medium, 3-high

SEMESTER III

23ME312	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	1	0	4

MODULE I PURE SUBSTANCES **7 + 2**

Phases of a pure substance – P-V-T surface - property diagrams - Critical and Triple points - Property tables – Ideal gas - equation of state – Real gas - Compressibility factor – Vander-Waals equation of state – vapor pressure and phase equilibrium.

MODULE II FIRST LAW OF THERMODYNAMICS **7 + 2**

Non-flow Systems – Ideal gas processes – Vapor processes - problems -. Flow Systems – Mass balance - Steady Flow Energy Equation – Application to simple Steady flow devices.

MODULE III SECOND LAW OF THERMODYNAMICS **10 + 4**

Carnot Cycle – Reversed Carnot Cycle – Carnot's Theorem – Absolute Thermodynamic Temperature Scale - Thermal Reservoir – Heat Engine, Refrigerator and Heat pump –Second Law statements – PMM-2 - reversibility and irreversibility - Causes of irreversibility – Types of irreversibility

MODULE IV ENTROPY AND EXERGY **10 + 4**

Entropy – Clausius Theorem – Inequality of Clausius – Entropy of Isolated system – Third law of Thermodynamics - Tds relations – Entropy change of liquids and solids – Entropy change of ideal gases. Exergy – Reversible work and Irreversibility - simple problems - Second law efficiency

MODULE V THERMODYNAMIC RELATIONS AND IDEAL GAS MIXTURES **11 + 3**

Thermodynamics Relations - Gibbs and Helmholtz Functions, Maxwell Relations, Joule-Thomson expansion, Claussius - Clapeyron Equation Ideal Gas Mixtures–Mass and Mole Fractions, Dalton's Law of partial pressures, Amagat-Leduc law of additive volumes – Properties of Ideal Gas mixture

Total (45+15): 60 Periods

COURSE OUTCOMES

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

CO1: Depict various thermodynamic processes on property diagrams, estimate properties of mixtures, and quantify deviation from ideal gas behavior.

CO2: Apply the first law of thermodynamics to non-flow and flow processes involving simple systems.

CO3: Arrive at benchmark performances of heat engines, refrigerators, and heat pump

CO4: Compute changes in entropy and exergy

CO5: Apply thermodynamic relations to calculate property changes and evaluate properties of mixtures of ideal gases

Text Books:

1. Yunus A. Cengel, Introduction to Thermodynamics and Heat Transfer, McGraw-Hill Companies, Inc., 2nd Edition, 2017.
2. Nag P K., Engineering Thermodynamics, Tata McGraw Hill, 2019.

Reference Books:

1. Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill, 2018.
2. Jones and Dugan, Engineering Thermodynamics, Prentice Hall of India, 2018.
3. Van Wylen, Fundamentals of Thermodynamics, John Wiley and Sons, 9th Edition, 2018.
4. C. P. Kothandaraman and Domkundwar, A Course in Thermodynamics (Thermal Engineering), DhanpatRai and Co. Ltd., 2018.

Further Reading:

NPTEL

1. https://nptel.ac.in/courses/112/104/112104113/

ONLINE

2. https://www3.nd.edu/~powers/ame.20231/notes.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	2	1	-	-	-	-		3	3	1	1
2	3	3	2	1	2		-	-	-	-		3	3		1
3	3	3	3	2	2	1	-	-	-	-		3	3		1
4	3	3	3	2	2	1	-	-	-	-		3	3		2
5	3	3	2	2	2	1	-	-	-	-		3	3		1
Avg..	3	3	2.4	1.6	2	1						3	3	1	1.2

1-low, 2-medium, 3-high

SEMESTER III

23ME313	MANUFACTURING PROCESSES I	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF METAL CASTING [10]

Sand casting – Patterns: types - allowances for pattern - pattern materials - molds and mold making - Molding sand preparation, types, composition, properties & testing – core: making, core print - gating types - riser – Melting Practices: Electric arc and Induction furnaces – metals for casting – Casting quality: testing and defects.

Special casting processes: CO_2 Process - shell molding – expanded polystyrene process - Investment casting - plaster mold and ceramic mold process – Permanent mold casting - Die casting process - vacuum die casting - centrifugal casting - continuous casting - Squeeze casting –Thixo casting.

MODULE II METAL FORMING PROCESSES [9]

Nature of plastic deformation - Hot and cold working of metals - Forging operations - Open, impression, and closed die forging - forging defects – dies, hammers, and presses - Rolling of metals - rolling stand arrangement - Flat rolling and Shape rolling processes - rolling defects - Extrusion of metals – Hot and Cold extrusion – Types - Dies and presses – wire drawing - Rod and tube drawing – swaging – thread rolling processes.

MODULE III SHEET METAL OPERATIONS [7]

Sheet metal characteristics – Formability: tests - shearing operations – drawing - spinning – super plastic forming - sheet metal die: types, die construction, punch design – Bending: sheets, plates, tubes – stretch, and roll forming - Embossing and coining - rubber and hydro forming – special forming processes: Explosive forming, electromagnetically assisted forming, peen forming, laser forming, electrohydraulic forming - Equipment for sheet metal forming.

MODULE IV WELDING PROCESSES [10]

Fundamentals of welding - Gas Welding - Oxy-Fuel - Flame characteristics - Electric Arc Welding: consumable and non-consumable - electrode processes - Thermal cutting: Gas and arc cutting - Other Welding: Thermit Welding - Laser Beam welding - Electron Beam Welding Processes- Explosion welding – Solid state welding: Resistance Welding - Friction welding - Friction stir welding – explosion welding – diffusion bonding - Welding Defects – Brazing – Soldering – adhesive bonding.

MODULE V POWDER METALLURGY AND PLASTIC PROCESSING: [9]

Introduction to powder metallurgy – Production of metallic powder: reduction, atomization, Electrolysis, chemical method – Processing methods: Mixing and blending, Compacting, Sintering – Secondary operations – Advantages – other compaction methods.

Introduction to Plastic processing – Properties of plastics – Additives in plastics – Plastic materials: thermoplastics, thermosetting plastics – extrusion of plastics – injection moulding – blow moulding – thermoforming – compression moulding – transfer moulding.

Total: 45 PERIODS

COURSE OUTCOMES

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

CO1: Explain the operation of several casting processes and demonstrate their applicability in the manufacturing process and Demonstrate different metal casting processes

CO2: Attain proficiency in metal forming processes, demonstrating competence in hot/cold working, forging, rolling, and rectifying related defects.

CO3: Develop expertise in sheet metal operations, covering formability tests, shearing, die design, bending processes, and special forming techniques.

CO4: Demonstrate proficiency in welding processes, including gas and electric arc welding, defect identification, thermal cutting, and alternative methods like brazing and soldering.

CO5: Showcase understanding of powder metallurgy, plastic processing, and their applications, including metallic powder production, processing methods, plastic properties, and processing techniques.

Text Books:

1. Rao, P. N., “Manufacturing Technology - Volume 1, 5e”, McGraw Hill, 2019.
2. Kalpakjian, S. and Schmid, S. R, “Manufacturing Engineering and Technology” 7e, Pearson Education, 2018.

Reference Books:

1. Groover, M. P., “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Wiley India Pvt. Ltd.,2019
2. R. K. Rajput "A Textbook of Manufacturing Technology: Manufacturing Processes", 3rd Edition, Laxmi publications, 2018.
3. Sharma, P.C., “A Text book of production Technology”, S.Chand Publishing., 2022
4. Black J.T and Kosher R A, “DeGarmo’s Materials and Processes in Manufacturing”, India Edition, Wiley India, 2019.

Further Reading:

NPTEL

1. https://archive.nptel.ac.in/courses/112/107/112107219/
2. https://onlinecourses.nptel.ac.in/noc23_me90/preview

Online Materials

1. https://www.britannica.com/science/metallurgy/Powder-metallurgy

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1							1	3	2	1
2	3	2	3	2	1							1	3	2	1
3	3	2	2	2	1							1	3	2	1
4	3	2	2	2	2							1	3	3	1
5	3	2	2	1	1							1	3	2	1
Avg..	3.0	2.2	2.4	2.0	1.2							1.0	3.0	2.2	1.0

1-low, 2-medium, 3-high

SEMESTER III

23ME314	METROLOGY AND QUALITY CONTROL	L	T	P	C
		3	0	0	3

MODULE I BASICS OF METROLOGY, LINEAR AND ANGULAR MEASUREMENTS (09)

Basic concepts, the importance of metrology, standards of measurement, concepts of limits, fits & tolerances, precision and accuracy, sources of errors, linear measuring instruments - advantages & limitations of precision instruments. Angular measuring instruments - Slip gauges, comparators, dial indicator - calibration - Interchangeability - Taylor's principle, design of plug and ring gauges.

MODULE II THREAD AND GEAR METROLOGY (09)

Elements of screw thread, errors in threads, measurement of major diameter, minor diameter, effective diameter, pitch - floating carriage micrometer. Elements of gear, measurement of tooth thickness (constant chord method), gear tooth vernier, Measurement of pitch, profile errors, and total composite errors of gears.

MODULE III SURFACE FINISH MEASUREMENTS AND INTERFEROMETRY (09)

Surface Finish: Surface topography - definitions, measurement of surface finish stylus probe instruments – Talysurf profilometer and Tomlinson surface meter. Analysis of surface finish patterns - Center Line Average (CLA), Average roughness (Ra), Root Mean Square (RMS), Rz values, and their interpretation. Interferometry: principle, types of interferometers - Michelson, Twyman Green Specialisation of Michelson, NPL flatness Interferometer, The Pitter NPL gauge - laser interferometer. Optical projectors and microscopes.

MODULE IV STATISTICAL QUALITY CONTROL AND CONTROL CHARTS (09)

SQC, Seven QC tools, chance causes and assignable causes, case studies on application of SQC. Probability distributions - binomial, Poisson, geometric, hyper geometric, poisson as an approximation to binomial, normal as an approximation to binomial, Need for control charts, analysis of patterns of control charts, control charts for variables - X bar and R chart, control charts for attributes - p, np, C charts, evaluation of process capability.

MODULE V ACCEPTANCE SAMPLING AND RELIABILITY (09)

Sampling Inspection – concepts of acceptance sampling, sampling plans - simple - double – multiple and sequential sampling plans, Operating Characteristic (OC) curves – construction, average outgoing quality level, average total inspection, producer risk, and consumer risk. Reliability - definition, Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR), types of failure, failure rate, evaluation of reliability-series, parallel and series-parallel device configurations. Redundancy and improvement factors evaluations – Reliability Curve.

TOTAL: 45 PERIODS

Course Outcomes:

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

CO1: Demonstrate various linear and angular measuring instruments and design of gauges.

CO2: Measure elements of the screw thread and gear tooth parameters using a floating carriage micrometer and gear tooth Vernier caliper.

CO3: Perform surface finish measurement by stylus probe instruments and demonstrate various types of interferometers.

CO4: Apply SQC tools and analyze the data statistically using various control charts.
CO5: Select a suitable method to inspect and assess the quality of industrial products.

Text Books:

1. Mahajan, M, "A Textbook of Metrology", Dhanpat Rai & Sons, New Delhi, 2023.
2. Montgomery, D. C. "Introduction to Statistical Quality Control", John Wiley & Sons, 2019.

Reference Books:

1. Jain, R. K. "Engineering Metrology", Khanna Publishers, New Delhi, 2022.
2. Gupta, I. C, “Textbook of Engineering Metrology”, Dhanpat Rai & Sons, New Delhi, 2018.
3. Mahajan, M. “Statistical Quality Control”, Dhanpat Rai & Sons, New Delhi, 2021.
4. Gupta. R.C, “Statistical Quality control and Quality management”, Khanna Publishers, 2023.

Further Reading:

NPTEL

1. https://onlinecourses.nptel.ac.in/noc22_me75/preview
2. https://nptel.ac.in/courses/112107259

Online Materials

1. https://www.engineering.com/story/an-introduction-to-metrology-and-quality-in-manufacturing
2. https://enggkatta.com/category/metrology-and-quality-control/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1								2		
2	3	2	1	1	1								2		
3	2	2	2	2	1				1				1		
4	2	3	2	1	1				1				1		
5	2	3	2	1	2			2					2		1
Avg..	2.4	2.4	1.8	1.4	1.2			2.0	1.0				1.6		1.0

1-low, 2-medium, 3-high

SEMESTER III

23ME321	COMPUTER AIDED MACHINE DRAWING I	L	T	P	C
		0	0	4	2

MODULE I LIMITS, FITS AND TOLERANCES (10)

Limits fit, and tolerances - fundamental of deviations - shaft and hole terminology – representation of tolerances on drawing, calculation of minimum and maximum clearance and allowance, selection of fits -representation of fits. Geometric tolerance - uses, types of form and position tolerances, symbols - geometric tolerances. Surface finish symbols - surface roughness and textures

MODULE II ASSEMBLY DRAWING PRACTICE (20)

Assembly drawings - introduction – types of assembly - importance of BOM - assembly procedures - assembly drawings (examples) - Process Chart.

MODULE III COMPUTER AIDED MACHINE DRAWING (30)

Introduction to CAD - Drafting practice using basic commands - Practice using, editing, and modifying commands - Advanced editing commands - object controlling commands, hatching and blocks-Creating Text and Inquiry Commands & Geometric Dimensioning and System Variables Isometric Drawings, Advanced Drawing Commands, Script Files and Plotting Commands- Creation of 2D sectional drawing.

1. Drawing of Simple machine components.
2. Drawing orthographic views of simple blocks.
3. Drawing isometric views of simple blocks.
4. Drawing of 2D assembled machined components.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Demonstrate the knowledge of Limits Fits Tolerance in technical drawing
CO2: Create drafting practices using basic commands to draw the component.
CO3: Construct and edit models using commands (object controlling commands, hatching, and blocks) in drafting
CO4: Specify text, use commands for geometric dimensioning and system variables for the mechanical drawing
CO5: Develop the orthographic projections of mechanical components

Text Books:

1. CIT, VRET Training Centre Manual, AutoCAD Level-I, (Preliminary Level). 2023.
2. Gopalakrishnan K.R., “Machine Drawing”, 17th Edition, Subhas Stores Books Corner, Bangalore,2003

Reference Books:

1. Prof. Sham Tickoo, AutoCAD 2017 for Engineers and Designers, Dream Tech Press, 2017.
2. George Omura, Mastering AutoCAD 2019 and AutoCAD LT 2019, Wiley India Pvt. Ltd, 2019.

Further Reading:

NPTEL

1. http://www.nptelvideos.in/2012/12/computer-aided-design.html
2. https://archive.nptel.ac.in/courses/112/105/112105294/

Online Materials

1. https://www.youtube.com/watch?v=s9JIUSyu_O0

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3									1		3			
2				3			1								
3	2	2		2					2	2		2	2		1
4				2	2					3					
5	1								2						
Avg..	2.0	2.0		2.3	2.0		1.0		2.0	2.0		2.5	2.0		1.0

1-low, 2-medium, 3-high

SEMESTER III

23ME322	METROLOGY LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Measurement of linear dimensions of a given component using Vernier caliper, Vernier height gauge, and micrometer.
2. Measurement of taper angle using sine bar and slip gauges.
3. Measurement of external taper angle using slip gauges and Roller set.
4. Measurement of gear tooth parameters using gear tooth Vernier caliper.
5. Calibration of micrometer using slip gauges.
6. Calibration of dial gauge using dial tester.
7. Measurement of screw thread elements using profile projector and Tool maker's microscope.
8. Measurement of the effective diameter of a screw thread using 3 wire method (Floating Carriage Micrometer).
9. Construct a P chart for the given specifications and comment on the nature of the process.
10. Construct $\bar{X}$ and R chart for given specifications and comment on the nature of the process.

TOTAL: 30 PERIODS

LIST OF EQUIPMENT

1. Combination Set 2
2. Depth Gauge (0-150 mm) 1
3. Dial indicator (0.01mm) 6
4. Dial indicator (0.001 mm) 1
5. Dial indicator Stand 2
6. Dial Tester 1
7. Flange Micrometer (0-25 mm) 2
8. Flange Micrometer (25-50 mm) 4
9. Floating Carriage Micrometer 1
10. Gear Tooth Vernier 3
11. Inside Micrometer (0-25 mm) 1
12. Magnetic Base 2
13. Michelson interferometer 1
14. Micrometer (0-25 mm) 4
15. Micrometer (25-50 mm) 4
16. Micrometer (0-25 mm) (Digital) 1
17. Optical Flat 1
18. Profile Projector 1
19. Sine bar (100 mm) 2
20. Sine bar (300 mm) 1
21. Slip Gauge Set 2
22. Surface Plate 3
23. Three wire set (0.17 to 3.2 mm) 1
24. Tool Maker's Microscope 1
25. Vernier caliper (0-150 mm) 2
26. Vernier Caliper (0 - 150mm) (Digital) 1
27. Vernier height Gauge (0-300 mm) 2

COURSE OUTCOMES

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

CO1: Calculate and compare various linear and angular measurements using a Vernier caliper,

Vernier height gauge, micrometer, sine bar, roller set, and slip gauges.

CO2: Calculate various gear tooth parameters of a given spur gear using the gear tooth Vernier caliper.

CO3: Calibrate micrometer and dial gauge.

CO4: Measure various screw thread elements like major diameter, minor diameter, and effective diameter and pitch using a profile projector, tool maker's microscope, and floating carriage micrometer for a given threaded component.

CO5 Interpret and analyze data for various control charts used in the industry like P chart, $\bar{\mathbf{X}}$ chart, and R chart.

Reference Book:

1. Metrology Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	3		1	1		1	2	2		2	2	
2	2	2	2	3		1	1		1	2	2		2	2	
3	2	2	2	3		1	1		1	2	2		2	2	
4	2	2	2	3		1	1		1	2	2		3	2	
5	2	2	2	3		2	2		1	2	2		3	2	
Avg..	2.0	2.0	2.0	3.0		1.2	1.2		1.0	2.0	2.0		2.4	2.0	

1-low, 2-medium, 3-high

SEMESTER III

23ME323	MOULDING AND WELDING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Estimate the grain fineness number of the given moulding sand.
2. Calculate the Permeability and Compressive Strength of the Moulding Sand.
3. Preparing a green sand mould for a solid pattern / split pattern.
4. Preparing a green sand mould for a core / self-core pattern.
5. Preparing a green sand mould for a loose piece pattern.
6. Prepare “Butt Joint/lap joint” using MMAW Process and prepare a welding procedure specification (WPS Sheet) & report on post weld inspection.
7. Develop a WPS Sheet for making “T Joint/ Corner Joint” using the TIG/MAG welding Process perform visual inspection on weld bead and record welding defects.
8. Prepare a lap Joint on the given work pieces using spot welding equipment.
9. Demonstration of gas welding process.
10. Prepare a simple joint of Aluminium plates by friction stir welding process

TOTAL: 30 PERIODS

LIST OF EQUIPMENT

1. Sieve Shaker - 1 No
2. Permeability Meter - 1 No
3. Compression Strength tester - 1 No
4. Moulding tools set - 5 Nos
5. Moulding Table - 5 nos
6. MMAW Machine - 2 Nos
7. GMAW Machine - 2 Nos
8. Gas welding equipment - 1 No
9. Friction stir welding machine - 1 No

COURSE OUTCOMES

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

CO1: Evaluate the characteristics of moulding sand, including grain fineness, permeability, and compressive strength, to determine its suitability for various casting applications.

CO2: Develop and demonstrate skills in preparing green sand moulds for different pattern types, including solid, split, core/self-core, and loose piece patterns, ensuring effective mould-making for casting processes.

CO3: Create and implement Welding Procedure Specifications (WPS) for various welding processes (MMAW, TIG, MAG, and Spot Welding) and joint types (Butt Joint, Lap Joint, T Joint, and Corner Joint), ensuring proper documentation and adherence to welding standards.

CO4: Conduct thorough visual inspections and post-weld assessments to identify and record welding defects, ensuring the quality and integrity of welded joints across different welding processes.

CO5: Gain hands-on experience with advanced welding techniques, including gas welding and friction stir welding, understanding their practical applications, benefits, and safety considerations in various industrial contexts.

Reference Book:

1. Moulding and Welding laboratory Manual, CIT,2023

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	2		1			1	2	2		1	2	1	
2	3	1	2		1			1	2	2		1	2	1	
3	1	3	2		1			1	2	2		1	2	1	
4	2	1	1		1			1	2	2		1	3	1	
5	2	3	2		1			1	2	2		1	3	1	
Avg..	2.0	1.8	1.8		1.0			1.0	2.0	2.0		1.0	2.4	1.0	

1-low, 2-medium, 3-high

SEMESTER IV

23ME	APPLIED THERMODYNAMICS	L	T	P	C
		3	1	0	4

MODULE I IC ENGINE CYCLES AND PERFORMANCE TESTING **7 + 3**

Air Standard Otto, Diesel, and Dual Cycles – Efficiency, mean effective pressure. Testing and performance of internal combustion engines

MODULE II GAS TURBINES CYCLES **7 + 3**

Ideal and actual Brayton cycle - open and closed cycle gas turbines - modifications in Brayton cycle - regeneration - compressor inter-cooling - turbine reheat.

MODULE III RECIPROCATING COMPRESSORS **9 + 3**

Working principle - equations for shaft work and efficiencies - effect of clearance on volumetric efficiency. Working principle of multistage reciprocating compressors, inter-cooler, optimum intermediate pressure in a two-stage compressor, and performance of multi-stage compressor.

MODULE IV STEAM POWER CYCLES AND STEAM NOZZLES **11 + 3**

Ideal and actual Rankine cycle - superheat - reheat - regeneration. Steam nozzles - Application of steady flow energy equation, the effect of friction. Pressure compounding and Velocity compounding of turbines (descriptive treatment only).

MODULE V PSYCHROMETRY **11 + 3**

Atmospheric air - Psychometric Properties - Dry Bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, Saturated Air, Vapour pressure, Degree of saturation -Adiabatic Saturation, Carrier's Equation – Psychrometric chart.

TOTAL (45+15) = 60 PERIODS

COURSE OUTCOMES

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

CO1: Develop expressions for air-standard Otto and Diesel cycles, and compute the performance of IC engines for a given data.

CO2: Analyze the Brayton cycle and estimate numerical values of performances for simple and modified cycles.

CO3: Compute performance parameters for reciprocating compressors and compare performances of single and two-stage compressors.

CO4: Analyze the performance of simple ideal and non-ideal, and modified Rankine cycles, flow of steam through nozzles using Steam Tables and Mollier chart; and explain compounding of steam turbines.

CO5: Estimate changes in enthalpy and humidity during sensible heating, cooling, humidification, and dehumidification processes, for specified air-conditioning requirements using a Psychrometric chart and compare those obtained through relations.

Text Books:

1 Yunus A. Cengel, Introduction to Thermodynamics and Heat Transfer, McGraw-Hill Companies, Inc., 2nd Edition, 2017.

2 Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill, 2018.

Reference Books:

1 Richard E. Sonntag, Claus Borgnakke, Gordon J. Van Wylen, Fundamentals of Thermodynamics, 9th Edition, Wiley, 2018.
2 Kothandaraman C. P. and Domkundwar, Thermodynamics and Thermal Engineering, Dhanpat Rai and Sons, 2018.
3 Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai and Sons, 2018.
4 Ganesan V., Internal Combustion Engines, Tata McGraw-Hill, 2017.

Further Reading:

NPTEL

1 https://nptel.ac.in/courses/112/103/112103275/
2 https://archive.nptel.ac.in/courses/112/106/112106314/

Online Materials

1 https://netl.doe.gov/sites/default/files/gas-turbine-handbook/1-1.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1		2		2			2	2	1	
2	3	3	2		1		2		2			2	2	1	
3	3	3	2		1		2		2			2	2	1	
4	3	3	2		1		2		2			2	2	1	
5	3	3	2		1		2		2			2	2	1	
Avg..	3.0	3.0	2.0		1.0		2.0		2.0			2.0	2.0	1.0	

1-low, 2-medium, 3-high

SEMESTER IV

23ME	ELECTRICAL MACHINES AND DRIVES	L	T	P	C
		2	0	2	3

MODULE I ELECTRIC DRIVES: FUNDAMENTALS AND CHARACTERISTICS **9**

Introduction - Basic Elements - Types of Electric Drives – Multi quadrant operation – Dynamic conditions of electric drive – Power rating - Factors influencing the choice of electrical drives - Heating and Cooling curves - Loading conditions and Classes of duty - Selection of power rating for drive motors - Load variation factors - Mechanical characteristics of various types of load.

MODULE II DC AND AC DRIVES **12**

DC Drive: Concept of Converter and Chopper - Single phase and three phase converter fed DC drives – Chopper Fed DC drives (Step down, Step up, and Four Quadrant)

AC Drive: Concept of VSI, CSI, and Cyclo converter –Three Phase Inverter - Variable Frequency Drives: Scalar control (V/F), Vector Control, Rotor Resistance Control, Slip power recovery scheme.

Microprocessors-based intelligent Control of AC and DC Drive system.

MODULE III APPLICATIONS **9**

Selection of Motor and Drive Systems for Industrial Applications: Cranes and Hoist, Machine Tools, Electric Traction, Centrifugal Pumps, Air compressors, Paper and Pulp Industry, Textile Industry, Steel Industry.

TOTAL = 30 PERIODS

PRACTICAL:

LIST OF EXPERIMENTS

1. Speed Control of Three-Phase Squirrel Cage Induction Motor.
2. Dynamic Braking and Reverse Current Braking Characteristics of DC and AC Motors.
3. Speed Control of the Stepper motor and BLDC motor
4. Speed Control of Induction Motor using Scalar and Vector Controlled Drive
5. Analysis of Power Consumption Saving of a Compressor Motor using Variable Frequency Drive

TOTAL (L=30, P=30): 60 PERIODS

COURSE OUTCOMES

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

CO1: Analyze the load dynamics and performance characteristics of the drive for different applications and adjust the drive parameters to match the characteristics of the motor with the load.

CO2: Develop the control schemes for any electric drive according to industrial and environmental standards

CO3: Apply suitable speed control techniques for drive motors by using suitable controllers in DC and AC drives

CO4: Select the Motor and Drive System for different industrial applications

CO5: Experimentally determine the braking characteristics of DC and AC motors.

CO6: Demonstrate the speed control of DC and AC motors by using a suitable drive and perform the speed control techniques for special electric machines by using a suitable drive.

Text Books:

1 S.K. Pillai, "A First Course on Electrical Drives", 4th Edition, New Age International Publishers, 2022.

2 Gopal K. Dubey, “Fundamentals of Electric Drives”, Narosa Publications, Second Edition, New Delhi, 2002.

Reference Books:

1 Vedham Subramanyam, "Electric Drives Concept and Applications", 3rd Edition, Tata McGraw-Hill Publishing Company, 2012.

2 B.K.Bose, “Modern Power Electronics and AC drives”, Prentice-Hall of India Pvt.Ltd, 2005

3 M.D.Singh, “Power Electronics”, McGraw Hill Education, Second Edition, 2013.

4 Sen P.C., “Principles of Electrical Machines and Power Electronics”, John Wiley Publications Private Limited, 3rd Edition, 2013

Further Reading:

NPTEL

1. NPTEL Lecture videos – Fundamentals of Electrical drives

Online Materials

1. MIT professional education – Lecture series – Design of Drive systems

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3			1		2		2			2	2		
2	3	3							2			2	2		
3	3				1				2			2	2		
4	3				1		2		2			2	2		
5	3	3			1		2					2	2		
Avg..	3.0	3.0			1.0		2.0		2.0			2.0	2.0		

1-low, 2-medium, 3-high

SEMESTER IV

23ME	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	1	0	4

MODULE I FLUID PROPERTIES AND FLUID STATICS **9+3**

Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies.

MODULE II GOVERNING EQUATIONS OF FLUID MOTION; DIMENSIONAL ANALYSIS **9+3**

Fluid acceleration; differential equations of continuity and momentum; Euler & Bernoulli's Equations; Stream-function, velocity potential, vorticity. Dimensional analysis - Buckingham's Pi theorem - applications - similarity laws and models.

MODULE III LAMINAR BOUNDARY LAYER AND ELEMENTARY TURBULENT FLOW **9+3**

Flow of viscous fluid through circular pipe - Flow of viscous fluid between two parallel plates - Turbulent flow - Reynolds Experiment - Darcy Weisbach equation. Boundary layer - boundary layer thickness - displacement thickness, momentum thickness, and energy thickness.

MODULE IV PIPE FLOW AND MEASUREMENT **9+3**

Flow through pipes, head losses in pipes bends and fittings. Flow and velocity measurement - venturi, orifice, pitot tubes.

MODULE V FLUID MACHINERY **9+3**

Classification of Fluid Machines, Euler Turbomachine equation, Velocity triangles, Centrifugal Pumps - working principle and performance; Rotary Pumps - classification; Reciprocating pump - working principle. Turbines - Pelton, Francis and Kaplan Turbines - Working Principle and Performance.

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Explain fluid properties, apply principles of manometry, and analyze the stability of floating bodies.
CO2: Develop conservation equations for fluid flow and perform dimensional analysis
CO3: Analyze the laminar boundary layer over a flat plate and distinguish between laminar and turbulent flows.
CO4: Estimate head loss through pipes and explain velocity measurement using venturimeter, orifice meter, and Pitot tubes.
CO5: Analyze turbines and pumps using velocity diagrams.

Text Books:

1. Fox R W, Mc Donald A and Pritchard, Introduction to Fluid Mechanics, Wiley, 2018.
2. F. M. White, Fluid Mechanics, 8th Edition, McGraw Hill India, 2019.

Reference Books:

1. Modi, P. M. and S. M. Seth, Hydraulics and Fluid Mechanics Including Hydraulics Machines, 22nd Edition, Standard Book House, 2019.
2. John. M. Cimbala Yunus A. Cengel, Fluid Mechanics: Fundamentals and Applications, 4th Edition, McGraw-Hill, 2019.

3. Muralidhar, K. and Biswas, G., Advanced Engineering Fluid Mechanics, Alpha science international limited, 3rd Edition, New Delhi, 2018.
4. Bansal, R. K., A textbook of Fluid Mechanics and Hydraulic Machines, Lakshmi Publications, 9th Edition (revised), 2018.

Further Reading:

NPTEL

1. https://nptel.ac.in/courses/112/104/112104117
2. https://nptel.ac.in/courses/112/105/112105206/

Online Materials

1. https://www.khanacademy.org/science/physics/fluids
2. https://ocw.mit.edu/courses/2-06-fluid-dynamics-spring-2013/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3		1		2		2			2	3	2	
2	3	3			1		2						3	2	
3	3	3			1		2		2				3	2	
4	3	3	3		1		2		2			2	3	2	
5	3	3	3		1				2			2	3	2	
Avg..	3.0	3.0	3.0		1.0		2.0		2.0			2.0	3.0	2.0	

1-low, 2-medium, 3-high

SEMESTER IV

23ME	MANUFACTURING PROCESSES II	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF MATERIAL REMOVAL PROCESSES [10]

Material removal processes classification - mechanics of metal cutting, orthogonal and oblique cutting - Mechanism of chip formation, Types of chips - Cutting tools Nomenclature - Machining forces and Merchant circle diagram (MCD) – Material removal rate - Simple Problems. Cutting tool materials: Properties, Types - Thermal aspects of machining - tool wear and tool life - Simple Problems, cutting fluids: Properties, Types.

MODULE II MACHINE TOOLS [12]

Centre lathe: specification, cutting tools, types, operations – taper turning methods - thread cutting methods - attachments - machining time and power estimation. Reciprocating machine tools: shaper, planer, slotter - constructional features – types. Milling machine: constructional features – operations – types - Indexing: Simple, compound, differential, and angular indexing. Drilling Machine: Constructional features – types – reaming. Broaching machines – types.

MODULE III ABRASIVE MACHINING AND FINISHING OPERATIONS [6]

Abrasive machining processes: Constructional features – grinding operations – types of grinding machines - grinding wheel nomenclature - grinding wheel selection – Honing – Lapping – Super finishing operations.

MODULE IV CNC MACHINES [9]

Fundamentals of NC technology – NC machines: Components and Classification - Adaptive control machine systems - Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centers – Computer aided programming – program languages – DNC.

MODULE V NON-TRADITIONAL MACHINING PROCESSES [8]

Need for non-traditional machining, Principle, equipment & operation of Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electro Chemical Machining, Electron Discharge Machining, Laser Beam, Electron Beam Machining, and Plasma Arc Machining.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- **CO1:** Explain and classify material removal processes, analyze metal cutting mechanics, and solve problems on material removal rate, tool wear, and tool life.
- **CO2:** Operate various machine tools (lathe, shaper, planer, slotter, milling, drilling, broaching) and perform machining time and power estimation.
- **CO3:** Master abrasive machining processes and finishing operations, including grinding, honing, lapping, and super finishing.
- **CO4:** Demonstrate CNC machine components, classification, and control systems, and perform computer-aided programming and operations.
- **CO5:** Illustrate principles and operations of non-traditional machining processes like Ultrasonic, Abrasive Jet, Water Jet, Electro Chemical, EDM, Laser Beam, Electron Beam, and Plasma Arc Machining.

Text Books:

1. Rao, P. N., “Manufacturing Technology - Volume 2, 5e”, McGraw Hill, 2019.
2. Kalpakjian, S. and Schmid, S. R, “Manufacturing Engineering and Technology” 7e, Pearson Education, 2018.

Reference Books:

1. Groover, M. P., “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Wiley India Pvt. Ltd.,2019
2. R. K. Rajput "A Textbook of Manufacturing Technology: Manufacturing Processes", 3rd Edition, Laxmi publications, 2018.
3. Sharma, P.C., “A Textbook of production Technology”, S.Chand Publishing., 2022
4. Black J.T and Kosher R A, “DeGarmo’s Materials and Processes in Manufacturing”, India Edition, Wiley India, 2019.

Further Reading:

NPTEL

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

Online Materials

1. https://www.fcusd.org/cms/lib/CA01001934/Centricity/Domain/4529/Fundamentals%20of%20Modern%20Manufacturing%20Materials%20%20Processes%20and%20Systems%20%204th%20Edition.pdf
2. https://soaneemrana.org/onewebmedia/Manufacturing%20Processes%20By%20H.N.%20Gupta.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1							1	3	2	1
2	3	2	3	2	1							1	3	2	1
3	3	2	2	2	1							1	3	2	1
4	3	2	2	2	2							1	3	3	1
5	3	2	2	1	1							1	3	2	1
Avg..	3	2	2.25	1.75	1.25							1	3	2.25	1

1-low, 2-medium, 3-high

SEMESTER IV

23ME	STRENGTH OF MATERIALS	L	T	P	C
		3	1	0	4

MODULE I DEFORMATION IN SOLIDS **9 + 3**

Hooke's law, stress and strain- tension, compression, and shear stresses- elastic constants and their relations – strain energy – proof resilience- volumetric, linear and shear strains- Thermal stresses-toughness and elastic recovery- principal stresses and principal planes- Mohr's circle.

MODULE II SHEAR FORCE AND BENDING MOMENTS – STRESSES IN BEAMS **9 + 3**

Transverse loading on beams- shear force and bending moment diagrams – singularity functions - simply supported and over-hanging beams, cantilevers. Theory of bending of beams - bending stress distribution - neutral axis, shear stress distribution for different loadings.

MODULE III DEFLECTION OF BEAMS **9 + 3**

Differential equations of elastic curve – Deflection by integration – singularity functions – deflection by superposition, Maxwell's reciprocal theorems.

MODULE IV TORSION **9 + 3**

Torsion, stresses, and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses, and deflection of helical springs.

MODULE V STRESS IN CYLINDERS, SHELLS AND COLUMNS **9 + 3**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure, critical load of long and slender columns, short columns, eccentric loading of different columns with end conditions.

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

- **CO1**: Identify the state of internal effects caused by external loads acting on real bodies that undergo deformation (stress & strain).
- **CO2**: Determine stresses in beams and draw shear force and bending moment diagrams of simple beams subjected to various loading conditions and also calculate the bending stress and shear stresses produced by non-uniform bending.
- **CO3**: Calculate slope and deflection in beams using the integration method.
- **CO4**: Apply the basic equation of torsion in designing shafts and helical springs.
- **CO5**: Compute stresses in thin and thick cylinders, spherical shells for applied pressures, and columns with different end conditions.

Text Books:

1. R. Subramanian, Strength of Materials, Oxford University Press, 2018.
2. Rattan S S, Strength of Materials, 3rd Edition, Tata McGraw Hill, 2017.

Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2017
2. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata

McGraw-Hill Publishing Co. Ltd., New Delhi 2017.

Further Reading:

NPTEL

1. https://nptel.ac.in/courses/112/102/112102284/
2. https://nptel.ac.in/courses/105/105/105105108/

Online Materials

1. https://nptel.ac.in/courses/105/106/105106172/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1		2		2			2	3	2	1
2	3	3	3	3	1		2		2			2	3	2	1
3	3	3	3	3	1		2		2			2	3	2	1
4	3	3	3	3	1		2		2			2	3	2	1
5	3	3	3	3	1		2		2			2	3	2	1
Avg..	3.0	3.0	3.0	3.0	1.0		2.0		2.0			2.0	3.0	2.0	1.0

1-low, 2-medium, 3-high

SEMESTER IV

23ME	COMPUTER AIDED MACHINE DRAWING II	L	T	P	C
		0	0	2	1

COMPUTER AIDED MACHINE DRAWING AUTOCAD **6**

Solid Modelling and the User Coordinate System (WCS, UCS) - Viewports, Model space, Paper space, and Layouts - External Reference – Line type Creation, Simple and Complex, Advanced Rendering.

PARAMETRIC CAD SOFTWARE AUTODESK INVENTOR **24**

2D Sketch – Line, Circle, Arc, Ellipse, Rectangle, Polygon, Text dimension, Project Geometry, Fillet, Chamfer, Offset, Trim, Extend, Mirror, Rotate, 2D Constrain – 3D Model – Part Model, Reference Planes, Reference Point, Reference axis – Extrude, Revolve, Lofts, Holes – Assembly – Place Constraints, Mate, Flush, Angle, Tangent, Insert, Symmetry – 2D Drawing – Views, Exploded view, Bill of Materials..

List of Experiments

1. 3D Solid Modelling of a given component - Model 1
2. 3D Solid Modelling of a given assembly - Model 2
3. Creating line types
4. 3D Solid Modelling of a given part model – Model 3
5. 3D Solid Modelling of a given assembly – Model 4
6. Generation of Part Drawing from 3D components.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

CO1: Demonstrate the knowledge of the solid model and user coordinates
CO2: Create drafting practices using layout, line, and Rendering
CO3: Construct and edit models using 2D sketch and project geometry
CO4: Specify text, use commands for geometric dimensioning and system variables
CO5: Develop the 3D model of a given component

Text Books:

1. CIT, VRET Training Centre Manual, AutoCAD Level-II, (Intermediate Level), 2023.
2. Autodesk Inventor 2023, SDC – Publications L. Scott Hansen Ph.D.
3. Autodesk Inventor 2023 by Cadartifex – Sandeep Dogra – John Willis

Reference Books:

1. Prof. Sham Tickoo, AutoCAD 2017 for Engineers and Designers, Dream Tech Press, 2017.
2. George Omura, Mastering AutoCAD 2019 and AutoCAD LT 2019, Wiley India Pvt. Ltd, 2019.

Further Reading:

NPTEL

1. http://www.nptelvideos.in/2012/12/computer-aided-design.html
2. https://archive.nptel.ac.in/courses/112/105/112105294/

Online Materials

1. https://www.youtube.com/watch?v=s9JIUSyu_O0

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3									1		3			
2				3			1								
3	2	2		2					2	2		3	2		1
4				2	2					3					
5	2								2						
Avg..	2.3	2.0		2.3	2.0		1.0		2.0	2.0		3.0	2.0		1.0

1-low, 2-medium, 3-high

SEMESTER IV

23ME	FLUID MECHANICS AND MACHINERY LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Venturimeter - Determination of coefficient of Discharge.
2. Pipe friction - Determination of coefficient of Friction.
3. Minor losses - Determination of coefficient of Losses.
4. Determination of coefficient of discharge - Rectangular notch, Orifice & Mouth piece.
5. Verification of Bernoulli's Theorem.
6. Performance test on Centrifugal pump
7. Performance test on Reciprocating pump
8. Performance test on Jet pump and Submersible pump
9. Performance test on Pelton wheel
10. Performance test on Francis turbine

TOTAL = 30 PERIODS

LIST OF EQUIPMENT

1. Petlon Wheel Turbine - 1 No
2. Jet Pump System - 1 No
3. Venturi meter - 1 No
4. Orifice meter - 1 No
5. Francis Turbine - 1 No
6. Centrifugal Pump – 1 No.
7. Pipe Friction Apparatus – 1 No.
8. Reciprocating Pump – 1 No.
9. Jet Pump – 1 No.
10. Submersible Pump – 1 No.
11. Rectangular Notch – 1 No.
12. Mouthpiece – 1 No.

COURSE OUTCOMES

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

CO1: Determine the coefficient of discharge of flow measurement devices - venturi meter, orifice meter, notches, and mouthpiece using Bernoulli's equation.
CO2: Experimentally estimate major and minor losses in pipelines.
CO3: Prove Bernoulli's theorem experimentally.
CO4: Experiment on centrifugal pump, reciprocating pump, jet pump, and submersible pump to evaluate their performances.
CO5: Experiment on the Pelton wheel and Francis turbine to evaluate their performances.

Reference Books:

1. Fluid mechanics and machinery laboratory manual, CIT, 2023

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		3	1		2					2	3	2	
2	3	3		3	1		2					2	3	2	
3	3	3		3	1		2					2	3	2	
4	3	3		3	1		2					2	3	2	
5	3	3		3	1		2					2	3	2	
Avg..	3.0	3.0		3.0	1.0		2.0					2.0	3.0	2.0	

1-low, 2-medium, 3-high

SEMESTER IV

23ME	MATERIAL CHARACTERIZATION AND TESTING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

1. Evaluation of grain size, and morphology of Stainless steel, Cast Iron, Aluminum, and Copper alloys.
2. Identification of microstructure of the post-weld heat-treated SMA welded mild steel material.
3. Measurement of the hardness of polymer composites using Shore A & Shore D hardness tester.
4. Determination of the effect of quenching on hardenability in a given material using the Jominy End Quench Test Apparatus.
5. Detection of surface crack using magnetic particle tester.
6. Study of Microstructure of different materials and chemical composition using Field Emission Scanning Electron Microscope (FESEM).
7. Calculate Young's modulus and rigidity modulus for a given steel using the Tension test & shear test.
8. Measurement of the hardness of different materials by performing a Hardness test on sample metal specimens.
9. Determination of the energy absorbed by the steel material during the Impact flexure test & ultimate torsional stress using the torsion test.
10. Measurement of the deflection of the helical spring and calculation of the spring constant using compression Test on helical spring.
11. Computation of the flexural rigidity of the material with different cross sections using Bending test on beams.

TOTAL = 30 PERIODS

LIST OF EQUIPMENT

1.	Metallurgical microscope	- 8 Nos
2.	Electric furnace	- 1 No
3.	Rockwell hardness tester	- 2 Nos
4.	Variable speed Single disc polishing machine	- 6 Nos
5.	Magnetic particle testing set	- 1 No
6.	Jominy End Quench apparatus	- 1 No
7.	Universal testing machine	- 2 Nos
8.	Hardness testing Equipment	- 3 Nos
9.	Torsion testing machine	- 1 No
10.	Impact testing machine	- 2 Nos

COURSE OUTCOMES

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

CO1: Evaluate the grain size and morphology of ferrous and non-ferrous materials.
CO2: Perform the hardness measurement of heat-treated steels.
CO3: Identify the surface crack using Non-Destructive Testing (NDT) methods.
CO4: Conduct a tension, shear, impact, hardness, and torsion test for a given specimen and calculate the various mechanical properties.
CO5: Calculate the stiffness for a given helical spring with different cross sections.

Reference Book:

1. Material Characterization and Testing Laboratory manual, CIT, 2023

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2					2		2		3	1	3
2	3	2	2	2					2		2		3	1	3
3	3		2		2				2		2		2	1	3
4	3	2		3	1				1		1		3	1	3
5	3	2	3	3	1				1		1		3	1	3
Avg..	3.0	2.0	2.5	2.5	1.3				1.6		1.6		2.8	1.0	3.0

1-low, 2-medium, 3-high

SEMESTER V

23ME	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	1	0	4

MODULE I DESIGN FUNDAMENTALS FOR MACHINE ELEMENTS 9 + 3

Introduction to design process factors influencing machine design – material selection, stress-strain diagram, axial, bending, torsional loading, and the factor of safety. Eccentric loading, principal stresses, theories of failure - stress concentration - fatigue - S-N curve, Soderberg and Goodman equations - equivalent stress, combined variable stress.

MODULE II DESIGN OF SHAFTS AND COUPLINGS 9 + 3

Forces on shafts due to gears and belts - design of solid and hollow shafts based on strength, and torsional rigidity - critical speed - Design of square and taper key. Design of rigid and flexible flange couplings, - applications.

MODULE III DESIGN OF ENERGY STORING ELEMENTS 9 + 3

Springs – Types and design of helical and concentric springs. Design of leaf springs - stress and deflection equation. Design of flywheel - fluctuation of speed - energy stored - stresses in rim and arms - punching machines.

MODULE IV DESIGN OF JOINTS 9 + 3

Welded joints - the strength of butt and fillet weldments subjected to axial and eccentric loads.

Riveted joints - joints of uniform strength, eccentrically loaded riveted joints. Design of longitudinal and circumferential boiler joints.

MODULE V DESIGN OF BEARINGS 9 + 3

Design of hydrodynamic and hydrostatic bearings - effect of friction under uniform pressure and wear conditions – theory of lubrication - selection of deep groove and angular contact ball bearings.Introduction to needle and air-thrust bearings.

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Demonstrate knowledge of various theories of failure applied to different loading conditions and design suitable machine elements for a given application
CO2: Design a shaft and coupling to transmit specified power.
CO3: Design the springs and flywheel.
CO4: Design part to withstand specific loads under joining conditions.
CO5: Select a suitable bearing for the specific application.

TEXT BOOKS:

1. Robert L Mott., "Mechanical Elements in Mechanical Design", 6th Edition, Macmillan Publishing Co., London, 2018
2. V. B. Bhandari, "Design of Machine Elements", 5th Edition, Tata McGraw-Hill Publishing Ltd., New Delhi, 2020.

REFERENCES:

1. S. S. Wadhwa, Er. S. S. Tolly, "Machine Design", 3rd Edition, Dhanpat Rai & Co, Delhi, 2012.
2. Robert L Norton, "Machine Design - An Integrated Approach", 5th Edition, Prentice Hall, New Delhi, 2018.
3. Shigley J. E. and Mischkee C. R., "Mechanical Engineering Design", 10th Edition, McGraw-Hill, Inc., New Delhi, 2014.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", 7th Edition, Wiley, 2019

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3					1	1			2	3	2	2
2	2	2	3					1	1			2	3	2	2
3	2	2	3					1	1			2	3	2	2
4	2	2	3					1	1			2	3	2	2
5	2	2	3					1	1			2	3	2	2
AVG..	2	2	3					1	1			2	3	2	2

SEMESTER V

23ME	HEAT TRANSFER	L	T	P	C
		3	1	0	4

MODULE I CONDUCTION – BASIC EQUATIONS – STEADY STATE 12 + 3

Introduction – overview of basics law of heat transfer - General three-dimensional heat conduction equations – Cartesian – cylindrical –spherical coordinates equation deduced to one-dimensional heat conduction - steady state Conduction – one dimensional – uniform – nonuniform thermal conductivities – with and without heat generation -temperature and heat flow through on - plan wall – hollow cylinder – hollow sphere – Composites - Overall Heat transfer coefficient - Insulation – Critical Thickness.

MODULE II CONDUCTION – EXTENDED SURFACES AND TRANSIENT STATE 9 + 3

Heat transfer on the extended surface – fins – different geometry –application – one-dimensional equation of different physical situations - temperature distribution – heat transfer and performance analysis of various materials and geometry – fin efficiency and effectiveness -comparisons. Unsteady state - heat transfer - Lumped parameter analysis - heat transfer analysis by using Heisler Charts.

MODULE III CONVECTION 9 + 3

Introduction to principle of convection – overview of dimensionless analysis – concepts of flow over the regions – laminar and turbulent - Forced convection: hydrodynamic boundary and thermal boundary layer –mean and bulk mean temperature – fluid properties - flow over flat, cylinder and sphere – internal flow - heat transfer coefficient - heat transfer rate calculation using empirical correlations. Free Convection:-Vertical surfaces – Horizontal surfaces - heat transfer coefficient – internal flow - heat rate calculation using empirical correlations.

MODULE IV HEAT EXCHANGERS 8 + 3

Introduction - Classification of heat exchangers – LMTD - Parallel, counter, and cross-flow - multi-pass flow - fouling factor – Effectiveness (ε)– NTU method relations for heat exchangers – performance analysis of heat transfer on LMTD and ε-NTU methods and comparisons with flows.

MODULE V RADIATION 7 + 3

Thermal radiation – overview the basic laws - different surfaces - emissivity-absorptivity-reflectivity - transmissivity - Intensity of radiation - emissive power - view factor – heat transfer analysis for simple geometries and surfaces - Radiation shield.

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Deduce and estimate temperature distribution and heat transfer rate for one-dimensional steady state heat transfer problems in different geometries with concepts of thermal conductivities and heat generation and understating of the overall heat transfer rate.

CO2: To understand and apply analytical techniques to the analysis of the temperate distribution and heat transfer rate of various materials and different configurations geometry and extend the concepts and ability to apply graphical techniques to find the temperature distribution and heat transfer rate in transient conduction problems.

CO3: Choose appropriate empirical correlations for convective heat transfer to determine the heat transfer coefficients and heat rates under the flow over surfaces and inlet flow with forced and

free convection.

CO4: To calculate different radiative properties associated with heat transfer and apply them to understand the radiation shield.

CO5: To estimate and analyze the heat transfer rate for different heat exchangers using LMTD and ε-NTU methods.

TEXT BOOKS:

1. Rajput, R.K., "Heat and Mass Transfer", S.Chand Publishers, 2002.
2. Mashesh M.Rathore., Engineering Heat and Mass Transfer., Laxmi Publication., New Delhi-2008

REFERENCES:

1. Holman. J.P. "Heat Transfer", McGraw Hill Book Co., SI Version, 1986.
2. C.P.Kothandaraman, S.Subramanyan " Heat and Mass Transfer Data Book", New age international publishers, 2010 (Latest Edition)
3. Frank P. Incropera, David P, Dewitt, " Heat and Mass Transfer", John Wiley and Sons (ASIA) Pvt.Ltd.,2008
4. M.Thirumaleshwar, Fundamentals of Heat & Mass Transfer- Pearson Education – 2006
5. P.K.Nag., Heat and Mass Transfer – Tata McGraw-Hill Publishing Company Limited – New Delhi,2008

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2			1	2	1	1		1	2		
2	3	3	2	2				1		1		1	2		
3	3	3	2	2				1		1		1	2		
4	3	3	2	2				1		1		1	2		
5	3	3	2	2		1	1	1		1		1	2		
Avg..	3	3	2	2		1	1	1.2	1	1		1	2		

1-low, 2-medium, 3-high

SEMESTER V

23ME	KINEMATICS OF MACHINERY	L	T	P	C
		3	1	0	4

MODULE I FUNDAMENTALS OF MECHANISMS 9 + 3

Kinematic links – Pairs – Lower and Higher pairs - Degrees of freedom, mobility-Grubbler's equation. Grashof's law - Kinematic inversions of four bar chains and slider crank chains. Study of Quick return mechanism, straight line generators- Universal Joint- Ratchet and Paul mechanism.

MODULE II KINEMATIC AND DYNAMIC ANALYSIS OF MECHANISMS 9 + 3

Displacement, velocity, and acceleration analysis of four bar and slider crank mechanisms - loop closure equations – instantaneous center of rotation- graphical method - Coriolis component of acceleration – static force analysis – dynamics of four bar mechanism – slider crank – piston effect.

MODULE III CAMS AND FOLLOWERS 9 + 3

Classification - Displacement diagrams - Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions - specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile.

MODULE IV GEARS AND GEAR TRAINS 9 + 3

Gear terminologies, a fundamental law of gearing, the effect of pressure angle, length of the path of contact, length of the arch of contact, contact ratio, Phenomenon of interference, Types of gear trains, simple gear train, compound gear train, epicyclic gear train, velocity ratio of epicyclic gear train, torques and tooth loads in epicyclic gear train.

MODULE V FRICTION IN MACHINE ELEMENTS 9 + 3

Surface Contact – Sliding and rolling friction – Friction Drives – Friction Clutches – Belt and Rope Drives – Friction in Brakes – Band and Block Brakes.

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Apply the basic concept of kinematic principles, degree of freedom, and rigid-body dynamics of kinematically driven machine components.

CO2: Understand and formulate the principles of kinematics to analyze the motion of machine components, including velocity, acceleration, and displacement

CO3: Understand and apply the cam design basics, apply principles to create displacement diagrams for diverse follower motions, and adeptly design specified contour and circular cams.

CO4: Understand and formulate the basic concepts of gear kinematics, demonstrating the ability to analyze and design various gear trains for practical and modern engineering applications

CO5: Understanding of the fundamental principles of belts, brakes, clutches, and ropes, enabling them to analyze, develop safe design, and apply these components in various engineering contexts for societal safety

TEXT BOOKS:

1. Thomas Bevan, "The Theory of Machines", Pearson Education, 3rd Edition, Ltd., 2009"

2. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 2017.

REFERENCES:

1. Ashoke G Ambekar, “Mechanism and Machine theory” PHI Learning, 2018
2. Cleghorn. W. L., Nikolai Dechev, “Mechanisms of Machines”, Oxford University Press, 2015
3. Jayakumar. V, “Theory of Machines”, Lakshmi Publications, 2019.
4. Sayyad F B, Kinematics of Machinery, Techknowledge publications, 2016

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1	1			2	3		2	3		2
2	3	3	3	1	1	1	1		2	3		2	2	1	2
3	3	3	3	1	1	1	3		2	3		2	2		1
4	3	3	2	2	1	1	1		2	3		2	1		2
5	3	3	1	2	2	1	1		1	3		2	1		1
Avg..	3.0	3.0	2.3	1.5	1.3	1.0	1.5		1.8	3.0		2.0	1.5	1.0	1.5

1-low, 2-medium, 3-high

SEMESTER V

23ME	APPLIED THERMODYNAMICS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Construction of Port timing (2S) diagram
2. Performance test on four-stroke multi-cylinder petrol engine (MPFI) and plot the performance graphs
3. Heat balance test on four-stroke single-cylinder diesel engine and plot the graphs
4. Determination of volumetric efficiency of reciprocating air compressor and plot the graph of Volumetric efficiency vs. pressure
5. Determination of viscosity of lubricating oil - Redwood viscometer 2
6. Performance test on vapor compression refrigeration (VCR) system
7. Performance test on four-stroke Single cylinder engine (VCR) and plot the Performance Graphs.
8. Construction of Valve timing (4S) diagram for a single-cylinder engine
9. Performance test on Heat Pump and predict the COP of the system
10. Calibration of Pressure and Vacuum gauge and plot the error.
11. Identify the components of the Boiler and performance test of the Turbine

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Identify and explain the components and mechanisms of IC engines, reciprocating compressors, and refrigeration systems.

CO2: Conduct performance tests on IC engines, reciprocating compressors, and refrigeration systems.

CO3: Evaluate the performance of refrigeration systems.

CO4: Estimate heat transfer parameters, including radiant factor, emissivity, and free and forced convection heat transfer coefficients.

CO5: Conduct performance tests on pin-fin, and heat exchangers (including Plate Heat Exchanger and Shell and Tube Heat Exchanger), and estimate the thermal conductivity of different solids.

Reference Book:

1. Applied Thermodynamics Laboratory Manual, CIT,2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3		1	2			1	3		1	1	2	
2	1	3		1		1	2	1			1				1
3	2	2	2			1				2		1	1		
4	3	1		3		1			3		1			2	1
5	1		1		2		1	3	1			1	2	1	1
Avg..	1.8	2.0	1.5	2.0	2.0	1.0	1.5	2.0	2.0	2.0	1.0	1.0	1.5	1.5	1.0

1-low, 2-medium, 3-high

SEMESTER V

23ME	FINITE ELEMENT ANALYSIS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Introduction to ANSYS Environment
2. Study of Mesh Generation and Types.
3. Static Structural Analysis
    a. Structural analysis of bars of constant cross-section, tapered cross-section, and stepped bar.
    b. Structural analysis of trusses. (Normal Load and Inclined Load).
    c. Structural analysis of beams (Simply Supported Beam and Cantilever Beam) with point load, UDL, and varying load.
    d. Structural analysis of a rectangular plate with a circular hole.
4. Modal Analysis
    a. Modal and Harmonic analysis of beams.
    b. Modal Analysis of a Plate.
5. Heat Transfer Analysis
    a. Heat Transfer of rod with conduction.
    b. Heat Transfer in Axisymmetric pipe with conduction.
    c. Heat Transfer in a Fin.
6. CFD Analysis
    a. Flow Analysis in a Nozzle

TOTAL: 30 PERIODS

LIST OF SOFTWARE:

1. ANSYS Academic Teaching Mechanical & CFD 2023 R2

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Acquire a fundamental understanding of ANSYS software and its essential tools, and delve into the principles and various types of mesh generation for engineering simulations.

CO2: Analyze bars, trusses, and beams under various loads to assess structural stability

CO3: Conduct modal and harmonic analyses on beams and plates to understand dynamic behavior.

CO4: Investigate heat transfer in rods, pipes, and fins, with a focus on comprehending the mechanisms of conduction and convection.

CO5: Investigate velocity, pressure distribution, and flow patterns in a nozzle using Computational Fluid Dynamics.

Reference Book:

1. Finite Element Analysis Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	3			2					3		1
2	3	3	2	2	3			2					3		1
3	3	3	2	2	3			2					3		1
4	3	3	2	2	3			2					3		1
5	3	3	2	2	3			2					3		1
Avg..	**3**	**3**	**2**	**2**	**3**			**2**					**3**		**1**

1-low, 2-medium, 3-high

SEMESTER V

23ME	LATHE AND SPECIAL MACHINES LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Study of workshop layout and machines
2. Prepare a component by Lathe machine using operations like Plain, Step Turning, knurling, and chamfering and Calculate the machining time.
3. Machine a tapered surface in a cylindrical object by taper turning method, drilling, and Convex / concave profile turning process using a centre lathe machine. Prepare a dimensional inspection report for the component produced.
4. Thread cutting and eccentric turning using a lathe machine.
5. Cutting force measurement using a lathe tool dynamometer in a centre lathe machine for different cutting conditions.
6. Manufacture a spur gear / helical gear using a universal milling machine/gear hobbing machine. Prepare a dimensional inspection report for the component produced.
7. Generate different holes and make threads by tapping using a drilling machine also make square keyways using the slotting machine. Prepare a dimensional inspection report for the component produced.
8. Produce a cube/stepped slide/ male and female stepped slide/angular slide/curve slide using a shaping machine also Prepare a dimensional inspection report for the component produced.
9. Generate a square / a pentagon / a hexagon, / a triangular head using the vertical milling machine. Prepare a dimensional inspection report for the component produced.
10. Prepare a Plane surface using a surface grinding machine.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Demonstrate knowledge of safety procedures and best practices in workshop environments.
CO2: Expound the function and operation of various machines commonly found in a workshop.
CO3: Perform lathe operations to produce a component and calculate machining time using given parameters like cutting speed, feed rate, and depth of cut.
CO4: Create various profiles using Shaping, drilling, grinding, and milling machines.
CO5: Develop a process plan for a given product.

Reference Book:

1. Lathe and Special machines Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	2		1			1	2	2		1	2	1	
2	3	1	2		1			1	2	2		1	2	1	
3	1	3	2		1			1	2	2		1	2	1	
4	2	1	1		1			1	2	2		1	3	1	
5	2	3	2		1			1	2	2		1	3	1	
Avg..	2	1.8	1.8		1			1	2	2		1	2.4	1	

SEMESTER VI

23ME	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION AND AUTOMATED FLOW LINES **10**

Origin of CIM, CIM Wheel - manufacturing automation – computerized manufacturing support systems, Automation strategies - Ten Strategies for Automation and Process Improvement.

Control of Production Line- Analysis of Transfer Lines-Transfer Lines with No Internal Parts Storage system. Analysis of Single Model Assembly Lines- Line Balancing Problem, Line Balancing Algorithms-Largest Candidate Rule, Kilbridge and Wester Method, Ranked Positional Weights Method.

MODULE II AUTOMATIC MATERIAL HANDLING AND STORAGE SYSTEMS **10**

Design Considerations in Material Handling, Material Transport Equipment-Industrial Trucks, Automated Guided Vehicles, Monorails and Other Rail-Guided Vehicles, Conveyors, Cranes and Hoists. Automated Storage/Retrieval Systems. Automated Inspection systems: Overview of Automated Identification Methods, Bar Code Technology, Radio Frequency Identification, and Machine Vision

MODULE III CELLULAR MANUFACTURING SYSTEMS **9**

Part Families, Parts Classification and Coding, Features of Parts Classification and Coding Systems, Opitz of Parts Classification and Coding Systems, Machine Cell Design, Applications of Group Technology, Quantitative analysis of Cellular Manufacturing, grouping of parts and Machines by Rank Order Clustering, Arranging Machines in a GT Cell. CAPP - Retrieval CAPP Systems, Generative CAPP Systems, Benefits of CAPP.

MODULE IV FMS AND SHOP FLOOR CONTROL **8**

FMS- components of FMS - types FMS-A Dedicated FMS, A Random Order FMS - Workstations, FMS material handling, FMS Applications and Benefits.

Computer Control System, Shop floor control-phases -factory data collection system.

MODULE V CIM IMPLEMENTATION AND DATA COMMUNICATION **8**

The Scope of CAD/CAM and CIM, Computerized elements of a CIM System, Components of CIM, Database for CIM, Manufacturing automation protocol (MAP) and technical office protocol (TOP). CIM open system architecture (CIMOSA) - CIM architecture.

Communication fundamentals- local area networks -topology -LAN implementations – network.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the principles and concepts behind computerizing the manufacturing system.

CO2: Apply an automated production line and analyze the line balancing for the manufacturing industry.

CO3: Classify the various material handling, transportation, and storage systems for better efficient shop floor design

CO4: Apply the concepts of Group technology and computer-aided process planning to a discrete manufacturing system.

CO5: Develop a Flexible manufacturing system for particular product/process varieties and control by Shop floor control system

TEXTBOOK:

1. London, 2018 Mikell.P.Groover "Automation, Production Systems, and Computer Integrated Manufacturing", Prentice Hall, 2016

REFERENCES:

1. Mikell.P. Groover and Emory Zimmers Jr., "CAD/CAM", Prentice Hall of India Pvt. Ltd., 2016.
2. Alavudeen, A and Venkateshwaran N, “Computer Integrated Manufacturing”, PHI Learning Pvt. Ltd, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1				1							2	1		
2	2	3	2	1	1							2	3		
3	2	2			1				2			3	2		2
4	2	2	2	1	2		1		2			3	2		1
5	1	1	2	1	1		1		2	1		3	2		2
AVG..	**1.6**	**2**	**2**	**1**	**1.2**		**1**		**2**	**1**		**2.6**	**2**		**1.6**

SEMESTER VI

23ME	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	1	0	4

MODULE I DESIGN OF BELT AND CHAIN DRIVES 9 + 3

Belt - Types, belt materials, stresses in belts, condition for maximum power transmission, selection of V-belt – design of V belt drive.

Chain - Types, polygonal effect, selection of transmission chain and sprockets, silent chains - chain lubrication.

MODULE II DESIGN OF SPUR, HELICAL, AND BEVEL GEARS 9 + 3

Spur gear - Terminology, gear materials, force analysis, and design of spur gear based on strength and wear considerations. Helical gear - terminology, force analysis, pressure angle, equivalent number of teeth, and design of helical gear based on strength and wear considerations. Bevel gear - terminology, virtual number of teeth, force analysis, design of straight bevel gears.

MODULE III DESIGN OF WORM GEAR AND MULTISPEED GEAR BOXES 9 + 3

Worm gear - Terminology, materials, force analysis, thermal considerations, efficiency, design of worm gear drive. Gearbox - Standard step ratio - Ray diagram, kinematic arrangement, Design of multi-speed gearbox for machine tool applications.

MODULE IV POWER SCREWS 9 + 3

Forms of threads, terminology, the torque required to raise/lower the load, self-locking, efficiency, collar friction, design of power screws for screw jack and lathe – Design of screw jack.

MODULE V DESIGN OF CLUTCH AND BRAKES 9 + 3

Clutch - classification, and design of single plate, multiple plate, and cone clutches.

Brakes – types of brakes, self-energizing brakes, design of internal expanding shoe brakes

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Select suitable V belt drive and chain drive for the given power.
CO2: Design spur, helical, and bevel gear for the given application.
CO3: Design worm gear drive and multi-speed gearbox for the given application.
CO4: Design power screws for the screw jack and lathe for the given power.
CO5: Design single and multi-plate friction clutches and internal expanding shoe brakes for automotive applications.

TEXT BOOKS:

1. Bhandari V.B., "Design of Machine Elements", 5th Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2020
2. Joseph Edward Shigley, Charles R. Mischke, Richard Gordon Budynas, "Mechanical Engineering Design", 10th Edition, McGraw Hill, Inc., New Delhi, 2014.

REFERENCES:

1. Robert L Mott, "Machine Elements in Mechanical Design", 6th Edition, Macmillan Publishing Co., London, 2018
2. Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, New Delhi, 2012
3. Robert L Norton, "Machine Design - An Integrated Approach", 5th Edition, Pearson Education, New Delhi, 2018
4. Prabhu T.J., "Design of Transmission Elements", Mani offset, Chennai, 2015
5. Darle W Dudley, "Hand Book of Practical Gear Design", CRC Press, Florida, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3					1	1			2	3	2	2
2	2	2	3					1	1			2	3	2	2
3	2	2	3					1	1			2	3	2	2
4	2	2	3					1	1			2	3	2	2
5	2	2	3					1	1			2	3	2	2
Avg..	2.0	2.0	3.0					1.0	1.0			2.0	3.0	2.0	2.0

1-low, 2-medium, 3-high

SEMESTER VI

23ME	DYNAMICS OF MACHINERY	L	T	P	C
		3	1	0	4

MODULE I FORCE ANALYSIS **9 + 3**

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three, and Four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members

MODULE II BALANCING OF MASSES **9 + 3**

Balancing – Balancing of single rotating mass, Balancing of masses rotating in the same plane, balancing of masses in different planes (Dalby's method)– primary and secondary forces of reciprocating masses, balancing of single cylinder reciprocating engines, balancing of multi-cylinder in line engines.

MODULE III GYROSCOPES **9 + 3**

Gyroscope – gyroscopic forces and torque – gyroscopic stabilization- gyroscopic effects in aircraft and ships Governors – types – centrifugal governors – gravity controlled and spring controlled centrifugal governors – characteristics, stability, sensitivity, hunting, isochronisms.

MODULE IV LONGITUDINAL VIBRATION **9 + 3**

Undamped free vibration of 1 DOF system – springs in series, springs in parallel, and combination. Damped free vibration of 1 DOF system. Types of dampings, Viscous damping, critically damped, underdamped system. Logarithmic decrement.

MODULE V TRANSVERSE AND TORSIONAL VIBRATIONS. **9 + 3**

Natural Frequency of Free transverse vibrations, Cantilever and simply supported beam, Effect of inertia of the constraint in transverse vibration, vibration isolation, and transmissibility. Critical speed – whirling of shaft. Transverse vibration of beams natural frequencies – Free torsional vibration with two and three-rotor systems.

TOTAL (45+15) = 60 PERIODS

COURSE OUTCOMES

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

CO1: Analyze forces in static and dynamic scenarios, mastering free body diagrams, equilibrium conditions, and dynamic force analysis

CO2: Understand and apply the balancing techniques to various rotating masses and reciprocating engines, showcasing proficiency in both single and multi-cylinder in-line engine balancing, along with a comprehensive understanding of primary and secondary forces in reciprocating masses for complex design systems.

CO3: Understand and examine the influence of gyroscopes on ships, and aircraft, developing a deep understanding of their complex effects and safety considerations. Understand the concepts, principles, and functionalities of governors in diverse mechanical applications

CO4: Predict the consequences of vibrations, analyze vibration frequencies, design and apply knowledge of damping mechanisms associated with vibrational forces

CO5: Design and develop transverse and longitudinal mechanisms providing design solutions for complex vibrating systems

TEXT BOOKS:

1. Uicker. J.J., Pennock. R.G.., and Shigley. E.J., Theory of Machines and Mechanisms, 5th Edition, Oxford University Press, 2017.
2. Sadhu Singh., Theory of Machines Kinematics and Dynamics, 3rd Edition, Dorling Kindersley Pvt Ltd, 2012

REFERENCES:

1. Rattan S.S., Theory of Machines, McGraw-Hill Publications, 5th Edition, 2019
2. V. Jayakumar, Engineering Mechanics, Lakshmi Publications, 3rd Edition, 2019.
3. Sayyad. F.B, Dynamics of Machinery, MacMillan Publishers, 2011

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2			1	1				1	2	1	2
2	3	3	3	1	1	1						2	3	1	3
3	3	2	2	1	1		1	1			1	1	3	3	3
4	3	2	3		1	1		1		1		1	3		2
5	3	3	3	3	2	1	2	1	1	1	1	1	2	2	2
Avg..	3.0	2.6	2.8	1.8	1.3	1.0	1.3	1.0	1.0	1.0	1.0	1.2	2.6	1.8	2.4

1-low, 2-medium, 3-high

SEMESTER VI

23ME	COMPUTER AIDED MANUFACTURING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Study of CNC turning and machining center – specification and part programming codes for various operations.
    a. Part Programming and simulation of CNC turning center
2. Develop a CNC program and simulate step and taper turning operations.
3. Develop a CNC program and simulate profile turning operations.
4. Develop a CNC program and simulate grooving and threading operations.
5. Machine a component in a CNC turning lathe machine and measure the workpiece to check for accuracy levels.
    a. Programming and simulation of CNC machining center
6. Develop a CNC program and simulate Linear and Circular Interpolation.
7. Develop a CNC program and simulate Pocketing operations.
8. Develop a CNC program and simulate a Mirror image.
9. Machining and measurement of a given component in the CNC machining center and generating inspection reports to validate the dimensions.
10. Develop a process plan for a given component and generate an automated part programming using software and validate with manual part programming.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Understand the basic procedures and concepts of programming, setup, and operation of a CNC Turning and Machining Center.

CO2: Demonstrate the basic programming (G and M) codes and structure.

CO3: Generate CNC programs for a given component as per part drawing by integrating through the CNC turning and machining center.

CO4: Operate CNC turning and machining center to produce components of simple shape.

CO5: Prepare initial set up and manufacture simple components in CNC turning and machining center.

Reference Book:

1. Computer Aided Manufacturing Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1				3	2						3	2		
2	1				3	2						3	2		
3	2	2	2		3	2			2			3	2		2
4	3	2	3		3	2			1			3	3	2	2
5	3	1	2		3	2			2	2		3	2		
Avg..	2.0	1.7	2.3		3.0	2.0			1.7	2.0		3.0	2.2	2.0	2.0

1-low, 2-medium, 3-high

SEMESTER VI

23MEL	DYNAMICS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Study of a gyroscopic couple using motorized gyroscope apparatus.
2. Determination of the whirling speed of a shaft using a whirling of shafts demonstrator.
   Using a universal vibration apparatus,
   Determining the radius of gyration of a compound pendulum;
   Determining the radius of gyration of a body using bifilar suspension;
3. Determining the radius of gyration of a body using tri-filar suspension;
4. Experiment on different types of cam and followers.
5. Determination of the controlling force at a given speed, sensitiveness at given limits of lift, and governor effort and power of various types of governors.
6. Study on balancing of reciprocating mass.
7. Determination of vibration response using free vibration test.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Demonstrate the working principle of the gyroscope, governor, and cam.

CO2: Examine the balancing of reciprocating mass.

CO3: Inspect the critical speed of the shaft under the given load conditions.

CO4: Determine the radius of gyration of different systems

CO5: Determine the vibration response of different systems

Reference Book:

1. Dynamics Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3											2		
2	2	2											2		
3	3	3											2		
4	3	3											2		
5	3	3			3								2		
AVG..	**3**	**3**			**3**								**2**		

1-low, 2-medium, 3-high

SEMESTER VI

23ME	HEAT TRANSFER LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

CONDUCTION

1. Determination of Thermal Conductivity through Composite walls
2. Determination of Thermal Conductivity of Insulation Material in Lagged Pipe
3. Determination of Thermal Conductivity of Insulation Powder
4. Unsteady State Heat Transfer Analysis

CONVECTION

5. Determination of Heat transfer in a Pin Fin
6. Determination of convective heat transfer co-efficient in Forced Convection
7. Determination of convective heat transfer co-efficient in Natural Convection

RADIATION

8. Determination of Stefan Boltzmann's Constant

HEAT EXCHANGERS

9. Performance Analysis of Parallel flow and Counter flow Heat Exchanger
10. Performance Analysis of a Shell and Tube Heat Exchanger
11. Performance Analysis of a Cross-Flow Heat Exchanger
12. Performance Analysis of a Plate-Type Heat Exchanger

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Measurement of Thermal Conductivity for a given various equipments to understand the concepts.

CO2: Determination of Heat Transfer through Forced Convection, Natural Convection and Pin-Fin Experiments.

CO3: Measurement of Stefan Boltzmann constant and estimate the emissivity through radiation surfaces.

CO4: Determination of overall heat transfer coefficient through various heat exchangers

Reference Book:

1. Heat Transfer Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	-	3	-	2	-	-	-	-	2	3	2	3
2	3	3	2	-	3	-	2	-	-	-	-	2	3	2	3
3	3	3	2	-	3	-	2	-	-	-	-	2	3	2	3
4	3	3	2	-	3	-	2	-	-	-	-	2	3	2	3
5	3	3	2	-	3	-	2	-	-	-	-	2	3	2	3
AVG..	**3**	**3**	**2**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**

SEMESTER VI

23ME	MINI PROJECT	L	T	P	C
		0	0	4	2

The Mini Project course is designed to provide students with hands-on, practical experience in solving real-world engineering problems. This course emphasizes the application of theoretical knowledge and technical skills acquired throughout the curriculum to develop innovative and effective solutions. Students will work individually or in teams to identify a problem, conduct thorough research, propose and evaluate potential solutions, and ultimately design, implement, and test a prototype or solution.

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Analyze complex engineering problems by breaking them down into smaller, manageable components and determining the underlying principles and theories that apply.

CO2: Evaluate various potential solutions to engineering problems based on criteria such as feasibility, cost-effectiveness, and sustainability, selecting the most appropriate one.

CO3: Design and develop innovative solutions to engineering problems, utilizing creativity and advanced technical skills.

CO4: Implement and test their designed prototypes or solutions, refining them based on test results and iterative feedback.

CO5: Effectively communicate their project outcomes, including methodologies, results, and conclusions, through comprehensive written reports and oral presentations.

CO-PO & PSO MAPPING

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

1-low, 2-medium, 3-high

SEMESTER VII

23ME	CONTROL SYSTEMS AND MECHATRONICS	L	T	P	C
		3	1	0	4

MODULE I SYSTEM MODELING **9 + 3**

A system, types of system, mathematical modeling of the system: Differential equation of mechanical, and electrical systems, transfer function.

MODULE II CONTROL SYSTEM **12 + 3**

Control system: Introduction, definition, open and closed loop system, general block diagram with examples. Representation of control system: Block diagram algebra, signal flow graph, Mason's Gain formula. Standard test signals, order of a system, first order and second order system, time responses of first and second order system, steady-state error and error constants, - time response specifications of second order

MODULE III FREQUENCY RESPONSE AND STABILITY ANALYSIS **8 + 3**

Correlation between time and frequency response, Root locus: concepts, rules for construction, polar plot, Routh Stability Criteria, bode plot, Stability: Concept, necessary condition, Hurwitz and Routh stability criteria.

MODULE IV DESIGN OF CONTROL SYSTEM **8 + 3**

Controllers: Preliminary considerations of classical design, Proportional controllers, Derivative controllers, Integral controllers, Tuning of PID controllers by Ziegler Nicholas method, and root locus analysis for a given system using Matlab.

MODULE V MECHATRONICS **8 + 3**

Mechatronics: Definition, block diagram and applications. Mechatronics design process. Microprocessor, microcontroller applications in mechatronics systems. PLC: Block diagram, applications, latching and internal relays, timers, counters, and shift registers.

TOTAL (45+15) = 60 PERIODS

COURSE OUTCOMES

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

CO1: Construct the mathematical model of a system in the form of a differential equation, and transfer function model, and understand the dynamic characteristics of the system.
CO2: Understand the concept of a control system
CO3: Study the open and closed loop system in terms of response, stability, and bandwidth
CO4: Design the controller for a simple system
CO5: Understand mechatronics system design and PLC programming.

TEXT BOOKS:

1. Control Systems Engineering, New Age International (P) Limited, Publishers, I J Nagrath, M Gopal, Sixth Multi Colour Edition:2021
2. Mechatronics, Electronic control systems in mechanical and electrical engineering, sixth Edition., pearson W.Bolton: 2019

REFERENCES:

1. "Modern Control Engineering, 5th Edition. Katsuhiko Ogata, 2015.

2. https://onlinecourses.nptel.ac.in/noc20_ee90/preview.
3. “https://archive.nptel.ac.in/courses/108/106/108106098/
4. https://nptelvideos.com/control_systems/control_systems_video_lectures.php

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2	1	2	2	1	1	2	1	2	2	2	1	1
2	2	2	2	1	1	1	2	1	2	3	3	2	1	2	1
3	1	2	2	3	2	2	2	2	2	3	1	2	1	1	3
4	2	1	2	3	1	2	2	3	2	2	1	2	1	2	2
5	3	3	2	3	1	1	2	1	1	1	1	1	2	1	1
Avg..	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**

1-low, 2-medium, 3-high

SEMESTER VII

23ME	FLUID POWER CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I PRINCIPLES OF FLUID POWER AND HYDRAULIC PUMPS **9**

Introduction: Fluid power – Advantages and Applications – Fluid power systems – Fluids: types, - Properties and selection. Basics of Hydraulics: Pascal's Law, Sources of Hydraulic power: Types of Pumps, Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps – Problems.

MODULE II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS **9**

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

MODULE III HYDRAULIC SYSTEMS AND CIRCUITS **9**

Hydraulic System: Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits.

Design of hydraulic circuits: Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Servo systems: Mechanical and Hydraulic.

MODULE IV PNEUMATIC SYSTEMS AND COMPONENTS **9**

Pneumatic Systems: Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, and Pneumatic actuators. Introduction to Fluidics, Pneumatic logic circuits.

MODULE V DESIGN OF PNEUMATIC CIRCUITS **9**

Design of Pneumatic circuit: Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumatic-hydraulic circuit.

Classifications - single cylinder and multi-cylinder Circuits-Cascade method, KV map method. Electro-Pneumatic System: Elements, Ladder diagram, timer circuits.

Pneumatic circuits: Pick and place applications, metal working, and handling, clamping counter, and timer circuits. IOT in Hydraulics and pneumatics. Maintenance, Troubleshooting, and Remedies in Hydraulic and Pneumatic systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the fundamental principles of fluid power and its advantages in various applications and demonstrate a comprehensive knowledge of hydraulic pumps.

CO2: Apply and control the fluid power system by selecting proper hydraulic actuators and assessing the operation of direction, flow, and pressure control valves.

CO3: Understand and design various industrial hydraulic circuits for specific applications, including drilling, planning, shaping, surface grinding, press, and forklift applications.

CO4: Apply the principles of pneumatic and evaluate the functions and applications of pneumatic

components.

CO5: Design pneumatics circuits for various applications using cascade and KV map methods and also explore the understanding of electro-pneumatic systems.

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TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2. James A. Sullivan, “Fluid Power Theory and Applications”, 4th Edition, Prentice Hall, 1997

REFERENCES:

1. “Anders Hedegaard Hansen, “Fluid Power Systems”, Springer Cham Publishers, 2023
2. Fitch, Jr., E.C., Fluid Power Control Systems, New York: McGraw Hill.
3. Ernest Eugene Lewis, Hansjoerg Stern, “Design of Hydraulic Control Systems, McGraw-Hill
4. Anders Hedegaard Hansen, “Fluid Power Systems”, Springer Cham Publishers, 2023
5. Modern Control Engineering, 5th Edition. Katsuhiko Ogata, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1		3							2	3		
2	2	2	1		3							2	3		
3	2	2	3		3				2	3		2	3		
4	2	2	1		3				2			2	3		
5	2	2	3		3				2	3		2	3		
Avg..	**2**	**2**	**1.8**		**3**				**1.2**	**1.2**		**2**	**3**		

1-low, 2-medium, 3-high

SEMESTER VII

23ME	OPERATIONS RESEARCH	L	T	P	C
		3	1	0	4

MODULE I LINEAR PROGRAMMING 9 + 3

Linear programming formulation, Graphical solutions, Simplex method, Big M Method, Two Phase Method. Primal - Dual relationship, Duality Theorems, Dual Simplex Method.

MODULE II TRANSPORTATION, ASSIGNMENT, AND NETWORK ANALYSIS 9 + 3

Formulation of Transportation Problem, Initial Feasible Solution Methods, Optimality Test, Degeneracy in Transportation Problem; Assignment Problem, Hungarian Method, Travelling Salesman Problem.

Definition of network models - minimal spanning tree algorithm, shortest route algorithm, maximal flow algorithms, PERT, CPM- LP formulation of minimal spanning, maximum flow and PERT, CPM calculations. Crashing of Network.

MODULE III GAME THEORY AND SEQUENCING 9 + 3

Game Theory – Terminologies Two Person Zero Sum Game, Pure and Mixed Strategies, Graphical Solution, Solving by Linear Programming.

Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through three machines and m Machines, Graphical Method of Two Jobs m Machines Problem.

MODULE IV INVENTORY CONTROL 9 + 3

Classical Economic Order Quantity (EOQ) Models, EOQ with Shortage, EOQ Model with Price Breaks, Probabilistic EOQ Model, Newsboy Problem. Selective Inventory Control

MODULE V QUEUING THEORY AND SIMULATION 9 + 3

Elements of Queuing Model, queue discipline, Pure Birth Death Model, Single Server and Multi-server Markovian Models with Infinite and Finite Capacity, Machine Repair Model, and Networks of Queues.

System concepts - Types of systems and models - system simulation procedure – Monte - Carlo simulation method (Simple Problems).

TOTAL (45+15): 60 PERIODS

COURSE OUTCOMES

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

CO1: Formulate a given engineering problem as a linear programming problem, and apply graphical, Simplex, Two-Phase, or Big-M methods to obtain the optimal solution.

CO2: Construct models, and complex project networks and solve the transportation, assignment, and network problems to make a managerial decision.

CO3: Model competitive real-world phenomena using concepts from game theory and sequencing, and evaluating game strategy and total elapsed time for processing of jobs.

CO4: Categorize and solve inventory control in the industry using quantitative techniques.

CO5: Analyze a queuing problem and apply the Monte Carlo simulation technique to solve simple and real-time problems.

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TEXT BOOKS:

1. Taha, H. A, "Operations Research - An Introduction", 11th Edition, Pearson, 2022.
2. Hiller, F. S., and Liebermann, G. J. "Introduction to Operations Research", 11th Edition, Tata McGraw Hill, 2021.

REFERENCES:

1. Srinivasan G, “Operations Research Principles and applications”, 3rd Edition, PHI, 2017.
2. Michael W. Carter, Camille C. Price, Ghaith Rabadi, Operations Research Practical Introduction, 2nd Edition, CRP Press, 2019
3. Wayne L. Winston, Operations Research: Applications and Algorithms, 4th Edition, Cengage Learning, 2004
4. https://nptel.ac.in/courses/111/107/111107128/
5. https://nptel.ac.in/courses/112/106/112106134/
6. https://www.udemy.com/topic/operations-research/
7. https://www.coursera.org/learn/operations-research-modeling

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2				1	1	2	2	1	2	1
2	2	3	3	2	2				1	1	2	2	1	2	1
3	3	3	3	2	2				1	1	2	2	1	2	1
4	2	3	3	2	2				1	1	2	2	1	2	1
5	3	3	3	2	2				1	1	2	2	1	2	1
Avg..	**2.6**	**3**	**3**	**2**	**2**				**1**	**1**	**2**	**2**	**1**	**2**	**1**

1-low, 2-medium, 3-high

SEMESTER VII

23ME	FLUID POWER LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Study of different components and symbols of hydraulic and pneumatic systems
2. Construct a circuit for Pneumatic/hydraulic control of a Single-acting Cylinder
3. Construct a circuit for Pneumatic/ hydraulic control of a Double-acting Cylinder
4. Design a speed control circuit for Pneumatic/hydraulic systems
5. Design an automatic reciprocating circuit
6. Construct a traverse and feed circuit
7. Develop circuits for simple machine tool applications such as milling, shaping, and grinding machine
8. Construct a sequential circuit for multi-cylinder applications
9. Construct a circuit for special applications
10. Construct a synchronization circuit for hydraulic/pneumatic systems
11. PLC Control Pneumatic/ Hydraulic linear actuator circuits
12. Electro-Pneumatic sequential circuits

TOTAL: 30 PERIODS

LIST OF EQUIPMENTS

1. Basic Pneumatic/Hydraulic trainer kit
2. Advanced Pneumatic Trainer Kit
3. Basic Electro-Pneumatic Trainer Kit
4. Advanced Electro-Pneumatic trainer kit
5. Basic Electro-Pneumatic PLC Trainer Kit
6. Advanced Electro-Pneumatic PLC Trainer kit

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Identify various components of hydraulic & pneumatic systems and determine their applications

CO2: Apply basic hydraulic and pneumatic principles to predict the behavior of hydraulic/pneumatic systems

CO3: Know the conversions in hydraulic, pneumatic, and electro-pneumatic systems and also make the components used to generate the hydraulic and pneumatic power

CO4: Built, operate, maintain, and troubleshoot electrically controlled hydraulic and pneumatic systems

CO5: Define the uses of programmable controllers to sequence and monitor the machine functions on automated equipment.

Reference Book:

1. Fluid Power Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			1				1				1			
2	1	2		1	2			1				1			
3		1	3	2	1			1							
4		1	2	3				1				1			
5	1		2	2	2			1				1			
Avg..	2	1.3	2.3	2	2			1				1			

1-low, 2-medium, 3-high

SEMESTER VII

23ME	MECHATRONICS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

1. Defining inputs, outputs and performing mathematical operations using LabVIEW
2. Using loop, timer, case structure, and shift register to perform problem-solving
3. Designing closed loop system with PID controller
4. Sensor interfacing with LabVIEW
5. PID controller design using electrical components and interfacing with LabVIEW
6. Writing script to do mathematical operations using MATLAB
7. Open and closed loop simulation of a plant in script and Simulink platform
8. Root locus analysis and automated PID controller design using MATLAB
9. Hardware (Sensor, LED, and buzzers) interfacing using MATLAB

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Do advanced LabVIEW programs to represent and control the system
CO2: Do interface hardware like sensors and actuators with the LabVIEW software
CO3: Write MATLAB coding in both script and Simulink platform
CO4: Develop an algorithm for the problem-solving procedure
CO5: Interface hardware with MATLAB

Reference Book:

1. Mechatronics Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	-	3	-	2	-	-	-	-	2			
2	3	3	2	-	3	-	2	-	-	2	3	2			
3	3	3	2	3	3	2	2	-	3	-	-	2			
4	3	3	2	-	3	-	2	-	-	-	-	2			
5	3	2	2	3	-		-	2	3	2	-	-			
AVG.	**3**	**3**	**2**	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**			

1-low, 2-medium, 3-high

SEMESTER VII

23ME	ADVANCED MANUFACTURING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS:

Advanced Manufacturing Technology Laboratory

1. To develop the polymer composites using open and closed molding techniques (Particulate Filled composite, Fiber Reinforced composite, Laminate composite, Sandwich composite)
2. To find out the tensile strength, compressive strength, and flexural strength of non-metallic specimens using a Universal Tensile Tester (30 kN) as per ASTM (D 638, D 695, D 790) standards
3. To find out the number of fatigue cycles of the metallic & non-metallic specimens using a multi-axial fatigue testing machine (20 kN) (ASTM E606)

Rapid Prototyping Laboratory

4. To design a product using captured data from modern data capturing devices and convert design files into suitable printing file format.
5. Pre-processing, part orientation, estimation of printing time and material consumption, and identify the suitable additive manufacturing method to develop the designed product
6. Investigate the dimensional accuracy of the developed product.

Welding Research Cell:

7. Prepare a surface composite on an aluminum substrate by using the friction stir surfacing process.
8. Develop a bead on the plate using robotic MIG welding and characterize the effect of input parameters.

Smart Manufacturing Center:

9. Import the 2D CAD drawing, select the cutting parameters, and generate the tool path for abrasive Waterjet cutting using MOST 2D and ITEM CAD.
10. Arrange the job in the CNC machine, create a Datum reference, and perform a trial cut in the CNC Abrasive Waterjet cutting machine.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Implement calibration and maintenance procedures for testing equipment to ensure accurate and consistent test results, adhering to ASTM standards and best practices.

CO2: Analyze test results statistically to assess the variability and confidence level of obtained mechanical properties, enhancing the reliability and validity of data interpretation.

CO3: Familiarize with modeling and file conversion methods used in additive manufacturing and also Identify the suitable additive manufacturing method to develop a designed product.

CO4: Demonstrate expertise in surface modification techniques like friction stir processing and robotic MIG welding, ensuring the ability to prepare surface composites and develop welded beads with desired properties on metallic substrates.

CO5: Proficiently operate CNC Abrasive Waterjet cutting machines, including importing CAD drawings, selecting cutting parameters, generating tool paths, arranging jobs, establishing datum references, and executing trial cuts, ensuring accurate and efficient cutting processes.

Reference Book:

1. Advanced Manufacturing Laboratory Manual, CIT, 2023.

CO-PO & PSO MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1	3		2				2	2		2
2	2	1	3	2	2				2	2		2
3	2	1	3	2	2				2	2		2
4	2	1	3		2				2	2		2
5	2	1	3	2	2				2	2		2
Avg..	**2**	**1**	**3**	**2**	**2**				**2**	**2**		**2**

1-low, 2-medium, 3-high

SEMESTER VIII

23ME	PROJECT WORK	L	T	P	C
		0	0	12	6

The Project course is designed to provide students with hands-on, practical experience in solving real-world engineering problems. This course emphasizes the application of theoretical knowledge and technical skills acquired throughout the curriculum to develop innovative and effective solutions. Students will work individually or in teams to identify a problem, conduct thorough research, propose and evaluate potential solutions, and ultimately design, implement, and test a prototype or solution.

COURSE OUTCOMES:

Upon completion of the course, the students will be able

CO1: Analyze complex engineering problems by breaking them down into smaller, manageable components and determining the underlying principles and theories that apply.

CO2: Evaluate various potential solutions to engineering problems based on criteria such as feasibility, cost-effectiveness, and sustainability, selecting the most appropriate one.

CO3: Design and develop innovative solutions to engineering problems, utilizing creativity and advanced technical skills.

CO4: Implement and test their designed prototypes or solutions, refining them based on test results and iterative feedback.

CO5: Effectively communicate their project outcomes, including methodologies, results, and conclusions, through comprehensive written reports and oral presentations.

CO-PO & PSO MAPPING

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

1-low, 2-medium, 3-high

PROFESSIONAL ELECTIVES

23ME	ADVANCED MACHINING PROCESSES	L	T	P	C
		3	0	0	3

MODULE I MATERIAL REMOVAL PROCESSES AND MECHANICAL PROCESSES **12**

Material Removal Processes: Introduction, history of machining, traditional machining processes, nontraditional machining processes, hybrid machining processes. Need for non-traditional machining processes.

Mechanical Processes: Ultrasonic machining (USM): machining system, material removal process, factors affecting material removal rate, dimensional accuracy, and surface quality, applications. Water jet machining (WJM): machining system, process parameters, applications, advantages and disadvantages of WJM. Abrasive jet machining (AJM): machining system, material removal rate, applications, advantages, and limitations of AJM.

MODULE II CHEMICAL PROCESSES **6**

Chemical Processes: Chemical Milling (CHM): tooling for CHM, process parameters, material removal rate, accuracy and surface finish, advantages, limitations, applications. Photochemical milling: process description, applications, advantages. Electro polishing: process parameters, applications, process limitations.

MODULE III ELECTROCHEMICAL PROCESSES **6**

Electrochemical Processes: Electrochemical machining (ECM): principles of electrochemical machining, ECM equipment, basic working principles, process characteristics, process control, applications. Basics of Electrochemical drilling and electro stream drilling

MODULE IV HYBRID ELECTROCHEMICAL PROCESSES **6**

Electrochemical grinding (ECG): material removal rate, accuracy and surface quality, applications, advantages, and disadvantages. Electrochemical honing: process characteristics, applications. Electrochemical super finishing: material removal process, process accuracy; Electrochemical buffing - material removal process, Electro chemical deburring.

MODULE V THERMAL PROCESSES **15**

Thermal Processes: Electric discharge machining (EDM): mechanism of material removal, machining system, material removal rates, heat-affected zone, applications. Wire EDM-principle, process parameters, surface finish and machining accuracy, applications. Laser beam machining (LBM): material removal mechanism, applications, advantages, and limitations. Electron beam machining (EBM): basic equipment and removal mechanism, applications, advantages, and disadvantages. Plasma beam machining (PBM): machining systems, material removal rate, accuracy, and surface quality, applications, advantages, and disadvantages.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the evolution of machining techniques, both traditional and nontraditional, highlighting their importance in modern manufacturing.

CO2: Evaluate mechanical material removal methods like ultrasonic machining, water jet machining,

and abrasive jet machining, focusing on factors affecting material removal rate and surface quality.

CO3: Examine chemical processes including chemical milling, photochemical milling, and electro-polishing, considering material removal rate, accuracy, and surface finish.

CO4: Describe the principles and applications of electrochemical processes like ECM, electrochemical drilling, and electrochemical grinding, emphasizing process control and accuracy.

CO5: Assess thermal processes such as EDM, wire EDM, laser beam machining, electron beam machining, and plasma beam machining, in terms of material removal mechanisms, surface finish, and machining accuracy.

TEXT BOOKS:

1. El-Hofy, Hassan Abdel-Gawad, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill, 2005.
2. V.K. Jain, Advanced Machining Processes, 12th reprint, Allied Publishers Ltd, 2010.

REFERENCES:

1. Pandey P.C. and Shah H.S, Modern Machining Processes, 1st Edition, TMH, 2010.
2. S. Kalpakjain and S. R.Schmid, Manufacturing Engineering and Technology, 7th Edition, Pearson, 2018.

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1. https://nptel.ac.in/courses/112104028

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		1			3			2		3	3		
2	3	3		1			3			2		3	3		
3	3	3					3					3	3		
4	3	3					3	3				3	3		
5	3	3		1			3	3		2		3	3		
Avg..	**3**	**3**		**1**			**3**	**3**		**2**		**3**	**3**		

1-low, 2-medium, 3-high

23ME	ALTERNATIVE ENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

MODULE I ENERGY RESOURCES AND SOLAR ENERGY SYSTEMS **9**

Energy resources – Types, availability, and consumption pattern. Solar Energy - Basics of solar radiation, Collectors – Flat plate and concentrating Solar energy storage, Applications of solar thermal systems, Solar photovoltaic systems.

MODULE II WIND ENERGY SYSTEMS **9**

Wind Energy – Basics, wind data, and energy availability. Principle of wind energy conversion, Betz limit, and power coefficient. Typical design of wind turbines, HAWT and VAWT, Site selection for windmills.

MODULE III BIO-ENERGY SYSTEMS **9**

Bio-Energy - Resources, Thermo-chemical, and Bio-chemical energy conversion techniques. Design of gasifiers and biogas digesters, Applications of bio-energy.

MODULE IV NUCLEAR PLANTS **9**

Nuclear energy – Nuclear fuels, Energy from fission and fusion reaction, Fission reactor types, Reactor control, Indian Scenario.

MODULE V NON-CONVENTIONAL PLANTS **9**

Geothermal energy conversion systems, OTEC, Tidal power systems, Wave energy generators, MHD systems, Thermo-electric generators, and Fuel cells.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Determine heat transfer in solar-thermal systems used for heating applications and electricity generation via solar-thermal and solar photovoltaic systems.

CO2: Calculate the maximum possible electrical energy conversion from available wind energy using horizontal and vertical axis windmills.

CO3: Choose the type of conversion technique (bio-chemical and thermo-chemical) required to produce desired bio-fuels from available biomass.

CO4: Calculate the energy released from different types of nuclear fission reactors for electrical energy generation in a nuclear power plant.

CO5: Compare the energy conversion efficiencies of non-conventional plants like geothermal energy conversion systems, OTEC, Wave energy generators, tidal power plants, MHD generators, thermo-electric systems, and fuel cells.

TEXT BOOKS:

1. Rai G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2022.
2. Khan B.H., “Non-Conventional Energy Resources”, McGraw Hill India, 3rd Edition, 2021

REFERENCES:

1. Ashok V Desai, “Non-Conventional Energy”, Wiley Eastern Ltd., New Delhi, 2023.
2. Sharma P.C., “Power Plant Engineering”, S.K.Kataria & Sons, New Delhi, 2019.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 3rd Edition, 2018

NPTEL

1. https://nptel.ac.in/courses/108108078
2. https://onlinecourses.nptel.ac.in/noc22_ge14/preview

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1			3	3		2		3	3		
2	3	3	3	1			3	3		2		3	3		
3	3	3	3	1			3	3		2		3	3		
4	3	3	3	1			3	3		2		3	3		
5	3	3	3	1			3	3		2		3	3		
Avg..	**3**	**3**	**3**	**1**			**3**	**3**		**2**		**3**	**3**		

1-low, 2-medium, 3-high

23ME	AUTOMOTIVE TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I AUTOMOTIVE AND IC ENGINE POWERTRAIN **9**

Powertrain: Automotive system, Classification of Power train, Introduction of IC Engines and types of engines, Transmission and its type, Types of Driveshaft, differential and its types, axles, and their types.

MODULE II DRIVETRAIN TECHNOLOGY **9**

Drive trains: Introduction of Drivetrain system, Types of Drive train system, front-wheel drive (FWD), rear-wheel drive (RWD), all-wheel drive (AWD), and four-wheel drive (4WD).

MODULE III HYBRID POWERTRAIN TECHNOLOGY **9**

Hybrid powertrain: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis, Hybrid vehicle architecture and its classification, main components, and its types: IC engine coupled with electric motor, Types of battery system, power control units, and the regenerative braking system.

MODULE IV EV POWER TRAIN TECHNOLOGY **9**

EV power Train: Introduction of EV power Train, Electric Vehicle Architecture, Types and classification of EV power Trains, inverters, high-power electric motors, reduction drive, and power delivery module (PDM).

MODULE V WHEELS AND TYRES **9**

Types of Wheels: Pressed Steel Disc Wheel, Wire Wheel, Light Alloy Wheel, Divided Rims Wheel, Split Rims, Advantages of Pressed Steel Disc Wheel, Tyres: constructed with five main components. Types of Tyres and properties of tires.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Comprehend the working principles of IC engine Power train, Transmission system and its types, Types of Driveshaft, differential and its types, axles, and their classification.

CO2: Understand the working principles of drivetrain systems and construct working principles of the various types of drivetrain components

CO3: Know the construction and working principles of front-wheel drive (FWD), rear-wheel drive (RWD), all-wheel drive (AWD), and four-wheel drive (4WD) systems.

CO4: Understand the application of a hybrid powertrain system, classifications, and Hybrid vehicle architecture.

CO5: Understand the concepts of EV power Train and components of EV power Train and Electric Vehicle Architecture, Construct the working principles and types and classification of EV power Trains, inverters, high-power electric motors, reduction drives, and power delivery modules (PDM)

TEXT BOOKS:

1. RK Gupta “Automobile Engineering:” Publisher, S. Chand Publishing, 2020
2. IMechE “ Internal Combustion Engines and Powertrain Systems for Future Transport” 2019: Proceedings of the International Conference on Internal Combustion Engines ... 2019),

REFERENCES:

1. Kirpal Singh " Automobile Engineering" by Kirpal Singh
2. SK Gupta "Automobile Engineering:" Publisher, S. Chand Publishing, 2020
3. Ehsani "Modern Electric Hybrid Electric and Fuel Vehicles ", 3RD Edition, Publisher, CRC Press, January 2019

NPTEL

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://nptel.ac.in/courses/107106088

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2		2	2	1		2		1	1	1	1	1	1
2	3						1							1	
3				2				2	1				1	1	1
4	1	2	2		2	1					1	1			
5	1	2	2		2			2	1	1	1	1	1	1	1
Avg..	1.8	2	2	2	2	1	1	2	1	1	1	1	1	1	1

1-low, 2-medium, 3-high

23ME	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO COMPOSITE MATERIALS **9**

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

MODULE II PROCESSING OF POLYMER MATRIX COMPOSITES **9**

Thermo set matrix composites: hand layup, spray, filament winding, pultrusion, resin transfer molding, autoclave molding - bag molding, compression molding with Bulk Molding Compound and sheet Molding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection molding – interfaces in PMCs - structure, properties, and application of PMCs –recycling of PMCs.

MODULE III PROCESSING OF METAL MATRIX COMPOSITES **9**

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

MODULE IV PROCESSING OF CERAMIC MATRIX COMPOSITES **9**

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, solgel–interfaces in CMCs – mechanical properties and applications of CMCs – Carbon carbon Composites – applications.

MODULE V INTRODUCTION TO COMPOSITE LAMINATES AND STRENGTH ANALYSIS **9**

Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminate- fatigue of laminate composites

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Interpret the types of fibers and reinforcements used for the production of composites
CO2: Develop a procedure to produce different polymer matrix composites.
CO3: Experiment with different metal matrix composites to find their applicability
CO4: Identify a suitable method for manufacturing ceramic matrix composites and carbon-carbon composites
CO5: Develop advanced materials to improve the performance of the product

TEXT BOOKS:

1. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2019, Fourth Edition, ISBN: 978-3-030-28982-9,978-3-030-28983-6.
2. P. K. Mallick, William E. Stirton, Processing of Polymer Matrix Composites, CRC Press Taylor & Francis Group, 2018, ISBN:13: 978-1-4665-7822-7

REFERENCES:

1. Davim, J. Paulo, Metal matrix composites: materials, manufacturing and engineering, De Gruyter, 2014, ISBN: 9781680157680,168015768X
2. C. T. Lynch, J. P. Kershaw, Metal Matrix Composites, CRC Press, Taylor & Francis Group, 2018, ISBN 13: 978-1-315-89534-5
3. SM Handbook – Composites, Vol-21, 2017, ISBN -13: 978-0-87170-703-1.
4. R.M. Jones, "Mechanics of composite Materials", second Edition, Republished by Taylor &. Francis, 2014

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-						1	1		1
2	3	3	3	3	2	1						2	2		3
3	3	3	3	3	2	1						1	2		3
4	3	3	3	3	2	1						1	2		3
5	3	3	3	3	2	1							2		3
Avg.	**3**	**2.8**	**2.6**	**2.6**	**2**	**1**						**1.2**	**1.8**		**2.6**

1-low, 2-medium, 3-high

23ME	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Introduction- Need and Scope of Computer Aided Design, Design process - Computer Aided Design – Shigley design process. Computer Graphics- video-display devices, raster-scan systems, random scan systems, input-output devices. Output Primitives-Generate scan line techniques for Points and lines, line drawing algorithms, mid-point circle, and ellipse algorithms. Filled area primitives, Scan line polygon fill algorithm, boundary fill, and flood-fill algorithms.

MODULE II 2D and 3D GEOMETRICAL TRANSFORMATIONS OF ENTITIES **9**

2D and 3D geometrical transforms - Translation, scaling, rotation, reflection, and shear transformations. Matrix representations and homogeneous coordinates, composite transformations. Clipping Algorithm – Point clipping, Line clipping - Cohen-Sutherland clipping algorithms, Polygon clipping – Sutherland Hodgeman polygon clipping algorithm.

MODULE III CURVES AND SURFACES MODELING **9**

Fundamental of Curve Design: Parametric and Non-parametric representation of curves and surfaces. Curve representation – Line, Circle, and Ellipse. Synthetic curve representations – Hermite cubic curve, Bezier curve, and B-Spline curves Representation of Surface: Introduction to surfaces, Synthetic surface – Hermite bicubic surface, Bezier Surface, B-Spline Surface, Surface manipulations.

MODULE IV SOLID MODELING AND VISUAL REALISM **9**

Solid Modeling: Solid Entities, Solid Representation - Regularized Boolean set operations, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG), Comparison of representation. Visual Realism: Techniques for visual realism – Hidden line – Surface removal – solid removal. Introduction to parametric and variational modeling, Design by features.

MODULE V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE **9**

Assembly modeling: Design applications: Introduction to Feature and Assembly Modeling, Conceptual Design, and Top-down design. Assembly and Tolerance representation – specifications. Mechanism simulation and interference checking. CAD Standards: Standards for computer Graphics-Graphical Kernel System (GKS)-standards for exchange image, Open Graphics Library (OpenGL). Evaluation of data etc

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand and design the process for implementing the CAD system and be able to apply different algorithms for creating lines, circles, and ellipses and visualize them in graphical display devices (raster & random scan systems).

CO2: Demonstrate transformations to translate, rotate, scale, shear, and reflect 2-D and 3-D objects under specified conditions by clipping algorithms used in a CAD system.

CO3: Apply equations of Hermite, Bezier, and B-Spline curves, Bezier, and B-Spline surfaces in explicit, implicit, and parametric representations for curve and surface modeling.

CO4: Impart the fundamentals to create and manipulate geometric models using solid modeling techniques.

CO5: Provide a clear understanding of CAD systems for 3D modeling and viewing. Create strong skills in assembly modeling, Tolerancing, and usage of standard exchange formats in CAD systems.

TEXT BOOKS:

1. Ibrahim Zeid and Siva Subramanian R., "CAD/CAM: Theory and Practice", McGraw Hill Education (P) Ltd., 2018
2. Donald D. Hearn and Paul Baker M., “Computer Graphics C Version”, Pearson Publication, 2018

REFERENCES:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007
2. Rao P.N., "CAD/CAM-Principles and Applications", Tata McGraw Hill Education Ltd., New Delhi,2012
3. Mikell P. Groover and Emory Jimmers W., "CAD/CAM", Prentice Hall of India (P) Ltd., 2009

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1. https://archive.nptel.ac.in/courses/112/102/112102101/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1		3	1			3	3		3	2		
2	3	2	1		3	1						3	2		
3	3	3	3		3	1						3	2		
4	1	2	2	1	3	2			3	2		3	2		
5	1	2	2	1	3	2			3	2		3	2		2
Avg.	2.2	2.2	1.8		3.0	1.4			3	2.3		3.0	2.0		2.0

1-low, 2-medium, 3-high

23ME	DESIGN OF JIGS AND FIXTURES	L	T	P	C
		3	0	0	3

MODULE I BASICS OF JIGS AND FIXTURES **9**

Objectives of tool design – Functions and Advantages of Jigs and Fixtures - Difference between Jigs and Fixtures – Standard parts of Jigs and Fixtures – Fool Proofing - Types of jigs and Fixtures – materials for jigs and fixtures –Essential features of jigs and fixtures - General Design Principle - Design steps, Economics of jigs and fixtures. Common defects in Jigs design.

MODULE II LOCATING AND CLAMPING PRINCIPLES **9**

Principles of location – Basic rules for locating - Locating methods and devices - pins and stud locators, V-locators, bush locators, and nest locators – Redundant location – Standard parts- Principles of clamping – clamping devices - mechanical actuation clamps - Pneumatic and hydraulic actuation clampings – magnetic clamps – spherical clamping operation

MODULE III ANALYSIS OF CLAMPING FORCES **9**

Analysis of clamping force - strap clamp, toggle clamp, cam-operated clamp, and screw clamp. Limit and fits, types of tolerance - Geometric dimensioning - Tolerance and error analysis

MODULE IV DESIGN OF JIGS **9**

Drill bushes – types of drill bushes – different types of jigs – plate, latch, channel, box, angle plate, post, turnover, pot jigs -Automatic drill jig - Rack and pinion operated, air operated, and hydraulically operated jigs - design and development of jigs for simple components

MODULE V DESIGN OF FIXTURES **9**

General principles of lathe, milling boring, and broaching fixtures - Grinding, planning, and shaping fixtures, assembly fixtures, Inspection and welding fixtures- modular fixtures - quick change fixtures - design and development of fixtures for simple components.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the basics of jigs and fixtures and its principle

CO2: Design appropriate locating systems to arrest possible degrees of freedom exhibited by the component.

CO3: Suggest and design appropriate clamping for specified operations.

CO4: Design appropriate Jigs for given components for efficient and effective manufacturing.

CO5: Design and develop appropriate fixtures for a given component

TEXT BOOKS:

1. Joshi P.H, “Jigs and Fixtures”, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.
2. Donaldson C, “Tool Design”, 5th Edition, Tata McGraw-Hill, New Delhi, 2017

REFERENCES:

1. K.Venkataraman, “Design of Jigs, Fixtures & Press tools”, Springer International Publishing, 2021

2. Franklin & D. Jones, “Jigs & Fixtures Design” Allied Publishers, 2018
3. Edward G Hoffman, “Jigs and Fixture Design”, Thomson – Delmar Learning, Singapore, 2004
4. Hiram E Grant, “Jigs and Fixture: Non-standard Clamping Devices” Tata McGraw Hill, New Delhi, 2003.

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1. https://archive.nptel.ac.in/courses/112/102/112102101/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1		1				1		1		3	2	1
2	3	3	3		1				1	1	1		3	2	1
3	3	3	3		1				1	1	1		3	2	1
4	2	3	3		1				1	1	1		3	2	1
5	3	3	3		1				1	2	1		3	2	1
Avg.	**2.80**	**2.60**	**2.60**		**1.00**				**1.00**	**1.25**	**1.00**		**3.00**	**2.00**	**1.00**

1-low, 2-medium, 3-high

23ME	ENERGY CONSERVATION AND WASTE HEAT RECOVERY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **7**

Energy Scenario - Basics of Energy and its various forms. Energy Resources Availability in India. Energy consumption pattern. Energy conservation and energy efficiency - needs and advantages. Energy auditing - types, methodologies, barriers. Role of the energy manager.

MODULE II INSTRUMENTS FOR ENERGY AUDITING **9**

Instrument characteristics - sensitivity, readability, accuracy, precision, and hysteresis. Error and calibration. Measurement of flow, velocity, pressure, temperature, speed, Lux, power, and humidity. Analysis of stack, water quality, power, and fuel quality.

MODULE III ENERGY CONSERVATION IN THERMAL SYSTEMS **10**

Energy Efficiency in Thermal Utilities - Fuels and Combustion - Boilers - Thermic Fluid Heaters - Steam Systems - Furnaces - Insulation and Refractory - FBC Boilers - Thermal Storage.

MODULE IV ENERGY CONSERVATION IN ELECTRICAL SYSTEMS **10**

Energy Efficiency in Electrical Utilities - Electric Motors - Compressed Air System - HVAC and Refrigeration System - Fans and Blowers - Pumps and Pumping System - CoolingTower.

MODULE V WASTE HEAT RECOVERY SYSTEMS **9**

Introduction - Principles of Thermodynamics and Second Law - sources of waste heat recovery. Waste heat recovery systems - Design Considerations - fluidized bed heat exchangers - heat pipe exchangers - plate heat exchangers - heat pumps – thermic fluid heaters - selection of waste heat recovery technologies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Identify the demand-supply gap of energy in the Indian scenario.
CO2: Carry out an energy audit of an industry/Organization.
CO3: Draw the energy flow diagram of an industry and identify the energy wasted or a waste stream
CO4: Select an appropriate energy conservation method to reduce the wastage of energy
CO5: Evaluate the techno-economic feasibility of the energy conservation technique adopted

TEXT BOOKS:

1. Chakrabarti, Amlan, "Energy Engineering And Management", PHI Learning Private Limited, 2013.
2. SenguptaSubrata, Lee SS EDS, "Waste Heat Utilization and Management", Hemisphere, Washington, 1983

REFERENCES:

1. Rajan G.G., "Energy Efficiency Optimization", Productivity & Quality Pub. P. Ltd, 2010.
2. Meenu Agrawal, "Energy Conservation & Energy Security in India", Kunal Books (Publishers & Dist.), 2013.
3. Smith C.B., "Energy Management Principles", Pergamon Press, NewYork, 1981.
4. "Handbook of Energy Audits", 9th Edition, Thumann, Albert, 2013

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1		1				1		1		3	2	1
2	3	3	3		1				1	1	1		3	2	1
3	3	3	3		1				1	1	1		3	2	1
4	2	3	3		1				1	1	1		3	2	1
5	3	3	3		1				1	2	1		3	2	1
Avg.	2.8	2.6	2.6		1.0				1.0	1.2	1.0		3.0	2.0	1.0

1-low, 2-medium, 3-high

23ME	ENGINEERING ECONOMICS AND MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I ECONOMICS **9**

Introduction –Nature and Scope –Significance of Economics for Engineers Basics of Micro Economics: Demand Analysis and Supply Analysis, Elasticity of demand and supply- Case study in Demand Forecasting - Cost concepts – Classifications – Short-run and long-run cost curves- Breakeven analysis,

MODULE II MARKET STRUCTURE **9**

Classifications of the market - Perfect competition, characteristics – Monopoly, Monopolistic competition, Oligopoly, and Duopoly – Price discrimination under different markets – Price and output determination in the short run and long run

MODULE III MONEY AND BANKING **9**

Money – Quantity theory of Money – Supply of Money – RBI Measures of Money Supply – Banking – Functions of Commercial Bank and Central Bank – Balance of Payments – Meaning and methods of Exchange control methods of foreign payments – IMF, IBRD, WTO- Agreements of WTO and its impact on the Indian Economy.

MODULE IV NATIONAL INCOME **9**

Meaning, Definition – National Income concepts – Methods of calculating National Income, Difficulties in calculating National Income – Inflation – Causes, Measures – Deflation, Causes & Measures – Phillips curve, Unemployment and its types- New Environment policy- Liberalization, Privatization and Globalization.

MODULE V HUMAN RESOURCE MANAGEMENT **9**

Principles of Management, Functions – Evaluation of Management, Development of Managerial Skills – Human Resource Management – Importance – Objectives- Job Analysis – Recruitment – Selection and Placement and Training Development

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TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Perceive the significance of Economics and demand forecasting current market trends
CO2: To know about the current market trends
CO3: Comprehend the banking system and money circulation
CO4: Learn the concepts of National Income, Inflation, and Economic policies
CO5: Develop cognizance of the importance of Management Principles

TEXT BOOKS:

1. D N Dwivedi “Managerial Economics” 9th Edition 25 July 2021 S. Chand and company limited, New Delhi
2. P C Tripathy, P N Reddy “Principles of Management” 7th Edition, October 2022, TATA McGraw Hill

REFERENCES:

1. Paul Krugman “Micro Economics” 6th Edition Worth Publishers October 2020
2. Mithani DN, “Money Banking and International Trade”, Himalaya, Mumbai 2013
3. Sethi TT, “Monetary Economic Theory”, S Chand & Co, New Delhi 2009

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1. https://onlinecourses.nptel.ac.in/noc22_hs16/preview
2. https://onlinecourses.nptel.ac.in/noc22_hs72/preview

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1							2								
2															
3															
4									2		3				2
5							2					3			2
Avg.							2		2		3	3			2

1-low, 2-medium, 3-high

23ME	ENGINEERING OPTIMIZATION	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Problem formulation - design variables, constraints, constraint surfaces, objective functions, and objective function surfaces. Classification of optimization - based on the existence of constraints, nature of design variables, the structure of the problem, nature of equation involved, permissible value of the design variables, deterministic nature of the variables, separability of the functions, and the number of objective functions. Example of engineering optimization problems

MODULE II SINGLE VARIABLE OPTIMIZATION **9**

Optimal criteria - bracketing method - exhaustive search method, region elimination method – interval halving, Fibonacci, golden search method, point estimation method - successive quadratic approximation, gradient search method - Newton Raphson's method.

MODULE III MULTIVARIABLE OPTIMIZATION WITH CONSTRAINTS **9**

Multivariable optimization – semi-definite case - saddle point. Multivariable optimization with equality constraints - solution by direct substitution - solution by the method of constrained variation - solution by the method of Lagrange multipliers. Multivariable optimization with inequality constraints - Kuhn-Tucker conditions, constraint qualification.

MODULE IV UNCONSTRAINED OPTIMIZATION **9**

Introduction - classification of unconstrained minimization methods - general approach - rate of convergence - scaling of design variables. Direct Search Methods - random search methods – random walk method with direction exploitation - advantages of random search methods. Indirect Search Methods - gradient of a function - evaluation of the gradient - the rate of change of function along a direction - steepest descent (Cauchy) method.

MODULE V NON-TRADITIONAL OPTIMIZATION TECHNIQUES **9**

Introduction to Genetic Algorithms – Simulated Annealing – Ant colony optimization – Neural-Network based Optimization – Fuzzy optimization techniques – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Apply the theory of optimization methods and algorithms to develop and solve various types of optimization problems

CO2: Formulate single engineering optimization problems and comply with the appropriate objective functions.

CO3: Select the appropriate optimization technique for the specified engineering problems based on several variables and constraints.

CO4: Derive, develop, and utilize the possible randomness or any other associated factors that would possibly occur during unconstrained optimization situations.

CO5: Use modern optimization tools in engineering decision-making.

TEXTBOOKS:

1. S. S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2019.
2. K. Deb, "Optimization for Engineering Design - Algorithms and Examples", 2nd Edition, Prentice Hall India, 2012.

REFERENCES:

1. J. S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press, 2016.
2. Ashok D. Belegundu, Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering", 3rd Edition, Kindle Edition, Cambridge University Press, 2019.
3. Ravindran, K. M. Ragsdell, Reklaitis G.V., "Engineering Optimization: Methods and Applications", John Wiley & Sons, Inc., 2006.

NPTEL

1. https://nptel.ac.in/courses/112/105/112105235/
2. https://nptel.ac.in/courses/105/108/105108127/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3				3	3	3	3	3	3	3
2	3	3	3	3	2				2	3	3	3	2	3	3
3	3	3	3	3	2				2	3	3	3	2	3	3
4	3	3	3	3	2				3	3	1	3	2	3	3
5	3	2	2	3	2				3	3	1	2	1	3	2
Avg.	3.0	2.8	2.8	3.0	2.2				2.6	3.0	2.2	2.8	2.0	3.0	2.8

1-low, 2-medium, 3-high

23ME	ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

MODULE I ENVIRONMENTAL IMPACT ASSESSMENT **9**

Environmental impact assessment objectives – rationale and historical development of EIA – Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive.

MODULE II ENVIRONMENTAL DECISION MAKING **9**

Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring, and management of environmental impacts- Socioeconomic impact assessment.

MODULE III ENVIRONMENTAL POLICY, PLANNING, AND LEGISLATION **9**

Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty, and risk

MODULE IV LIFE CYCLE ASSESSMENT **9**

Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting

MODULE V SUSTAINABLE URBAN ECONOMIC DEVELOPMENT **9**

Spatial economics – Knowledge economy and urban regions.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Describe the concepts of environmental sustainability and trained to make decisions related to the Environment.

CO2: Make a decision that affects our environment

CO3: Evaluate the basics of environmental policy, planning, and various legislation Get valuable information for exploring decisions in each life stage of materials, buildings, services, and infrastructure.

CO4: Clarify the Life cycle assessment of Environmental sustainability.

CO5: Illuminate sustainable urban economic development.

TEXTBOOKS:

1. Aaron J. MacKinnon, Peter N. Duinker, Tony R. Walker “The Application of Science in Environmental Impact Assessment”, Routledge; 1st Edition 2019, ISBN-10: 0367340194
2. Kevin Hanna, “Routledge Handbook of Environmental Impact Assessment”, Routledge; 1st Edition 2022, ISBN-10: 0367244470

REFERENCES:

1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and Sustainable Development – Edward Elgar Publishing, 2007
2. Robort B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005
3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3				3	3	3	3	3	3	3
2	3	3	3	3	2				2	3	3	3	2	3	3
3	3	3	3	3	2				2	3	3	3	2	3	3
4	3	3	3	3	2				3	3	1	3	2	3	3
5	3	2	2	3	2				3	3	1	2	1	3	2
Avg.	**3.0**	**2.8**	**2.8**		**2.2**				**2.6**	**3.0**	**2.2**		**2.0**	**3.0**	**2.8**

1-low, 2-medium, 3-high

23ME	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

MODULE I BASICS OF FINITE ELEMENT METHOD **9**

Introduction –Continuum and discrete modeling - Initial Value Problems and boundary value problems -Energy methods - Variational approach - Rayleigh-Ritz method - Weighted Residual Method: Least squares, Collocation method, Galerkin methods - Strong and weak forms - Solving boundary value problems using finite element method.

MODULE II ONE-DIMENSIONAL ANALYSIS **9**

Degree of freedom - steps in FEA - discretization of domain - linear and quadratic shape functions - natural coordinate system- derivation of element stiffness matrix for elasticity and thermal strain problems - assembly of equations - applying boundary conditions - solution and post-processing - solving problems for elastically deforming bars - Extension of bar elements to solve truss problems - beam elements and problems

MODULE III TWO-DIMENSIONAL ANALYSIS **9**

Plane strain, plane stress, and axisymmetric analysis - Global and natural coordinates, shape functions for higher order formulations -Jacobian matrices and transformations – CST and LST elements - Four node quadrilateral elements - Isoparametric elements - element stiffness matrices and assembly -Numerical integration - Gaussian quadrature-Problems.

MODULE IV APPLICATION TO HEAT TRANSFER AND FLUID MECHANICS **9**

One dimensional heat transfer element - application to one-dimensional heat transfer problems- Applications to simple heat transfer problems in 2- Dimension - Application to simple problems in fluid mechanics in 1-D.

MODULE V DYNAMIC ANALYSIS AND COMPUTER IMPLEMENTATION **9**

Dynamic Analysis - Equation of Motion - Mass & damping matrices - Free Vibration analysis – Natural frequencies of Longitudinal, Transverse, and torsional vibration - Introduction to transient field problems. Computer implementation of FEM – Preprocessing- Solution - Post-processing, solution convergence, h-type, p-type methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Solve governing differential equations of physical problems up to fourth order using variation and weighted residual methods with two and three-parameter trial solutions.

CO2: Generate finite element equation and solve a simple 1D structural problem of bars, beams, and trusses subjected to static loads using a finite element method

CO3: Formulate finite element model and solve 2D structural engineering problems under plane stress, plane strain, and axisymmetric conditions, with and without numerical integration

CO4: Develop a finite element model for eigenvalue problems and determine the natural frequencies of longitudinal, transverse, and torsional vibrations of 1D bar and cantilever and simply supported beams subjected to static loads

CO5: Create finite element equation and analyze 1D and 2D conduction and convection heat transfer problems of composite walls and fins, and fluid flow problems in uniform cross-section pipes and porous media of variable cross-section pipes.

TEXTBOOKS:

1. Fish, J, and T. Belytschko, 'A First Course in Finite Elements', John Wily Sons, 2007.
2. Seshu. P., ‘Textbook of Finite Element Analysis’ Prentice Hall of India, 2012.

REFERENCES:

1. Reddy, J.N., ‘Introduction to Finite Element Method’, 4th Edition (Indian Edition), Tata McGraw-Hill Education, 2020
2. Daryl L. Logan., ‘A First Course in the Finite Element Method’, 6th Edition, 2016
3. Rao S.S., ‘The Finite Element Method in Engineering’ 6th Edition, Elsevier, 2019.
4. Krishnamoorthy. C., ‘Finite Element Analysis: Theory and Programming’ 2nd Edition, Tata McGraw-Hill Education, 2017.
5. Senthil S and R. Panneerdhass, ‘Finite Element Analysis’ Lakshmi publications, 2016.

NPTEL

1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/112/104/112104116/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3								2		
2	3	3	3	3	3								2		
3	3	3	3	3	3								2		
4	3	3	3	3	3								2		
5	3	3	3	3	3								2		
Avg.	**3**	**3**	**3**	**3**	**3**								**2**		

1-low, 2-medium, 3-high

23ME	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

MODULE 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

MODULE II FLOW THROUGH DUCTS **9**

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

MODULE III NORMAL AND OBLIQUE SHOCKS **9**

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications.

MODULE IV JET PROPULSION **9**

Jet Propulsion - Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle of ram jet, turbojet, turbofan and turbo prop engines

MODULE V SPACE PROPULSION **9**

Space Propulsion -Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion– Applications – space flights

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

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

TEXT BOOKS:

1. Yahya S. M ., " Fundamental of Compressible Flow and Aircraft and Rocket Propulsion", New Age International (P) Ltd, 3rd Edition, 2017
2. Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2012.

REFERENCES:

1. Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd.,1980
2. Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 2010.
3. Shapiro. A.H.," Dynamics and Thermodynamics of Compressible fluid Flow", John wiley, New York, 1953.
4. Sutton. G.P., "Rocket Propulsion Elements", John wiley, New York, 2010.
5. Zucrow. N.J., "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, 1970.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2			1	1							1	
2	3	3	2			1	1							1	
3	3	3	2			1	1							1	
4	3	3	2			1	1							1	
5	3	3	2			1	1							1	
Avg.	**3**	**3**	**2**			**1**	**1**							**1**	

1-low, 2-medium, 3-high

23ME	INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3

MODULE I SI ENGINE **9**

Working and constructional details of MPFI petrol engines, GDI, TSI, GDCI, Petrol Injection and – introduction, Ignition, Advanced ignition system, Stages of combustion in petrol engines, Combustion chambers for a petrol engine, formation of a knock-in petrol engine

MODULE II CI ENGINE **9**

Working and constructional details of diesel engines, fuel injection system – requirements, types of injection systems – inline, distributor pumps, unit injector. Fuel injector, Types of injection nozzles, Spray characteristics. Injection timing, Split and multiple injections. Stages of combustion in Diesel engines, direct and indirect combustion chambers for diesel engines, knocking in diesel engines, Introduction to supercharging and turbocharging

MODULE III ENGINE COOLING SYSTEM **9**

Requirements, Types- Air cooling and liquid cooling systems, forced circulation cooling systems, pressure, and Evaporative cooling systems, properties of coolants for IC engine. Need of lubrication, Lubricants for IC engines – Properties of lubricants, Types of lubrication – Mist, Wet and dry sump lubrication systems.

MODULE IV LUBRICATION SYSTEMS **8**

Need of lubrication, Lubricants for IC engines - Properties of lubricants, Types of lubrication – Mist, Wet and dry sump lubrication systems.

MODULE V ADVANCED CI ENGINE **10**

Hydrogen internal combustion engine , HCCI Engines – construction and working, CRDI injection system, GDCI Technology, E-turbocharger, Variable compression ratio engines, variable valve timing technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand different types of IC engines, their cycles, fuel metering, and supply systems. Explain the working and construction of MPFI, GDI, HICE, and TSI engines.

CO2: Differentiate between air, liquid, forced circulation, pressure, and evaporative cooling systems. Understand lubrication methods, lubricant properties, and mist, wet sump, and dry sump systems.

CO3: Explain diesel engine principles, fuel injection requirements, and various injection systems (inline, distributor pumps, and unit injectors). Describe combustion stages, direct and indirect chambers, and knocking in diesel engines.

CO4: Introduce supercharging and turbocharging. Distinguish between HCCI engines, CRDI systems, and GDI technology.

CO5: Understand advanced technologies like E-turbochargers, variable compression ratio engines, variable valve timing, fuel cells, and hybrid electric technology.

TEXT BOOKS:

1. Ganesan.V., Internal Combustion Engines, Tata McGraw Hill Publishing Co., New York,2020
2. Ramalingam. K. K., Internal Combustion Engines, Scitech publications, Chennai, 2003

REFERENCES:

1. Ellinger, H.E., Automotive Engines, Prentice Hall Publishers, 2020.
2. Heldt.P.M. High Speed Combustion Engines, Oxford IBH Publishing Co., Calcutta,1975.
3. Obert E.F., Internal Combustion Engines Analysis and Practice, International Text Books:Co., Scranton, Pennsylvania, 2021.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	2	1	3	2	2		1		1	2	3	1	1
2	3	3	2		1		1	1		1	1	2	3	2	1
3	2	3	2	2	3		2		2			2	3	2	
4	3	1	2		3	1	2	2		2		1	1	1	
5	2	3	1	1	3		2		1		2	2	1	2	1
Avg.	2.2	2.4	1.8	1.3	2.6	1.5	1.8	1.5	1.3	1.5	1.3	1.8	2.2	1.6	1.0

1-low, 2-medium, 3-high

23ME	LEAN AND AGILE MANUFACTURING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO LEAN MANUFACTURING **5**

Objectives of lean manufacturing -Key principles and implications of lean manufacturing - Traditional Vs lean manufacturing.

MODULE II LEAN MANUFACTURING CONCEPTS **8**

Value creation and waste elimination- main kinds of waste. Pull production-different models of pull production. Continuous flow-continuous improvement. Kaizen- worker involvement – cellular layout- administrative lean. Toyota Production System.

MODULE III LEAN MANUFACTURING TOOLS AND METHODOLOGIES **12**

5S, Poka Yoke. Team work and team engagement · ABCXYZ method of supply management. JIT, JIS principles and Kanban. Kanban circles. DFMA (Design for Manufacturing and Assembly). Production layout, process and logistic approach. Layout of production cell. Warehouse layout. TOC (Theory of Constraints) principle and DBR (Drum-Buffer-Rope) methods. SMED (Single Minute Exchange of Die) principles.

MODULE IV AGILE MANUFACTURING **12**

Definition, business need, conceptual framework, characteristics, and generic features. CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing. Cellular manufacturing, concepts, examples. Robust design approach, Approaches to enhance agility in manufacturing. Role of QFD, Managing people in agile organization, Approaches. Applications of multimedia to improve agility in manufacturing.

MODULE V AGILE SUPPLY CHAIN MANAGEMENT **8**

Principles, IT/IS concepts in supply chain management. Enterprise integration and management in agile manufacturing concepts. Agility, Adaptability. Strategic options in agile manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Learn the concepts of Lean, Flexibility, and Agility as applied in automotive manufacturing and supply chain management.
CO2: Acquire the ability to apply tools like Production Line Diagnostics and Value Stream Mapping.
CO3: Understand the best business practices in supply chain management.
CO4: Apply various tools such as 5S, Kanban, JIT and poke yoke in production system
CO5: Decide inputs for locating the integrating points in a supply chain to optimum functionality.

TEXT BOOKS:

1. S N Chary, Production and Operations Management, Tata McGraw-Hill,5th Edition, 2019
2. R Panneerselvam, Production and Operations Management, PHI Learning pvt Ltd, 2012.

REFERENCES:

1. Ohio Seichi, Toyota production System, McGraw Hill, 2001.
2. Korgaonkar, Just in Time Manufacturing, PHI, 1998.
3. Yam Guichi, Total Productive Maintenance, Japanese Institute of Plant Maintenance, Oxford Press, 1994.

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CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	1		2	1	2			1		3		1
2	1	1		1		2			3		1		3		1
3	2	3		1							1		3		2
4	3	3	2	1			1	2	3		1		3		3
5	2	3	1	1		2			3		1		3		2
Avg.	**1.8**	**2.2**	**1.6**	**1**		**2**	**1**	**2**	**3**		**1**		**3**		**1.8**

1-low, 2-medium, 3-high

23ME	MANUFACTURING COST ESTIMATION	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO PROCESS PLANNING **9**

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

MODULE II PROCESS PLANNING ACTIVITIES **9**

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

MODULE III INTRODUCTION TO COST ESTIMATION **9**

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Ladder of Cost - Estimation labor cost, material cost - Allocation of overhead charges- Depreciation, Calculation of depreciation cost

MODULE IV 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.

MODULE V PRODUCTION COST ESTIMATION **9**

Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Select the process, equipment and tools for various industrial products.
CO2: Prepare process planning activity chart and documents related to process [planning activities.
CO3: Explain the concept of estimation, costing along with its procedure and do the depreciation analysis.
CO4: Compute machining time for basic machining processes and special purpose machines
CO5: Prepare cost estimation for different types of jobs and various production processes

TEXT BOOKS:

1. Banga. T.R and Sharma. S.C., "Mechanical Estimating and Costing", Khanna Publishers, New Delhi, 2016.
2. Narang. G.B.S. and Kumar. V., "Production and Costing", Tata McGraw Hill, New Delhi, 2014.

REFERENCES:

1. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
2. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.

3. Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley, 1998.

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CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1								2		
2	3	2	1	1	1								2		
3	2	2	2	2	1				1				1		
4	2	3	2	1	2			2					2		1
5	1	2	2	1	2			2					2		1
Avg.	2	2.25	1.75	1.25	1.5			2	1				1.75		1

1-low, 2-medium, 3-high

23ME	MEASUREMENTS AND CONTROLS	L	T	P	C
		3	0	0	3

MODULE I MEASUREMENTS AND ERROR ANALYSIS **9**

General concepts – Units and standards – Measuring instruments –sensitivity, readability, range, accuracy, precision – static and dynamic response – repeatability hysteresis – systematic and random errors –Statistical analysis of experimental data – Regression analysis – Curve fitting - calibration and Uncertainty.

MODULE II TRANSDUCER AND MEASURING DEVICES **9**

Transducer, modifying (intermediate) and Terminal stages – Mechanical and electrical transducers, preamplifiers – charge amplifiers – filters – attenuators – D' Arsonval – CRO – Oscillographs – recorders – microprocessor-based data logging, processing and output.

MODULE III PARAMETERS FOR MEASUREMENT **9**

Dimension, displacement, velocity, acceleration, Impact – Force, torque, power- Pressure, Temperature, Heat Flux, Heat Transfer Coefficients, Humidity – Flow – Velocity - Time, frequency and phase angle – noise and sound level.

MODULE IV CONTROL SYSTEMS **9**

Basic elements – feedback principle, implication of measurements – Error detectors – final actuating elements – Two position, multi-position, floating, proportional controls – relays – servo amplifiers – servo motors – Electrical, magnetic, electronic control systems.

MODULE V APPLICATION OF CONTROL SYSTEMS **9**

Governing of speed, kinetic and process control – pressure, temperature, fluid level, flow-thrust and flight control – photo electric controls – designing of measurement and control systems for different applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Demonstrate various instruments used for measurement and control systems.
CO2: Identify measurement parameters and evaluate errors of measurements.
CO3: Select a suitable transducer and sensor or a specific measurement process in an industry.
CO4: Apply the principle of automatic control systems to control various parameter(s) in industry automation.
CO5: Develop an automated measurement and control system for specific applications.

TEXT BOOKS:

1. Venkateshan S P, Mechanical Measurements, John Wiley & Sons, Ltd, 2022.
2. William Bolton, Instrumentation and Control Systems, Newnes, 2021.

REFERENCES:

1. Ernest Doebelin and Dhanesh Manik, Measurement Systems, McGraw Hill International Edition, 2019.

2. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Pearson, 2020.
3. Nagrath I J, “Control Systems Engineering”, New Age International Publishers, 2021.
4. NakraB.C , and Chaudhry K.K, Instrumentation, Measurement, and Analysis, Tata McGraw Hill, 4th Edition, 2021.

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CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2	2	1								2		
2	3	2	1	1									2		
3	2	2	2	2					1				1		
4	2	3	2	1									2		
5	1	2	2	1									2		
Avg.	1.8	2.2	1.8	1.4	1				1				1.8		

1-low, 2-medium, 3-high

23ME	POWDER METALLURGY	L	T	P	C
		3	0	0	3

MODULE I POWDER MANUFACTURE AND CONDITIONING **9**

Mechanical methods Machine milling, ball milling, atomization, shotting- Chemical methods, condensation, thermal decomposition, carbonyl Reduction by gas-hydride, dehydride process, electro deposition, precipitation from aqueous solution and fused salts, hydrometallurgical method. Physical methods: Electrolysis and atomisation processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending, Self-propagating high-temperature synthesis (SHS), sol-gel synthesis- Nanopowder production methods.

MODULE II CHARACTERISTICS AND TESTING OF METAL POWDERS **9**

Sampling, chemical composition purity, surface contamination etc. Particle size and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. Adsorption methods and resistivity methods: particle shape, classifications, microstructure. Specific surface area. Apparent and tap density. Green density, Green strength, sintered compact density, porosity, shrinkage.

MODULE III POWDER COMPACTION **9**

Pressure less compaction: slip casting and slurry casting. Pressure compaction- lubrication, single ended and double ended compaction, isostatic pressing, powder rolling, forging and extrusion, explosive compaction.

MODULE IV SINTERING **9**

Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing (HIP), vacuum sintering, sintering furnaces-batch and continuous-sintering atmosphere, Finishing operations – sizing, coining, repressing and heat treatment, special sintering processes- microwave sintering, Spark plasma sintering, Field assisted sintering, Reactive sintering, sintering of nanostructured materials.

MODULE V APPLICATION **9**

Major applications in Aerospace, Nuclear and Automobile industries- Bearing Materials-types, Self-lubrication and other types, Methods of production, Properties, Applications. Sintered Friction Materials-Clutches, Brake linings, Tool Materials- Cemented carbides, Oxide ceramics, Cermet's - Dispersion strengthened materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Explain powder manufacturing methods, conditioning processes, and Nano powder production.

CO2: Proficiently characterize and test metal powders for quality assessment and suitability.

CO3: Demonstrate expertise in powder compaction and sintering techniques for diverse applications.

CO4: Develop skills in sintering processes and finishing operations for desired component properties.

CO5: Identify major applications of metal powders in aerospace, nuclear, and automobile industries, comprehending production methods and properties.

TEXT BOOKS:

1. P.C. Angelo and R. Subramanian.," Powder Metallurgy: Science, Technology and Application" Prentice Hall, 2008
2. Anish Upadhya and G S Upadhaya, "Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011

REFERENCES:

1. R.M. German, Powder Metallurgy Science, Metal Powder Industries Federation, Princeton, New Jersey
2. Sinha A. K., "Powder Metallurgy", Dhanpat Rai& Sons. New Delhi, 1982
3. ASM Handbook. Vol. 7, "Powder Metallurgy", Metals Park, Ohio, USA, 1990.

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CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2	1	2	1	1	1	1	2	2		
2	3	3	2	2	2	1	2	1	1	1	1	2	2		
3	3	2	3	2	3	1	2	1	1	1	1	2	2		
4	3	2	3	2	3	1	2	1	1	1	1	2	2		
5	3	2	2	1	2	1	2	1	1	1	1	2	2		
Avg.	3	2.2	2.4	1.6	2.4	1	2	1	1	1	1	2	2		

1-low, 2-medium, 3-high

23ME	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I HYDROLOGY & HYDRO-ELECTRIC POWER PLANT **8**

Rainfall & Runoff measurements – Hydrographs – Flow duration curves – Mass curves and storage – Hydro-electric power plant – classification – Site selection considerations – Selection and Governing of Turbines, Energy Storage – Pumped Hydro – Compressed Air Energy Storage – Flywheels – electrochemical – magnetic – thermal – chemical energy storage.

MODULE II THERMAL POWER PLANT **10**

General Layout – Site selection considerations – Coal types, classification, handling and storage – Stokers – Burners – Ash handling and dust collection systems – mechanical dust collectors – electrostatic precipitators – Draught and its types – Chimneys.

MODULE III NUCLEAR & DIESEL POWER PLANT **8**

Nuclear energy – Isotopes – Radioactivity – Radioactive decay - Nuclear fission and fusion – Nuclear reactors – Types – Site selection considerations – Nuclear waste – effects – radioactive waste disposal system. Diesel Power Plant – Layout and components – comparison of diesel with thermal power plants

MODULE IV POWER PLANT ECONOMICS **11**

Terms and Factors – Tariffs – Economics of Power Generation –Load curves – Ideal and Realized load curves – Effect of variable loads – Energy economics – Total and net energy – EROEI – Metrics for energy economics – Payback period – return on investment – net present value – levelized cost of energy – input-output analysis.

MODULE V NON-CONVENTIONAL POWER GENERATION **8**

Non-Conventional Power Generation – MHD – Thermionic Power Generation – Thermoelectric Power Generation – Fuel Cells – Geothermal energy – Hydrogen energy

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Identify a suitable hydroelectric power plant from the run-off details available.
CO2: Select suitable components for a thermal power plant based on the requirements specified.
CO3: Compare different power plants and choose the relevant one based on the environment and available resources.
CO4: Sketch hydrographs, flow duration curves, and load curves for the details specified.
CO5: Identify the Non-Conventional Power Generation – MHD – Thermionic Power Generation – Thermoelectric Power Generation – Fuel Cells – Geothermal energy – Hydrogen energy. Power plant from the run-off details available.

TEXT BOOKS:

1. Domkundwar S, “Power Plant Engineering”, Dhanpat Rai and Sons, 2016.
2. Sharma P C, “Power Plant Engineering”, S K Kataria and Sons, 2019.

REFERENCES:

1. Nag P K, “Power Plant Engineering”, 4th Edition, Tata McGraw Hills Publications, 2017.
2. Nagpal G R, "Power Plant Engineering", Khanna Publishers, 2002.
3. Morse F P, "Power Plant Engineering", Affiliated East West Press Ltd, 2003.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	3	2	2	-	1	-	1	2	3	2	1
2	3	3	2	-	3	-	2	1	-	2	1	2	3	2	1
3	3	3	2	2	3	-	2	-	2	-	-	2	3	2	
4	3	3	2	-	3	1	2	2	-	2	-	2	3	2	
5		3	1	1	3	-	2	-	1	-	2	2	3	2	1
Avg.	**3**	**3**	**1.83**	**1.33**	**3**	**1.5**	**2**	**1.33**	**1.33**	**1.66**	**1.33**	**2**	**3**	**2**	**1**

1-low, 2-medium, 3-high

23ME	PRECISION MANUFACTURING	L	T	P	C
		3	0	0	3

MODULE I PRECISION ENGINEERING **9**

Introduction to Precision Engineering, Need for precision manufacturing, Taniguchi diagram, Four Classes of Achievable Machining Accuracy – Normal, Precision, High-precision, Ultraprecision Processes and Nanotechnology.

MODULE II PRECISION MACHINING **9**

Overview of Micro- and Nano-machining, Conventional Micro Machining techniques - Micro turning, Micro-milling, micro-grinding, Ultra-precision diamond turning, Non-conventional Micromachining techniques – Abrasive jet and Water jet micromachining, Ultrasonic Micromachining, Micro Electrical Discharge machining, Photochemical machining, Electro Chemical Micromachining

MODULE III MACHINE DESIGN FOR PRECISION MANUFACTURING **9**

Philosophy of precision machine design, Ultra-Precision Machine Elements: Guide- ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Bearings: Principle, construction and application of Rolling, Hydrodynamic and Hydrostatic Bearings, Aerostatic Bearings, Magnetic bearings

MODULE IV MECHANICAL AND THERMAL ERRORS **9**

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors – background, thermal effects, Environmental control of precision machinery. Error mapping and error budgets.

MODULE V MEASUREMENT AND CHARACTERISATION **9**

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus-Based Optical Metrology- Fringe projection method, Measurement of Typical Nano features.

Surface metrology - 3D surface topography - Need, Measurement – Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the need, significance and progress of precision manufacturing and the different levels of manufacturing.

CO2: Understand the principle and working of different methods of precision machining.

CO3: Understand the special construction requirements of precision machine tools.

CO4: Understand the errors involved in precision machine tools and calculate the error budgets for a given situation.

CO5: Select a suitable measurement solution to measure and characterize precision machined features.

TEXT BOOKS:

1. Jain, V.K., Introduction to micromachining, Narosa publishers, 2018
2. Venktesh V.C., Sudin Izman, Precision Engineering, Tata Mc.Graw Hill Publishing Company, New Delhi 2007.

REFERENCES:

1. David Dornfeld, Dae-Eun Lee, Precision Manufacturing, Springer, 2008.
2. Jain, V.K., Micromanufacturing Processes, CRC Press, 2012.
3. Joseph McGeough, Micromachining of Engineered Materials, Marcel Dekker Inc., 2002.
4. Kevin Harding, "Handbook of Optical Dimensional Metrology, Series: Series in Optics and optoelectronics", Taylor & Francis, 2013.
5. Murty, R.L., Precision Engineering in Manufacturing, New Age publishers, 2005

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CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	2	1	1	1	2	2	2	3		
2	3	2	2	1	2	3		1	1	2	3	3	2		
3	3	3	2	2	1	2			2	2	3	3	1		
4	3	3	2	2	1	2	1		2	2	3	3	1		
5	3	3	2	1	2	2	1		2	2	2	3	1		
Avg.	**3**	**2.8**	**2**	**1.6**	**1.6**	**2.2**	**1**	**1**	**1.6**	**2**	**2.6**	**2.8**	**1.6**		

1-low, 2-medium, 3-high

23ME	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

MODULE I FACILITIES LOCATION AND LAYOUT **9**

Introduction - plant location - facilities layout - classification of layout - modular design concepts- facilities layout in manufacturing - layout design procedures - Computerized Relative Allocation of Facilities (CRAFT) - features and benefits of CRAFT. Automated Layout Design Program (ALDEP), COmputerized RElationship Layout Planning (CORELAP)

MODULE II FORECASTING **9**

Introduction - forecasting - Techniques - simple averaging method - moving averages - exponential smoothing - SES. Holt's linear method – Holts - winter trend and seasonality method.

MODULE III AGGREGATE & DISAGGREGATE PLANNING **9**

Aggregate Planning - Nature and scope - Alternatives for responding to fluctuation in orders - Managerial inputs to aggregate planning, Pure and Mixed strategies – Transportation Method.

Disaggregation - Master Production Schedule (MPS) – Role, terminology, Inputs/output, performance measures - Bill of Materials (BOM) - types.

MODULE IV CAPACITY REQUIREMENT PLANNING **9**

Capacity Requirement Planning (CRP) - measuring Capacity - available capacity. Loads - Planned and unplanned loads. CRP - Inputs/ outputs – scheduling strategies -finite vs infinite loads - benefits and Drawbacks of CRP.

MODULE V LOT SIZING & SCHEDULING DECISIONS **9**

Lot Sizing - Fixed order quantity (FOQ), Economic Order Quantity (EOQ), Lot for Lot (LOL), Fixed Period Requirements (FPR), Periodic Ordering Quantity (POQ), Least Unit Cost (LUC), Least Total Cost (LTC), Part Period Balancing (PPB), and Wagner - Whitin Algorithm.

Scheduling techniques - First Come First Serve (FCFS) - Earlier Due Date (EDD) - Shortest Processing Time (SPT) - Last in First out (LIFO) - Least slack time (LST). Critical ratio - least change over cost - Single machine sequencing. Two / N - machine scheduling problems - Johnson's algorithm. Job shop scheduling.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Create a new layout or improvise the existing layout in the manufacturing/service sector to provide uninterrupted services by utilizing the resources efficiently.

CO2: Conduct forecasts in the manufacturing and service sectors using appropriate quantitative and qualitative forecasting techniques.

CO3: Implement the concepts of Aggregate, Disaggregate and Capacity Requirement Planning in the manufacturing/service sector.

CO4: Identify and recommend an appropriate production strategy under uncertain demand.

CO5: Apply lot sizing and scheduling rules in managing inventories and meet customer demands.

TEXT BOOKS:

1. Mukhopadhyay SK., "Production Planning and Control: Text and Cases", Phi Learning, 2nd Edition, 2014.
2. Kanishka Bedi, "Production and Operations Management", Oxford University Press, 2nd Edition, 2019

REFERENCES:

1. D.R. Kiran, “Production Planning and Control: A Comprehensive Approach”, 1st Edition, Butterworth-Heinemann, 2019.
2. Elwood S. Buffa and Rakesh K. Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2007.
3. S N Chary, “Production and Operations Management ", 6th Edition, McGraw-Hill India, 2019.
4. Norman Gaither, Frazier G., "Operations Management", Thomson Learning, 9th Edition IE, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	3	2	2	1	1	2	2	2	2	2	2
2	3	3	2	2	3	2	2	1	1	2	2	3	1	1	1
3	3	3	3	2	3	2	2	1	1	2	2	3	2	2	2
4	3	3	3	2	3	2	2	1	1	2	2	3	1	2	1
5	3	3	3	2	3	2	2	1	1	2	2	3	2	2	2
Avg.	3	2.8	2.8	2	3	2	2	1	1	2	2	2.8	1.6	**1.8**	**1.6**

1-low, 2-medium, 3-high

23ME	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

MODULE I AIR CYCLE REFRIGERATION **9**

Review of Thermodynamic, Principles of Refrigeration – Bell Coleman Refrigeration cycle - Aircraft cycle – Simple, Bootstrap and regenerative cycle analysis – COP calculations. REFRIGERANT SELECTION Properties - Eco-friendly refrigerant, Selection of refrigerants. Advanced vapor compression, absorption cycles, Refrigerants and their mixtures: properties and characteristics

MODULE II VAPOUR COMPRESSION SYSTEM **9**

T-s and p-h charts – Analysis – Performance of systems under varying operating conditions - Multi-stage refrigeration working principles – Analysis.

MODULE III VAPOUR ABSORPTIONSYSTEM **9**

Ammonia – water systems, three fluid systems. Water – lithium bromide system – comparison – steam jet refrigeration, solar refrigeration.

MODULE IV BASIC COMPONENTS OF REFRIGERATION SYSTEM **9**

Condensers – Air cooled, water cooled and evaporative condensers - Evaporators – Flooded, dry expansion, shell and tube, double pipe - Compressors – reciprocating, rotary and centrifugal types - Expansion Devices – Capillary and TEV.

MODULE V AIR CONDITIONING SYSTEM **9**

Psychrometric processes – use of psychrometric chart – by-pass factor - Air-conditioning cycles – winter, summer and year-round air-conditioning system, evaporator, condenser pipe - Duct design – economic considerations - Methods – air-distributing systems – humidification - Air cleaning – controls – window air conditioners, split type AC.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Perform basic calculations related to various refrigeration cycles and air conditioning processes.
CO2: Differentiate between various refrigerants, selection and their characteristics.
CO3: Analysis by using T-S and P-h charts of vapour and understand concepts of absorption systems
CO4: Analyze thermodynamic processes occurring inside compressors and condensers and expansion devices used in refrigeration systems.
CO5: Analyze the air – conditioning system problems by using Psychometric charts

TEXT BOOKS:

1. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd., Third Edition, 2007.
2. Domkundwar and Arora, "A Course in Refrigeration and Air Conditioning", Dhanpat Rai and Co. (P) Ltd., 2007

REFERENCES:

1. Arora C P, “Refrigeration and Air Conditioning”, Tata McGraw Hill Publishing Company Ltd., NewDelhi, 2010.
2. Roy J Dosat, Principles of Refrigeration, Prentice Hall of India Pvt Ltd, 2005
3. Stocker W F and Jones J W, Refrigeration and Air Conditioning, McGraw Hill book Company, 1995
4. ASHRAE – Fundamental Volume, ISHRAE Handbook

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	2										1	
2	1	1	1				2					1		1	
3	2	2	1	1										1	
4	3	2	3	2											
5	2	2	2	2										1	
Avg.	2	1.8	1.6	1.75			2					1		1	

1-low, 2-medium, 3-high

23ME	ROBOTICS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO ROBOTICS **9**

Introduction, brief history, definition, anatomy, classification, specification, role and need of robots for the immediate problems of the society, future of mankind and automation, ethical issues; industrial scenario local and global

MODULE II ROBOT CONFIGURATION AND GRIPPERS **9**

Robot geometrical configurations - wrist and gripper subassemblies - robot drives system. General Structure of robotic workspace, robotic workspace performance index, extreme reach of robotic hands.

MODULE III TRAJECTORY PLANNING **9**

Robotic task description, robotic motion, trajectory design, general design considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory

MODULE IV ROBOT KINEMATICS **9**

Robot kinematics - Geometric approach for 2R, 3R manipulators, homogenous transformation using D-H representation, Forward kinematics, inverse kinematics - analytical and geomentrical approach

MODULE V RECENT TRENDS IN ROBOTICS **9**

Mapping & Navigation – SLAM, types of control architectures - Cartesian control, hybrid position/velocity control, Behaviour based control, application of neural network, fuzzy logic, optimization, Application of Machine learning.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the basic concepts associated with the design, functioning, applications and social aspects of robots
CO2: Select suitable robot configuration and end effectors
CO3: Define robot task and design the suitable trajectory
CO4: Learn about various motion planning techniques and the associated control architecture
CO5: Understand the implications of AI and other trending concepts of robotics

TEXT BOOKS:

1. Saeed. B. Niku, Introduction to Robotics, Analysis, system, Applications, Pearson educations, 2002
2. Roland Siegwart, Illah Reza Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2011

REFERENCES:

1. Richard David Klafter, Thomas A. Chmielewski, Michael Negin, Robotic engineering: an integrated approach, Prentice Hall, 1993
2. Craig, J. J., Introduction to Robotics: Mechanics and Control, 2nd Edition, Addison-Wesley, 1989.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	2	1	2	2	1	1	2	1	2	2	2	1	1
2	2	2	2	1	1	1	2	1	2	3	3	2	1	2	1
3	1	2	2	3	2	2	2	2	2	3	1	2	1	1	3
4	2	1	2	3	1	2	2	3	2	2	1	2	1	2	2
5	3	3	2	3	1	1	2	1	1	1	1	1	2	1	1
Avg.	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**2**

1-low, 2-medium, 3-high

23ME	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

MODULE II TQM PRINCIPLES **9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planningCustomer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

MODULE III TQM TOOLS & TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability Bench marking - Reasons to benchmark, Benchmarking process, What to Benchmark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

MODULE IV TQM TOOLS & TECHNIQUES II **9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

MODULE 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, students will be able to

CO1: Explain the basic concepts of TQM and its framework suitable for a product or process.

CO2: Apply TQM principles for various processes and analyze the quality of customers and suppliers.

CO3: Demonstrate Six Sigma, Traditional tools, new tools, Benchmarking and FMEA.

CO4: Apply Taguchi's Quality Loss Function, Performance Measures like QFD, TPM, COQ and BPR.

CO5: Select suitable quality standards and Apply Quality Management system for maintaining the quality of industry and society.

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre,HemantUrdhwareshe and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, 2018
2. Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017

REFERENCES:

1. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
3. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1								2		
2	3	2	1	1	1								2		
3	2	2	2	2	1				1				1		
4	2	3	2	1	2			2					2		1
5	1	2	2	1	2			2					2		1
Avg.	**2.2**	**2.2**	**1.8**	**1.4**	**1.4**			**2**	**1**				**1.8**		**1**

1-low, 2-medium, 3-high

23ME	TRIBOLOGY	L	T	P	C
		3	0	0	3

MODULE I SURFACES AND FRICTION **9**

Fundamentals and history of tribology-topography of engineering surfaces- Contact between surfaces - Laws of friction - Causes of friction - Theories of Friction - Sliding and Rolling Friction, laws of friction, Friction properties of metallic and non-metallic materials - Friction instability - measurement methods.

MODULE II WEAR **9**

Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture - wear - Wear of Ceramics and Polymers - Wear Measurements.

MODULE III LUBRICATION OF LUBRICANTS **9**

Importance of lubrication - Boundary Lubrication - mixed lubrication - solid lubrication - Hydrostatic and Hydrodynamic lubrication - Elastohydrodynamic lubrication - Lubricants - Types, and properties of lubricants - Additives - Selection of Lubricants - Lubricants standards

MODULE IV FLUID FILM LUBRICATION AND APPLICATION OF TRIBOLOGY **9**

Fluid mechanics concepts, Equations of Continuity and Motion, Generalized Reynolds Equation with Compressible and Incompressible Lubricants. Introduction, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings.

MODULE V TRIBOLOGY TESTING AND APPLICATIONS **9**

Common Geometries, Instrumentation and Methods used for Testing, Influences of Test Parameters –Tribology in metal cutting –Automotive Tribology – Nano scale tribology-Interatomic Interactions Atomic Force Microscope (AFM) - Challenges of Tribological Testing at Small Scales.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Identify the surface topography of various components and estimate friction characteristics.
CO2: Estimate wear in interacting surfaces.
CO3: Apply the principles of Lubrication.
CO4: Calculate the pressure and estimate load carrying capacity of a bearing.
CO5: Test the components and characterize tribological failures.

TEXT BOOKS:

1. GwidonStachowiak, Andrew W Bachelor, Engineering Tribology, Butterworth-Heinemann, 2013.
2. Williams.J.A, “Engineering Tribology”, Cambridge University Press, 2012.

REFERENCES:

1. Bharat Bhushan, Introduction to Tribology, John Wiley & Sons, 2013.
2. Majumdar, “Introduction of Tribology and bearings”, A.H. Wheeler Co, 2010.
3. M.M.Khonsari&E.R.Booser, “Applied Tribology”, John Willey & Sons, New York, 2001.
4. Dudley D. Fuller, “Theory and practice of Lubrication for Engineers”, John Wiley and Sons, 1984.
5. Cameron A., “Basic Lubrication Theory”, Wiley Eastern Ltd, 1987.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-										
2	3	3	2	-	-		1						1		2
3	3	3	2	-	-		1	1					1		
4	3	3	3	2	1		1	1					3		3
5	3	3	3	2	1		1	1					3		3
Avg.	**3**	**2.8**	**2.2**	**2**	**1**		**1**	**1**					**2**		**2.6**

1-low, 2-medium, 3-high

23ME	WORK SYSTEM DESIGN	L	T	P	C
		3	0	0	3

MODULE I PRODUCTIVITY **9**

Definition - Reasons for low productivity - Methods to improve productivity - Concept of work study and productivity – Possibility guides - Methods study - Scope of motion and time study- Productivity measurement - Productivity models - Kurosawa structural approach, Lawlor's approach, Gold's approach, Quick Productivity Appraisal approach (QPA), Inter-firm comparison (IFC) - Work methods design.

MODULE II METHOD STUDY **9**

Total work content, Developing methods - Process analysis - Process charts, Process flow charts - Multiple activity charts – Man and Machine chart - Two handed process chart - String diagram - Travel chart - Cycle graph - Chrono-cycle graph - Therbligs - Micro motion and memo motion study - Simo chart - Principles of motion economy - Development and installation of new method.

MODULE III WORK MEASUREMENT AND ITS METHODS **9**

Work sampling - Various techniques of work - Measurement of work - Stopwatch time study & its procedure - Job selection - Equipment and forms used for time study - Rating, methods of rating, allowances and their types - Determining time standards from standard data and formulas - Predetermined motion time standards - Work factor system - Methods time measurement, Analytical Estimation

MODULE IV APPLIED WORK MEASUREMENT **9**

Measuring work by physiological methods - Heart rate measurement - Measuring oxygen consumption- Establishing time standards by physiology methods - Methods Time Measurement (MTM) and its application to production and maintenance - Organization and Methods (O&M) - Wage incentive plans.

MODULE V ERGONOMICS **9**

Motion economy- Ergonomics practices - Human Factors Engineering - Human performance in physical work under heat, cold, illumination, vibration, noise, pollution, static and dynamic conditions, human body measurement - Layout of equipment – Seat design - Design of controls and compatibility - Environmental control - Vision and design of displays. Design of work space, chair table.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

CO2: Calculate Work Measurement with various types and techniques will be able to apply the time study for job and equipment selection

CO3: Design, implement and improve systems that include people, materials, information, equipment, and energy.

CO4: Compare the operations and using systematic approach to improve the shop floor operations.
CO5: Develop equipment and devices by considering ergonomic factors

TEXT BOOKS:

1. Groover, M. P. Work Systems and the Methods, Measurement, and Management of Work, New Jersey: Pearson Education Inc, 2007.
2. Niebel, B. and Freivalds, A. Methods, Standards, and Work Design, 12th Edition, Boston: McGraw-Hill, 2013.

REFERENCES:

1. Barnes, R.M. “Motion and Time Study”, John Wiley and sons, 2002.
2. Bridger, R.S. “Introduction to Ergonomics”, McGraw Hill, 1995.
3. “Introduction to work study”, ILO, 3rd Edition, Oxford & IBH publishing, 2001.
4. Konz, S. and Johnson, S. “Work Design: Industrial Ergonomics”, 5th Edition, Holcomb Hathaway.
5. Marvin, E., Mundel. And David, L. “Motion & Time Study: Improving Productivity”, Pearson Education, 2000.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-										
2	3	3	2	-	-		1						1		2
3	3	3	2	-	-		1	1					1		
4	3	3	3	2	1		1	1					3		3
5	3	3	3	2	1		1	1					3		3
Avg.	**3**	**2.8**	**2.2**	**2**	**1**		**1**	**1**					**2**		**2.6**

1-low, 2-medium, 3-high

VERTICAL 1

	BIOMATERIALS	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF BIOMATERIALS **9**

Introduction - Biomaterial – Biocompatibility, Bioinert/tolerant, Bioactive, Bioresorbable -Host Response - Experimental Evaluation of Biocompatibility - Steps for characterizations of biomaterials

MODULE II BIOMATERIALS **9**

Introduction - Structure and Properties of Hard Tissues-Processing and Properties of Bioceramics and Bioceramic Composites - Calcium Phosphate Based Biomaterials - Hydroxyapatite-Ceramic Composites - Glass-Ceramics Based Biomaterials - Mica Based Glass Ceramics - Other Bioglass-Ceramics - Bioinert Ceramics - Polymeric Biomaterials - Polymer Composites - Polymer-Ceramic Composites HDPE-HAp-Al_2O_3 Hybrid Composites - Metals and Alloys in Biomedical Applications - Issues Limiting Performance of Metallic Biomaterials - Ti-Based Alloys.

MODULE III FABRICATION AND CHARACTERIZATIONS OF BIOMATERIALS **9**

Introduction – Processing and Fabrication of Biomaterials - Metals - Ceramics - Polymers - Biocomposites -Micro/Nano- Film. Structural Characterizations (FTIR, XRD, SEM, AFM), Mechanical Characterizations (Tensile Strength, Compressive Strength, Flexural Strength, Shore D Hardness) and as per ASTM standards, Thermal Characterizations (DSC, TGA), tribological Characterizations *Wear* and Corrosion.

MODULE IV IN-VITRO AND IN-VIVO CHARACTERIZATIONS OF BIOMATERIALS **9**

Sterilization, in-vitro tests (Direct and Indirect Cytotoxicity), in-vivo tests (Short-and Long Term Implantations), in-vitro wound scratch, Tryan blue staining, cells attachment.

MODULE V APPLICATION OF BIOMATERIALS **9**

Applications in Medicine, Biology, and Artificial Organs - Cardiovascular Medical Devices - Extracorporeal Artificial Organs - Orthopedic Implants - Dental Implantation-Bioadhesive - Ophthalmologic Applications - Cochlear Prosthesis - Drug Delivery - Tissue Engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Identify the suitable biomaterial for human implants and perform structural, mechanical, and tribological characterizations.

CO2: Carry out experiments for biomaterials to find out the microstructure (SEM, AFM) and evaluation of Interfacing, bonding, particle dispersion, size of the particle, internal defects.

CO3: Estimate the percentage of reinforcement to increase the strength under specified constraints for human implants.

CO4: Estimate the percentage of cell viability, percentage of cytotoxicity through in-vitro and in-vivo characterizations

CO5: Design and develop the implants for dental and implant applications

TEXT BOOKS:

1. Bikramjit Basu, Dhirendra Katti, & Ashok Kumar 2009, ‘Advanced biomaterials fundamentals, processing, and applications’, A John Wiley & Sons, Inc, Publication
2. Joon. B. Park and Joseph D. Bronzino 'Bio Materials - Principles and Applications', CRC press, 2013

REFERENCES:

1. Park J. B. and Lakes R.S., 'BioMaterials - An Introduction', Plenum Press, New York, 2012
2. J. L. Ong, Mark R. Appleford, Gopinath Mani., ‘Introduction to Biomaterials: Basic Theory with Engineering Applications’, Cambridge University Press, UK, 2014

NPTEL:

1. https://nptel.ac.in/courses/113104009

ONLINE MATERIALS:

1. https://onlinecourses.nptel.ac.in/noc24_bt28/preview
2. https://shodhganga.inflibnet.ac.in/handle/10603/434739

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	1	1						2	2		2
2	3	3	3	3	2	1						2	2		3
3	3	3	3	3	2	1						1	2		3
4	3	3	2	3	2	1						1	2		3
5	3	3	3	3	2	1							2		3
Avg.	**3**	**2.8**	**2.6**	**2.6**	**1.8**	**1**						**1.2**	**2**	**0**	**2.8**

1-low, 2-medium, 3-high

VERTICAL 1

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

MODULE I DESIGN TERMINOLOGY **9**

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

MODULE II INTRODUCTION TO DESIGN PROCESSES **9**

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

MODULE III CREATIVITY IN DESIGN **9**

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

MODULE IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT **9**

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

MODULE V MATERIAL AND PROCESSES IN DESIGN **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Analyze the various design requirements and get acquainted with the processes involved in product development.
CO2: Apply the design processes to develop a successful product.
CO3: Apply scientific approaches to provide design solutions.
CO4: Design solution through relate the human needs and provide a solution.
CO5: Apply the principles of material selection, costing and manufacturing in design.

TEXT BOOKS:

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

REFERENCES:

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

NPTEL:

1. https://archive.nptel.ac.in/courses/107/101/107101086/
2. https://nptel.ac.in/courses/107106089

ONLINE MATERIALS:

1. https://www.youtube.com/watch?v=YogRDMa6ALs
2. https://www.digimat.in/nptel/courses/video/107106089/L01.html

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3					1			1	3	1	
2	3	3	3	3					1			1	3	1	
3	3	3	3	3					1			1	3	1	
4	3	3	3	3					1			1	3	1	
5	3	3	3	3					1			1	3	1	
Avg.	**3**	**3**	**3**	**3**					**1**			**1**	**3**	**1**	

1-low, 2-medium, 3-high

VERTICAL 1

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

MODULE I INTRODUCTION AND DFM APPROACH **9**

Methodologies and tools, design axioms, design for assembly and evaluation. Minimum part assessment - Taguchi method. Robustness assessment, manufacturing process rules, failure mode effect analysis, value analysis. Design for minimum number of parts, development of modular design, Poka Yoke principles.

MODULE II GEOMETRIC ANALYSIS **9**

Process capability, feature tolerance, geometric tolerance, surface finish, tolerance grades. Analysis of tapers, screw threads probability to tolerances.

MODULE III FORM DESIGN **9**

Redesign of castings based on parting line consideration, minimizing core requirements, redesigning cast numbers using weldments, use of welding symbols.

MODULE IV DESIGN FOR ASSEMBLY **9**

Selective assembly, deciding the number of groups, control of axial play, grouped datum systems - types, geometric analysis and applications - design features to facilitate automated assembly.

MODULE V TRUE POSITION THEORY **9**

Virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges. Operation sequence for typical shaft type of components. Preparation of process drawings for different operations, tolerance worksheets and centrality analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Design mechanical parts for use in a flexible automation system for the increased effectiveness and to automate assembly of existing design.

CO2: Design such a system with no errors and defects so that they can be used for subsequent assembly and subassembly.

CO3: Implement newer approaches for the better form design with the help of knowledge on positional tolerances.

CO4: Design the components suitable for various manufacturing processes such as welding, casting, and machining.

CO5: Identify and design components according to standards.

TEXT BOOKS:

1. Harry Peck, "Design for Manufacture", Pitman Publications, 1983.
2. Matousek, "Engineering Design - A Systematic Approach", Blackie & Son Ltd., London, 1999.

REFERENCES:

1. *Geoffrey Boothroyd, Peter Dewhurst , Winston A. Knight "Product Design for Manufacture and Assembly", 2010*.

2. M. P. Groover, Fundamentals of modern manufacturing: materials, processes and systems, 4th ed. John Wiley & Sons, 2010.
3. Shah, J. J., Anderson, D., Kim, Y. S., & Joshi, S 'A discourse on geometric feature recognition from CAD models', Journal of Computing and Information Science in Engineering, 1(1), 2001

NPTEL:

1. https://nptel.ac.in/courses/107103012

ONLINE MATERIAL:

1. https://www.dfma.com/forum/2019pdf/dewhurstpres.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	1	1						2	2		2
2	3	3	3	3	2	1						2	2		3
3	3	3	3	3	2	1						1	2		3
4	3	3	2	3	2	1						1	2		3
5	3	3	3	3	2	1							2		3
Avg.	**3**	**2.8**	**2.6**	**2.6**	**1.8**	**1**						**1.2**	**2**	**0**	**2.8**

1-low, 2-medium, 3-high

VERTICAL 1

	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO STRESS ANALYSIS **9**

Stresses, Strains and Displacements – Determination of Principal Values of Stresses and Strains in 2-D & 3-D – Maximum Shear Stress – Strain Measurement Using Mechanical Extensometers – Principles of Measurements – Basic Characteristics and Requirements of a Measuring System – Sources of error – Statistical Analysis of Experimental Data – Non-Contact Measurement.

MODULE II STRAIN MEASUREMENT TECHNIQUES **9**

Electrical Strain Gauges: Principles and Applications – Optical Strain Measurement Techniques: Moiré Fringes, Speckle Interferometry – Acoustic Emission Techniques for Strain Measurement – Advanced Strain Measurement Methods: Digital Image Correlation (DIC), Strain Rosettes – Calibration and Validation of Strain Measurement Devices.

MODULE III STRESS ANALYSIS USING PHOTOELASTICITY **9**

Principles of Photoelasticity – Isoclinics and Isochromatics: Interpretation and Analysis – Types of Photoelastic Materials and their Properties – Applications of Photoelasticity in Structural Analysis – Limitations and Challenges of Photoelastic Stress Analysis.

MODULE IV EXPERIMENTAL TECHNIQUES FOR STRUCTURAL ANALYSIS **9**

Load Testing Methods: Tensile, Compression, Bending, and Shear Tests – Instrumentation for Structural Analysis: Strain Gauges, Load Cells, Displacement Transducers – Data Acquisition Systems and Signal Processing Techniques – Structural Health Monitoring: Condition Assessment and Damage Detection – Case Studies and Real – World Applications of Structural Analysis Techniques.

MODULE V MODERN METHODS IN EXPERIMENTAL STRESS ANALYSIS **9**

Digital Image Correlation (DIC): Principles and Applications – Moiré Interferometry and Holographic Interferometry – Nano indentation Techniques for Mechanical Characterization – High-Speed Imaging Techniques for Dynamic Stress Analysis – Multi-Scale Experimental Approaches in Stress Analysis: From Micro to Macroscopic Scales.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Comprehend the fundamental principles of stress, strain, and displacement analysis in structures, enabling them to determine principal values of stresses and strains in both 2-D and 3-D scenarios, and calculate maximum shear stress.

CO2: Gain proficiency in employing various strain measurement techniques, including electrical strain gauges and optical methods such as moiré fringes, enabling them to accurately measure and interpret strain in structural components.

CO3: Apply principles of photo elasticity to analyze stress distribution in structural components, interpret isoclinic and isochromatic, and understand the limitations and challenges associated with photo elastic stress analysis.

CO4: Acquire practical skills in conducting load testing methods such as tensile, compression,

bending, and shear tests, utilizing instrumentation like strain gauges, load cells, and displacement transducers for structural analysis.

CO5: Master with modern experimental stress analysis methods such as digital image correlation (DIC) and moiré interferometry, enabling them to effectively analyze stress distribution across different scales and dynamic scenarios.

TEXT BOOK:

1. Dally, J. W., & Riley, W. F. (2020). Experimental Stress Analysis (3rd ed.). McGraw-Hill Education.

REFERENCES:

1. Starr, J. E. (2021). Photoelasticity for Designers (3rd ed.). Springer.
2. Tedesco, J. W., McDougal, W. G., & Ross, C. A. (2022). Structural Dynamics: Theory and Applications (7th ed.). Wiley.
3. Dally, J. W., & Riley, W. F. (2023). Advanced Experimental Stress Analysis (2nd ed.). Pearson Education

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	3	2	2	1	1	2	1	2	2		
2	3	3	2	2	3	2	2	1	1	2	1	2	2		
3	3	3	3	2	3	2	2	1	1	2	1	2	2		
4	3	3	3	3	3	2	2	1	1	2	1	2	3		
5	3	3	3	3	3	2	2	1	1	2	1	2	3		
Avg.	3	2.8	2.6	2.4	3	2	2	1	1	2	1	2	2.4		

1-low, 2-medium, 3-high

VERTICAL 1

	SMART MATERIALS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO SMART MATERIALS **9**

Smart materials -The principal ingredients of smart materials - Generation of smart materials - Diverse areas of smart materials - Primitive functions of smart materials - System intelligence-components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems - Wolff's law, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect.

MODULE II PIEZOELECTRIC MATERIALS **9**

Electrostriction - Pyroelectricity - Piezoelectricity -Piezoelectric effect direct and converse-Industrial piezoelectric materials - PZT - PVDF - PVDF film - Properties of piezoelectric materials - Piezoceramics, Piezopolymers - Bimorphs – SAW filters. Piezeoelctric Strain Sensors, Accelerometers, Active Fibre Sensing.

MODULE III SHAPE - MEMORY (ALLOYS) MATERIALS **9**

Shape memory alloys (SMA) - Nickel - Titanium alloy (Nitinol) - Materials characteristics of Nitinol - Thermoelastic martensitic transformations -SMA memorization process, Shape memory effect (SME), One way and two-way SME, training of SMAs, Functional properties of SMAs - Applications of SMA - SMA fibers - Micro robot actuated by SMA - Satellite antenna applications.

MODULE IV ELECTRO-RHEOLOGICAL AND MAGNETORHEOLOGICAL FLUIDS **9**

Bingham-body model - Newtonian viscosity and non-Newtonian viscosity - Principal characteristics of electro rheological and magnetorheological fluids - The electrorheological phenomenon - Charge migration mechanism for the dispersed phase –Magnetorheological effect Applications of electrorheological and magnetorheological fluids.

MODULE V SMART POLYMERS AND HYDROGELS **9**

Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Drug delivery using smart polymers Hydrogel - Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Hydrogels in microfluidics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand various smart materials and its importance in engineering application.

CO2: Describe the effect of piezoelectricity.

CO3: Analyze the functionality of shape memory materials.

CO4: Explain the working of Magnetorheological and Electrorheological phenomenon.

CO5: Apply smart polymers and hydrogels for sensing and actuation.

TEXT BOOKS:

1. Smart Structures and Materials, Brain Culshaw, Artech House, London, 1996.
2. Smart Materials and Structures, Mukesh V. Gandhi, Brian S. Thompson, , Springer, May 1992

REFERENCES:

1. Smart Structures: Analysis and Design, A. V. Srinivasan, Cambridge University Press,Cambridge, New York, 2001..
2. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi, Springer, Berlin, New York, 2002.
3. K. Otsuka, C.M. Wayman (Eds.), Shape Memory Materials, Cambridge University Press, 1998.
4. Engineering aspects of Shape memory Alloys, T. W. Duerig, K. N. Melton, D. Stockel,C

NPTEL:

1. https://nptel.ac.in/courses/112104173/
2. https://nptel.ac.in/courses/112104251/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2		2	2								2		
2	2	2		2	2								2		
3	2	2		2	2								2		
4	2	2		2	2								2		
5	2	2		2	2								2		
Avg.	**2**	**2**		**2**	**2**								**2**		

1-low, 2-medium, 3-high

VERTICAL 1

	TOOL ENGINEERING AND DESIGN	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

General requirement of machine tool design, techno-economic prerequisites.

MODULE II DESIGN OF CUTTING TOOLS **9**

Cutting tool materials, properties, classification, selection, tool wear, and tool life. Single point tools: nomenclature, types and styles, design and manufacture of tools in HSS and carbides, tools for turning, boring, shaping, planning and slotting operations, form tools, tools and holders for CNC applications. Multipoint cutters, nomenclature, classification and selection, construction methods, design and manufacture of drills, reamers, taps, dies, thread chasers, milling cutters, broachers, hobs and gear shaping cutters.

MODULE III MACHINE TOOLS **9**

Kinematics structure & mechanical, hydraulic and electrical drives, design of hydrostatic, hydrodynamic and antifriction guideways, design of spindles, design of speed box and feed box, stepped and step less regulations of speed and feed diagram, ray diagram, layout of spindles drive and feed drive in machine tools, machine tool structures, design of bed, heard stock, spindle supports and power screws, machine tool dynamics.

MODULE IV JIGS AND FIXTURES DESIGN **9**

Applications in manufacturing, principle of location & clamping, types of locators and clamps, design of jigs and fixtures, selection of materials.

MODULE V DIE AND PUNCH DESIGN **9**

Applications in manufacturing, design of various types of dies, selection of materials for casting and forging dies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Develop the conceptual design, manufacturing framework and systematic analysis of design Problems on the machine tools.

CO2: Apply the design procedures for different types of design problems such as gearbox design, guide way design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.

CO3: Design, develop, and evaluate cutting tools and work holders for a manufactured product.

CO4: Design and develop the JIGS and Fixture for holding the product manufacturing.

CO5: Design and develop the die and punching tools and work holders for a manufactured product

TEXT BOOKS:

1. Mehta, N. K., Machine Tool Design & Numerical Control, McGraw Hill, New Delhi, 2017.

2. Cyrill Donoldson.V.C, Tool Design, 4th Edition, Tata McGraw Hill, 2017.

REFERENCES:

1. Pandey, P.C. and Singh, C.K., Production Engineering Sciences, Standard Publishers, 7th Edition, New Delhi (2013).
2. Basu, S. K. and Pal, D.K., Design of Machine Tools, Oxford & IBH Publishing Co Pvt.Ltd, 2018.
3. Ranganath, B.J., Metal cutting and tool design, Vikas Publishing House Pvt.Ltd., New Delhi 2018.
4. Sen, G.C. and Bhattacharya, A., Machine Tools, New Central Book Agency, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	2						2	2		2
2	3	3	3	3	2	2						2	1		3
3	3	3	3	3	2	2						2	2		1
4	3	3	3	3	2	1						3	2		3
5	3	3	3	3	2	1							2		3
Avg..	**3**	**3**	**3**	**3**	**2**	**1.6**						**1.8**	**1.8**	**0**	**2.4**

1-low, 2-medium, 3-high

VERTICAL 2

23ME	COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER	L	T	P	C
		2	1	0	3

MODULE I GOVERNING EQUATIONS OF FLUID FLOW AND HEAT TRANSFER 6 + 3

Introduction - Governing equations of fluid flow and heat transfer - Navier-Stokes (N-S) equations for a Newtonian fluid, Classification of PDEs and Physical Significance.

MODULE II IRROTATIONAL FLOWS 6 + 3

Introduction - Potential functions and stream functions - Numerical treatment of steady irrotational flows in two dimensions.

MODULE III LAMINAR BOUNDARY LAYERS 6 + 3

Simple two-dimensional laminar flows - Boundary layer over a flat plate – Blasius solution - Numerical treatment of ordinary differential equations related to Blasius solution.

MODULE IV NUMERICAL HEAT TRANSFER – FINITE VOLUME METHOD 6 + 3

Introduction - Discretization of governing partial differential equations of heat transfer- Applications to steady and unsteady heat conduction in one and two dimensions - Treatment of heat sources – Explicit and implicit solution schemes for steady and unsteady heat conduction.

MODULE V NUMERICAL TREATMENT OF FLUID FLOW – FINITE VOLUME METHOD 6 + 3

Discretization of governing partial differential equations of fluid flow - Differencing schemes for convective diffusive flows - Treatment of flow boundary conditions - Introduction to the SIMPLE Algorithm.

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Derive the governing equations of fluid flow and heat transfer, Classify and explain their physical significance

CO2: Analyze numerically steady irrotational flows in two-dimensions.

CO3: Analyze laminar boundary layer flow in two-dimensions and solve Blasius equation numerically.

CO4: Apply finite volume method to solve steady and unsteady heat conduction in two dimensions

CO5: Analyze fluid flow numerically using the finite volume method and explain the SIMPLE algorithm

TEXT BOOKS:

1. Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", Ane Books Pvt. Ltd. New Delhi, 2017.
2. John D, Anderson, Jr., "Computational Fluid Dynamics - The basics with Applications", McGraw Hill, New Delhi, 9th reprint, 2015.

REFERENCES:

1. Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Pearson Education, 2nd Edition, England, 2007.
2. Muralidhar K., Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa

Publishing House, New Delhi, 2014.
3. Chung T.J., "Computational Fluid Dynamics", Cambridge Univ. Press, New York, 2002.

NPTEL:

1. https://nptel.ac.in/courses/112105045
2. https://nptel.ac.in/courses/112/105/112105254/

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3					2		1	3		
2	3	1	1	1	2					2		2	3		
3	3	2	2	2	3					2		2	3		2
4	3	2	2	2	3					3		2	3		2
5	3	3	3	3	3					3		2	3		3
Avg.	3	2.2	2.2	2	2.8					2.4		1.8	3		2.3

1-low, 2-medium, 3-high

VERTICAL 2

23ME	COMPUTATIONAL SOLID MECHANICS	L	T	P	C
		2	1	0	3

MODULE I BASIC ON THEORY OF ELASTICITY 6 + 3

Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lame's constant –cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.

MODULE II FINITE ELEMENT METHOD FOR STATIC LINEAR ELASTICITY 6 + 3

Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variational forms; mixed methods. Accuracy and convergence; the Patch test.

MODULE III NON-LINEAR AND HISTORY DEPEND PROBLEMS 6 + 3

Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity -Large strain visco-plasticity.

MODULE IV TIME DEPENDENT AND DYNAMIC PROBLEMS 6 + 3

First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration.

MODULE V STRUCTURAL ELEMENTS & INTERFACES AND CONTACT 6 + 3

Continuum Beams – Shells – Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions)

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Discuss the definition and basics on theory of elasticity.
CO2: Derive the finite element method for static linear elasticity and solve problems.
CO3: Discuss and solve Non-Linear and History depend problems.
CO4: Discuss and solve time dependent and dynamic problems.
CO5: Discuss and solve Structural Elements & Interfaces and contact problems.

TEXT BOOKS:

1. L.S.Srinath, Advanced Mechanics of Solids, 3rd Edition 2008.
2. S.Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010.

REFERENCES:

1. The Mechanics of Solids and Structures - Hierarchical Modeling and the Finite Element Solution (Computational Fluid and Solid Mechanics) by Miguel Luiz Bucalem and Klaus-Jurgen Bathe 25 February 2013.
2. The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid

Mechanics) by Dominique Chapelle and Klaus-Jurgen Bathe | 27 January 2013

3. Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics)by M. Kojic and Klaus-Jurgen Bathe | 22 October 2010.
4. High-Resolution Methods for Incompressible and Low-Speed Flows (Computational Fluid and Solid Mechanics) by D. Drikakis and W. Rider | 22 October 2010.
5. Discontinuous Finite Elements in Fluid Dynamics and Heat Transfer (Computational Fluid and Solid Mechanics) by Ben Q. Li | 22 October 2010.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1					1			1	3		
2	3	3	2	1					1			1	3		
3	3	3	2	1					1			1	3		
4	3	3	2	1					1			1	3		
5	3	3	2	1					1			1	3		
Avg.	**3**	**3**	**2**	**1**					**1**			**1**	**3**		

1-low, 2-medium, 3-high

VERTICAL 2

23ME	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	L	T	P	C
		2	1	0	3

MODULE I INTRODUCTION TO MACHINE LEARNING 6 + 3

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

MODULE II CLUSTERING AND SEGMENTATION METHODS 6 + 3

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

MODULE III FUZZY LOGIC 6 + 3

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples. Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic with mechanical Application.

MODULE IV NEURAL NETWORKS 6 + 3

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics.

MODULE V RNN AND REINFORCEMENT LEARNING 6 + 3

Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics and mechanical devices.

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand basic machine learning techniques such as regression, classification.
CO2: Understand about clustering and segmentation.
CO3: Model a fuzzy logic system with fuzzification and defuzzification.
CO4: Understand the concepts of neural networks and neuro fuzzy networks.
CO5: Gain knowledge on Reinforcement learning.

TEXT BOOKS:

1. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011.

REFERENCES:

1. Bruno Siciliano, Oussama Khatib, “Handbook of Robotics”, 2016 2nd Edition, Springer.
2. Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, Delhi 2016.
3. Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester, 2011, Sussex Wiley

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		3		2					3					
2		2				2		3					2		
3	3		3		2							2			
4										2					
5												2			
Avg.	2.5	2	3		2	2		3		2.5		2	2		

1-low, 2-medium, 3-high

VERTICAL 2

23ME	PYTHON PROGRAMMING	L	T	P	C
		2	1	0	3

MODULE I INTRODUCTION TO PYTHON PROGRAMMING LANGUAGE 6 + 3

Introduction to Python Language and installation, overview on python interpreters, working with python, Numeric Data Types: int, float, Boolean, complex and string and its operations, Standard Data Types: List, tuples, set and Dictionaries, Data Type conversions, commenting in python.

MODULE II VARIABLES AND OPERATORS 6 + 3

Understanding Python variables, multiple variable declarations, Python basic statements, Python basic operators: Arithmetic operators, Assignment operators, Comparison operators, Logical operators, Identity operators, Membership operators, Bitwise operators, Precedence of operators, Expressions.

MODULE III CONTROL FLOW AND LOOPS 6 + 3

Conditional (if), alternative (if-else), chained conditional (if- elif else), Loops: For loop using ranges, string, Use of while loops in python, Loop manipulation using pass, continue and break.

MODULE IV FUNCTIONS 6 + 3

Defining Your Own Functions, Calling Functions, passing parameters and arguments, Python Function arguments: Keyword Arguments, Default Arguments, Variable length arguments, Anonymous Functions, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables. Powerful Lambda functions in python.

MODULE V I/O AND ERROR HANDLING IN PYTHON 6 + 3

Introduction, Access Modes, Writing Data to a File, Reading Data from a File, Additional File Methods introduction to Errors and Exceptions, Handling IO Exceptions, Run Time Errors, Handling Multiple Exceptions.

Introduction to Data Structures: Types of Data structures, Introduction to Stacks and Queues.

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Interpret the fundamental Python syntax and semantics and be fluent in the use of Python control flow statements.

CO2: Express proficiency in the handling of strings and functions.

CO3: Determine the methods to create and manipulate Python programs by utilizing the data structures like lists, dictionaries, tuples and sets.

CO4: Identify the commonly used operations involving file systems and regular expressions.

CO5: Articulate the Object-Oriented Programming concepts such as encapsulation, inheritance and polymorphism as used in Python.

TEXT BOOKS:

1. R. Nageswara Rao, “Core Python Programming”, Dreamtech.
2. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist ‘‘, 2nd Edition, Shroff/O‘Reilly Publishers, 2016.

REFERENCE:

1. Introduction to Python, Kenneth A. Lambert, Cengage.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	3	2	2	1	2	2	2	3	3	2	
2	3	2	2	1	3	2	2	1	2	2	2	3	3	2	
3	3	3	2	1	3	2	2	1	2	2	2	3	3	2	
4	3	2	2	1	3	2	2	1	2	2	2	3	3	2	
5	3	3	2	1	3	2	2	1	2	2	2	3	3	2	
Avg.	3	2.4	2	1	3	2	2	1	2	2	2	3	3	2	

1-low, 2-medium, 3-high

VERTICAL 2

23ME	THEORY ON COMPUTATION AND VISUALIZATION	L	T	P	C
		2	1	0	3

MODULE I REVIEW OF MATHEMATICAL THEORY 6 + 3

Sets, Functions, Logical statements, Proofs, Relations, Languages, Principle of Mathematical Induction, Strong Principle, Recursive Definitions, Structural Induction.

MODULE II REGULAR LANGUAGES AND FINITE AUTOMATA 6 + 3

Regular Expressions, Regular Languages, Application of Finite Automata, Automata with output – Moore machine & Mealy machine, Finite Automata, Memory requirement in a recognizer, Definitions, union intersection and complement of regular languages, Non-Deterministic Finite Automata, Conversion from NFA to FA, Kleene's Theorem, Minimization of Finite automata, Regular and Non Regular Languages – pumping lemma.

MODULE III CONTEXT FREE GRAMMAR (CFG) AND PUSHDOWN AUTOMATA 6 + 3

Definitions and Examples, Unions Concatenations and Kleene's of Context free language, Regular Grammar for Regular Language, Derivations and Ambiguity, Unambiguous CFG and Algebraic Expressions, Bacos Naur Form (BNF), Normal Form – CNF. Definitions, Deterministic PDA, Equivalence of CFG and PDA &amp.

MODULE IV VALUE OF VISUALIZATION 6 + 3

Information Visualization, In Readings in Information Visualization, Graphical Excellence, Graphical Integrity, Sources of Graphical Integrity In The Visual Display of Quantitative Information.

MODULE V DESIGN VISUALIZATION 6 + 3

The Power of Representation, Data-Ink and Graphical Redesign, Data-Ink Maximization and Graphical Design, Data Density and Small Multiples.

TOTAL (30+15): 45 PERIODS

COURSE OUTCOMES

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

CO1: Discuss the concepts and techniques of discrete mathematics for theoretical computer science.
CO2: Explain the different formal languages and their relationship.
CO3: Discuss to classify and construct grammars for different languages and vice-versa.
CO4: Explain Visualization, Graphical and Quantitative Information.
CO5: Apply the Visualization design and data Ink.

TEXT BOOKS:

1. Michael Sipser, "Introduction to the Theory of Computation" Thomson course Technology; 2006.
2. John Hopcroft, Rajeev Motowani, and Jeffrey Ullman, "Automata Theory, Languages, and
3. Computation" Addison Wesley; 2001.

REFERENCES:

1. John Martin, “Introduction to Languages and the Theory of Computation”, 4th, Tata Mc Graw Hill; 2010.
2. Adesh K. Pandey, “An introduction to automata theory and formal languages” S.K. Kataria& Sons; 2013.
3. Deniel I. Cohen, “Introduction to computer theory” Joh Wiley & Sons, Inc; 1986.
4. Marvin L. Minsky , “Computation: Finite and Infinite” Prentice-Hall; 1967

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	2	2				3	2		3	2		1
2	3	1	1	2	2				3	2		3	2		1
3	3	1	1	2	2				3	2		3	2		1
4	3	1	1	3	2				3	2		3	2		1
5	3	2	1	3	2				3	2		3	2		1
Avg.	3	2	2	3	2				3	2		3	2		1

1-low, 2-medium, 3-high

VERTICAL 2

23ME	COMPUTATIONAL BIOMECHANICS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO BIOMECHANICS **9**

Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles.

MODULE II BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM **9**

Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle.

MODULE III BIOMECHANICS OF JOINTS AND HUMAN MOTION **9**

Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.

MODULE IV COMPUTATIONAL APPROACHES IN BIOMECHANICS **9**

Finite Element Analysis in Biomechanics, Computational modeling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.

MODULE V GAIT ANALYSIS **9**

Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Explain the principles and concepts of biomechanics.
CO2: Comprehend the studies of tissues and structure of the musculoskeletal system.
CO3: Describe the mechanics of joints and human motion.
CO4: Explain the computational approaches in biomechanics.
CO5: Explain the quantification of forces and motion

TEXT BOOKS:

1. Susan J Hall, —Basic Biomechanics, 6th Edition, the McGraw-Hill Companies Inc., 2011.
2. Jay D Humphrey and Sherry L Delange, —An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st Edition, Springer-Verlag, 2010.

REFERENCES:

1. Margareta Nordin and Victor H Frankel, —Basic Biomechanics of the Musculoskeletal System, 3rd Edition, Lippincott Williams and Wilkins, 2001.
2. Ozkaya, Nihat, Nordin, and Margareta, —Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, 2nd Edition, Springer, 2009.
3. Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose, Advances in Computational

Approaches in Biomechanics, 2022.

4. Kinetics and Dynamics: From Nano- to Bio-Scale: 12 (Challenges and Advances in Computational Chemistry and Physics) by Piotr Paneth and Agnieszka Dybala-Defratyka | 12 August 2010.
5. Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity) by Gábor Náray-Szabó and Arieh Warshel | 31 March 2002.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2	2	2	1	1	2	1	2	2		
2	3	2	2	1	2	2	2	1	1	2	1	2	2		
3	3	2	2	1	2	2	2	1	1	2	1	2	2		
4	3	2	3	2	3	2	2	1	1	2	1	2	3		
5	3	2	3	2	3	2	2	1	1	2	1	2	3		
Avg.	3	2	2.4	1.4	2.4	2	2	1	1	2	1	2	2.4		

1-low, 2-medium, 3-high

VERTICAL 3

23ME	DIGITAL MANUFACTURING AND IOT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.

MODULE II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT **9**

Collaborative product development, Mapping requirements to specifications – Part numbering, Engineering vaulting, and product reuse – Engineering change management, Bill of material and process consistency – Digital mock up and Prototype development – Virtual testing and collateral. Overview of digital supply chain - Scope& Challenges in Digital SC - Effective digital transformation - Future practices in SCM

MODULE III SMART FACTORY **9**

Smart Factory – Levels of smart factories – Benefits – Technologies used in Smart factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

MODULE IV INDUSTRY 4.0 **9**

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.

MODULE V STUDY OF DIGITAL TWIN **9**

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Impart knowledge to use various elements in digital manufacturing.
CO2: Differentiate the concepts involved in digital product development life cycle process and supply chain management in the digital environment.
CO3: Select the proper procedure for validating practical work through digital validation in Factories.
CO4: Implementation of the concepts of IoT and its role in digital manufacturing.
CO5: Analyse and optimize various practical manufacturing processes through digital twin.

TEXT BOOKS:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.

REFERENCES:

1. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.
2. Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017
3. Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		1	1	3	3		1	2	2		2	3	2	1
2	3	2	3	1	3	3	2	2	2	2		2	3	2	3
3	3		3	1	3	3	2		3	2		2	3	2	3
4	3	2	2	2	3	3	2	2	2	2	2	2	3	2	3
5	3		2		1	3		2	2	2		2	3	2	2
Avg.	3	2	2.2	1.2	2.6	3	2	1.7	2.2	2	2	2	3	2	2.4

1-low, 2-medium, 3-high

VERTICAL 3

23ME	DRIVES AND ACTUATORS FOR ROBOTICS	L	T	P	C
		3	0	0	3

MODULE I RELAY AND POWER SEMI-CONDUCTOR DEVICES **9**

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT - Triggering and commutation circuit - Introduction to Driver and snubber circuits.

MODULE II DRIVE CHARACTERISTICS **9**

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

MODULE III DC/AC MOTORS **9**

DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications.

MODULE IV ELECTRICAL DRIVES **9**

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

MODULE V STEPPER AND SERVO MOTOR **9**

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation-Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Familiarize A Relay And Power Semiconductor Devices.
CO2: Get a Knowledge On Drive Characteristics.
CO3: Obtain the Knowledge on DC & AC Motors and Drives
CO4: Obtain the Knowledge on Stepper and Servo Motor
CO5: Select Suitable Drive System for Real Time Application

TEXT BOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2019.

REFERENCES:

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2. Theraja B.L. A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
3. Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”,

Springer., Switzerland, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	2	1	2	2	1	1	2	1	2	2	2	1	1
2	2	2	2	1	1	1	2	1	2	3	3	2	1	2	1
3	1	2	2	3	2	2	2	2	2	3	1	2	1	1	3
4	2	1	2	3	1	2	2	3	2	2	1	2	1	2	2
5	3	3	2	3	1	1	2	1	1	1	1	1	2	1	1
Avg.	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**2**

1-low, 2-medium, 3-high

VERTICAL 3

	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO MICROCONTROLLER **9**

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

MODULE II PROGRAMMING AND COMMUNICATION **9**

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

MODULE III PERIPHERAL INTERFACING **9**

I/O Programming – Interfacing of Memory, Keyboard and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

MODULE IV ARM PROCESSOR **9**

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

MODULE V SINGLE BOARD COMPUTERS AND PROGRAMMING **9**

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages -– Python for Embedded Systems- GPIO Programming – Interfacing

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Explain the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.

CO2: Develop microcontroller programming and data exchange methods using various communication protocols.

CO3: Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing

CO4: Clarify ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.

CO5: Explain architecture of single board computers and Develop real time programming applications using embedded operating systems.

TEXT BOOKS:

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

REFERENCES:

1. Muhammad Ali Mazidi and Janice GillispicMazdi, “The 8051 Microcontroller and Embedded Systems”, Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd Edition, 2015.
3. James W. Stewart, “The 8051 Microcontroller Hardware, Software and Interfacing”, Regents Prentice Hall, 2003.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		3	3									3		
2	3		2	3	3							2		3	
3	3	3	2	2		3						3	3	2	
4	3		3	3		3						3		3	
5	2	2	2		2		3	3				2	2	2	
Avg.	2.6	2.5	2.5	2.7	2.5	3.0	3.0	3.0				2.7	2.7	2.5	

1-low, 2-medium, 3-high

VERTICAL 3

23ME	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO INDUSTRY 4.0 **9**

Introduction - Industrial Revolutions - Road to Industry 4.0 - Digitalization - Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Comparison of today's factory and an Industry 4.0 factory.

MODULE II INDUSTRIAL IOT (IIOT) **9**

Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.

MODULE III IOT IN MANUFACTURING **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.

MODULE IV AUGMENTED REALITY **9**

Augmented Reality (AR) in Industry 4.0: Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance, Assembly, Collaborative Operations.

MODULE V CASE STUDIES AND APPLICATIONS **9**

Industry 4.0: Opportunities and Challenges - Works and Skills for Workforce in I4.0 Era - Strategies. Case study & applications: Industry 4.0 in Car Manufacturing – Electronics Manufacturing – IOT Based Building Automation - Agricultural Automation. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Identify the need of industry 4.0 and its inter-connectivity.

CO2: Interpret the architecture of IoT and its protocols.

CO3: Familiar with the concepts of integrated IOT.

CO4: Relate the effectiveness of Smart Factories, Smart cities, Smart products and Smart services.

CO5: Design and develop the Industrial IoT Systems for various applications.

TEXT BOOKS:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, 2019.
2. Jolanda G. Tromp, Dac-Nhuong Le , Emerging Extended Reality Technologies for Industry 4.0- 1st Edition, 2020.

REFERENCES:

1. Kiran Kumar Pabbathi, “Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0”, Create space Independent Publishing Platform, 2018.
2. Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess, Rivers Publishers, 2016, ISBN 978-87-93379-81-7
3. The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in

Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017, ISBN 978-3-6581-6502-4.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		3	3									3		
2	3													3	
3	3	3	2	2		3						3	3	2	
4	3		3	3		3						3		3	
5	2	2	2		2		3	3				2	2	2	
Avg.	2.6	2.5	2.5	2.7	2.0	3.0	3.0	3.0				2.7	2.7	2.5	

1-low, 2-medium, 3-high

VERTICAL 3

23ME	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO SENSORS **9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

MODULE II MOTION, PROXIMITY AND RANGING SENSORS **9**

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

MODULE III FORCE, MAGNETIC AND HEADING SENSORS **9**

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

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors,

MODULE IV TEMPERATURE, FLOW AND SMART SENSORS **9**

Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

MODULE V SIGNAL CONDITIONING AND DAQ SYSTEMS **9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the concepts of measurement technology.
CO2: Select the sensors used to measure various physical parameters.
CO3: Specify various sensor dynamical characteristics
CO4: Explore various optical, pressure and temperature sensor
CO5: Execute effective signal conditioning, data acquisition and communication systems used in mechatronics system development

TEXT BOOKS:

1. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th Edition New Delhi, 2015.
2. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGrawHill, 2017.

REFERENCES:

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2004.
2. Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	2	2	1	3	2	2	1	2	1	2	1	3	1
2	1	2	2	3	2	2	3	2	2	3	1	1	1	2	2
3	3	1	3	2	3	1	1	3	1	1	1	2	1	1	1
4	1	3	1	1	1	3	1	2	2	1	2	1	2	2	2
5	3	1	2	3	2	3	2	3	1	2	2	1	1	1	2
Avg.	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**2**

1-low, 2-medium, 3-high

VERTICAL 3

23ME	SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO AUTOMATED VEHICLES **9**

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicle

MODULE II SENSOR TECHNOLOGY FOR SMART MOBILITY **9**

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

MODULE III CONNECTED AUTONOMOUS VEHICLE **9**

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomous

MODULE IV VEHICLE WIRELESS TECHNOLOGY & NETWORKING **9**

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

MODULE V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY **9**

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Explain key electronics in smart, connected vehicles - infotainment, body, chassis, and powertrain.
CO2: Gain proficiency in sensor tech like radar, lidar, and camera for smart mobility applications.
CO3: Analyze and apply control systems and cyber-physical theory for autonomous vehicles and data fusion
CO4: Understand wireless networking and connected car tech for V2V and V2I communication
CO5: Critically evaluate technical, ethical, legal, and social aspects of autonomous vehicles

TEXT BOOKS:

1. “Intelligent Transportation Systems and Connected and Automated Vehicles”, 2016, Transportation Research Board.
2. Radovan Miucic, “Connected Vehicles: Intelligent Transportation Systems”, 2019, Springer.

REFERENCES:

1. Tom Denton, “Automobile Electrical and Electronic systems, Roult edge”, Taylor & Francis Group, 5th Edition, 2018.
2. Autonomous Vehicles: Definitions and a Framework for Regulation" by National Academies of Sciences, Engineering, and Medicine, 2019.
3. "Control Systems for Robotics and Automation" by A. Isidori (2013).
4. "Cyber-Physical Systems: Foundations, Principles, and Applications" by Raj Rajkumar and Insup Lee (2016).
5. "Fundamentals of Wireless Communication" by Andrea Goldsmith (2020)

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1		1						1	2	1	
2	3	2	1	1		1						1	2	1	
3	3	2	1	1		1						1	2	1	
4	3	2	1	1		1						1	2	1	
5	3	2	1	1		1						1	2	1	
Avg.	**3**	**2**	**1**	**1**		**1**						**1**	**2**	**1**	

1-low, 2-medium, 3-high

VERTICAL 4

23ME	ADVANCED HEAT TRANSFER	L	T	P	C
		3	0	0	3

MODULE I CONDUCTION **9**

General heat conduction in 3D for cartesian and cylindrical coordinates, types of boundary conditions, heat conduction in radial fins – Bessel functions, Analytical solution to one-dimensional unsteady heat conduction problems in cartesian coordinates.

MODULE II CONVECTION **10**

Forced Convection - External flows – hydrodynamic and thermal boundary layers – the von Karman Pohlhausen integral approach, Internal flows – fully developed 2D flow through circular pipes.

Natural Convection – Boussinesq approximation – laminar natural convection over a vertical plate.

MODULE III RADIATION **10**

Electromagnetic Spectrum, Relation between intensity and emission, Planck's distribution, Shape factor computation for simple geometries, Radiosity-Irradiation method for radiation heat exchange between gray surfaces, Radiation in Participating Media.

MODULE IV BOILING AND CONDENSATION, MASS TRANSFER **7**

Heat transfer with phase change, boiling curve, critical heat flux, correlations for boiling heat transfer, laminar film condensation on a flat plate - Nusselt's theory, Mass Transfer – Classification.

MODULE V NUMERICAL SOLUTIONS OF HEAT TRANSFER PROBLEMS **9**

Steady 2D heat conduction - Finite difference method, 1 D Unsteady heat conduction – Implicit and Explicit Schemes, 1D convection-diffusion equation – Finite volume method, 1 D heat conduction of a fin in vacuum – finite difference method.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Model heat conduction in radial fins and 1D unsteady heat conduction problems to obtain their solutions analytically.
CO2: Analyze forced and natural convective flows.
CO3: Estimate radiation heat exchange between gray surfaces.
CO4: Classify two-phase heat transfer and mass transfer.
CO5: Numerically solve simple problems in heat transfer.

TEXT BOOKS:

1. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 7th Edition, 2011.
2. Versteeg, H. K. and W Malalasekara, "An Introduction to Computational Fluid Dynamics", Pearson, 2nd Edition, 2007.

REFERENCES:

1. Bryon Bird, R., Warren E. Stewart and Edwin N. Lightfoot, “Transport Phenomena”, John Wiley, 2nd Edition, 2002.
2. Amir Faghri, “Heat Pipe Science and Technology”, 2nd Edition, Global Digital Press, 2016.
3. Sreenivas Jayanti, “Computational Fluid Dynamics for Engineers and Scientists”, Springer, 2018
4. Venkateshan, S. P., “Heat Transfer”, Ane books, 3rd Edition, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1							2	3		1
2	3	3	2	2	2							2	3		1
3	3	3	3	2	2							2	3		1
4	1	1	1	1								1	2		1
5	2	2	2	2	3							2	3		
Avg.	2.4	2.2	2	1.8	2							1.8	2.8		1

1-low, 2-medium, 3-high

VERTICAL 4

23ME	ADVANCED FLUID MECHANICS	L	T	P	C
		3	0	0	3

MODULE I FLUID STATICS **9**

Hydrostatic forces on surfaces – plane, curved and layered fluids, Metacentric Height and Stability, Pressure Distribution in Rigid body motion.

MODULE II GOVERNING EQUATIONS OF FLUID FLOW **10**

Integral relations for a control volume - Reynolds transport theorem - Conservation equations of Mass - Linear Momentum Equation – Angular Momentum Theorem – Energy Equation

Differential relations for a fluid particle – Conservation equation of Mass Linear Momentum Equation – Angular Momentum Theorem – Energy Equation – Boundary Conditions.

MODULE III FLUID KINEMATICS **8**

Stream-function and velocity potential, Vorticity transport equation, Vorticity – stream function equation for 2-D flows, Specification of boundary conditions.

MODULE IV VISCOUS FLOWS **9**

External flow over a flat plate - Boundary layer theory, Integral Momentum Equation, Skin Friction Coefficient

Internal flows – Flow through circular pipes - Developing and fully developed flows.

MODULE V NUMERICAL TREATMENT OF FLUID FLOW **9**

Flow over a flat plate - Blassius similarity solution, Discretization of governing partial differential equations, the constraint in incompressible flows, co-located vs staggered grid, SIMPLE algorithm.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Analyze hydrostatic forces of surfaces, stability of rigid bodies in a fluid, and compute pressure distribution in a rigid body motion of a fluid.

CO2: Develop integral and differential forms of governing equations of fluid flow.

CO3: Distinguish rotational and irrotational flow and obtain governing equations in terms of vorticity and stream function.

CO4: Analyze viscous flows over a flat plate and through circular pipes to obtain velocity and pressure field.

CO5: Explain numerical methods to solve simple fluid flow problems.

TEXT BOOKS:

1. Muralidhar K. and Biswas G., "Advanced Engineering Fluid Mechanics", 3rd Edition. Alpha Science Intl., New Delhi, 2014.
2. White, Frank. M. and Henry Xue, “Fluid Mechanics”, 9th Edition, Mc Graw Hill, 2022.

REFERENCES:

1. Versteeg, H. K. and W Malalasekara, “An Introduction to Computational Fluid Dynamics”, Pearson, 2nd Edition, 2007.

2. John D, Anderson, Jr., "Computational Fluid Dynamics - The basics with Applications", McGraw Hill, New Delhi, 9th reprint, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3		2	1	1				2	3		
2	3	2	1									2	2		
3	3	3	2	2	2							2	3		
4	3	3	3	3	2							3	3		
5	3	2	2	2	2					2		2	3		
Avg.	3	2.6	2.2	2.5	2	2	1	1		2		2.2	2.8		

1-low, 2-medium, 3-high

VERTICAL 4

23ME	CRYOGENICS	L	T	P	C
		3	0	0	3

MODULE I GAS LIQUEFACTION SYSTEM **9**

System performance parameters - ideal system, liquefaction systems - simple Linde - Hampson, Claude systems - systems for neon, hydrogen and helium.

MODULE II CRYOGENIC REFRIGERATION SYSTEM **9**

Claude refrigerator - Philips refrigerator, Solvay, Gifford-Mc Mahon refrigerators - magnetic cooling - magnetic refrigerators systems.

MODULE III SEPARATION AND PURIFICATION SYSTEMS **9**

Theoretical plate calculations of air columns - air separation systems - Linde double column systems - Argon, Neon, Hydrogen and Helium separation systems - Gas purification methods.

MODULE IV MEASUREMENT SYSTEM **9**

Temperature, pressure, flow rate, fluid quality, liquid level measurement systems.

MODULE V STORAGE AND APPLICATIONS **9**

Cryogenic fluid storage systems - vacuum technology - applications of cryogenics - Benefits of cryogenic treatment-Wear resistance, Stress Relieving, Hardness.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Analyze different gas liquefaction systems and estimate their figure of merit and examine refrigeration systems used for above and below 2K to evaluate their performance parameters.

CO2: Calculate the theoretical number of plates in rectification columns used for gas separation.

CO3: Compare and choose appropriate system for measurement of temperature, pressure, flow rate, fluid quality, and liquid level at cryogenic temperatures.

CO4: Design inner and outer vessels for cryogenic storage for given parameters of volume, pressure and material.

CO5: Calculate pump-down time for a vacuum system. Choose appropriate insulation for a given cryogenic system and estimate the heat transfer rate through the insulation.

TEXT BOOKS:

1. Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", Prentice Hall of India, 2010.
2. Randal F. Barron, "Cryogenic Systems", Oxford University Press, 1985.

REFERENCES:

1. Thomas M. Flynn, "Cryogenic Engineering", 2nd Edition, Taylor and Francis, 2005.
2. Guglielmo Ventura and Lara Risegari, "The art of Cryogenics - Low Temperature Experimental Techniques", Elsevier, 2008.
3. Guy K. White, "Experimental Techniques in Low Temperature Physics", Clarendon Press, Oxford, 1987.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	1							1	3		
2	3	3	3	2	2							1	3		
3	3	3	3	3	1							2	3		
4	3	3	3	3	2							2	3		
5	3	3	3	3	2								3		
Avg..	3	3	3	2.6	1.6							1.5	3		

1-low, 2-medium, 3-high

VERTICAL 4

23ME	DESIGN AND OPTIMIZATION OF THERMAL EQUIPMENT	L	T	P	C
		3	0	0	3

MODULE I DESIGN AND OPTIMIZATION **9**

Overview of the steps followed for making decisions in engineering; Basic considerations in Design, Formulation of the Design Problem need or opportunity; criteria of success; probability of success; Market analysis; feasibility; iterations; research and development; optimization etc.

MODULE II EQUATION FITTING AND MODELLING OF THERMAL EQUIPMENT **9**

Mathematical modeling; matrices; polynomial represtations; Lagrange interpolation; function of two variables; exponential forms; Selecting versus simulating; counter flow heat exchanger; evaporators and condensers; pumping power and turbo machinery.

MODULE III SYSTEM SIMULATION AND OPTIMISATION **9**

Description of system simulation; information flow diagrams; sequential and simultaneous calculation; successive substitution method; Newton-Raphson method; setting up the mathematical statement of the optimization problem in terms of a single objective function and a number of constraints; several illustrative examples.

MODULE IV LAGRANGE MULTIPLIER METHODS **9**

Calculus for optimizing unconstrained problems (single and multiple variables); Lagrange multiplier equations (unconstrained and constrained problems).

MODULE V LINEAR PROGRAMMING **9**

Mathematical statement and geometric visualization of the method; the simplex algorithm; maximization or minimization with inequality constraints

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: To develop mathematical steps for solving thermal equipment problems in real-world applications.

CO2: To solve the design problems of various thermal equipments by using mathematical iteration techniques to consider the thermo-physical variables in order to form equations, fitting, and modelling.

CO3: Create a system flow diagram based on physical information, then use simulation methods to solve problems as functions of constraints to optimize them

CO4: Test the capabilities of thermal systems, analyze unconstrained problems using Lagrange multiplier methods

CO5: Create and build linear mathematical statements, as well as solve physical thermal equipment systems**.**

TEXT BOOKS:

1. Stoecker,W.,Design of Thermal Systems,McGraw-Hill,1999.

2. Yogesh Jaluria,Design and Optimization of thermal systems, CRC Press, Taylors and Francis Group, 2007.

REFERENCES:

1. Kakac,S.and Liu.H., Heat Exchangers, CRC Press,2002.
2. W.F.Stoecker, Refrigeration and Air-Conditioning, McGraw Hill Book Company, 1985.
3. Ozisik.M.N., Heat Transfer – Tata McGraw-Hill,1988.
4. Arthur P.Frass, Heat Exchangers Design, John Wiely& Sons, 1988.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3		2				1			1	1	
2	3	3	3	3		2				1			1	1	
3	3	3	3	3		2				1			1	1	
4	3	3	3	3		2				1			1	1	
5	3	3	3	3		2				1			1	1	
Avg.	**3**	**3**	**3**	**3**		**2**				**1**			**1**	**1**	

1-low, 2-medium, 3-high

VERTICAL 4

23ME	DESIGN OF HEAT EXCHANGERS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION & ANALYSIS OF HEAT EXCHANGER 11

Classification of Heat Exchangers - Heat Transfer Mechanisms - Flow Arrangements - Applications - Selection of Heat Exchangers. Analysis of heat exchanger: Introduction - Arrangement of flow paths in Heat Exchangers - Overall heat transfer co-efficient - LMTD and - NTU Method for heat exchanger analysis - Heat exchanger design methodology - Variable overall heat Transfer co-efficient - Heat exchanger design calculation.

MODULE II FORCED CONVECTION CORRELATIONS FOR SINGLE-PHASE HEAT EXCHANGERS 9

Introduction - Hydro dynamically developed & Thermally developing laminar flow in smooth circular ducts effect of variable physical properties - laminar flow of liquids and gases in ducts - Turbulent forced convection - Turbulent flow in smooth straight non- circular ducts – Turbulent flow liquid and gases in ducts.

MODULE III SHELL-AND-TUBE HEAT EXCHANGERS 9

Introduction - Basic components - Basic design procedure of a heat exchanger – Preliminary estimation of unit size -Rating of the preliminary design - Shell and tube -Side heat transfer, pressure drop, heat transfer coefficient -Bell-Delaware method- Design of heat exchanger subject to fouling.

MODULE IV HEAT EXCHANGER PRESSURE DROP AND PUMPING POWER 9

Introduction - Tube-side pressure drop - Circular cross-section tubes - Non circular cross-sectional ducts Pressure drop in tube bundles in cross flow - Pressure drop in helical and spiral coils - Pressure drop in bends and fittings - Pressure drop for abrupt contraction, expansion, and momentum change – pumping Power.

MODULE V HEAT EXCHANGERS WITH TWO-PHASE FLOW 7

Introduction - Characteristic of multiphase flow - Classification of two-phase flow -Evaporator - Condensers - Flow pattern maps for vertical and horizontal in-tube and shell side flows – Thome's flow pattern – Void fraction - dryness fraction.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: An ability to apply knowledge of mathematics, science, and engineering principles relevant to area of fluid/thermal

CO2: Selects and apply an appropriate models or simulations of the real world and analyzes output of models/simulations to provide information for design decisions.

CO3: Performs feasibility analysis and uses results to choose candidate solutions and evaluates quality of solutions to select the best once

CO4: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, and sustainability

CO5: Select the proper model to solve problems by using modern software packages, employed as standard tools in the industrial and developmental environment

TEXT BOOKS:

1. Ramesh K, Shah and Dusan P. Sekulic, “Fundamental of Heat Exchangers Design”, John Wiley & Sons, Inc., 2003.
2. Sadik Kakaç, Hongtan Liu , Anchasa Pramuanjaroenkij, “Heat Exchangers: Selection, Rating, and Thermal Design”, CRC Press, 2012.

REFERENCES:

1. Arthur P.Frass, “Heat Exchanger Design” , Second Edition, John Wiley & Sons, New York, 1996.
2. T.Taborek, G.F.Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980.
3. Walker, “Industrial Heat Exchangers” - A Basic Guide, McGraw Hill Book Co., 1980.
4. Holger Martin, Heat Exchangers, Hemisphere Publishing Corporation, London, 1992.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3		2				1			1	1	
2	3	3	3	2		2				1			1	1	
3	3	3	2	2		2				1			1	1	
4	3	3	2	2		2				1			1	1	
5	3	3	2	2		2				1			1	1	
Avg.	3	3	3	3		2				1			1	1	

1-low, 2-medium, 3-high

VERTICAL 4

23ME	TURBO MACHINES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO TURBOMACHINES **9**

Classification of Turbomachines. Energy transfer between fluid and rotor. Euler equation and its interpretation. Velocity triangles. Basics of Compressor and Turbine stages.

MODULE II CENTRIFUGAL FANS AND BLOWERS **9**

Types, components, and working. Flow analysis in impeller blades, volute, and diffusers. Velocity triangles and h-s diagram. Stage parameters. Performance characteristic curves. Fan bearings, drives, and noise.

MODULE III CENTRIFUGAL COMPRESSOR **9**

Components, blade types. Velocity triangles, h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics, losses, and geometry calculation.

MODULE IV AXIAL FLOW COMPRESSOR **9**

Construction details. Work done factor. Velocity triangles, h-s diagram, stage work. Performance characteristics, efficiency, and stage losses. Stalling and Surging. Free and Forced vortex flow.

MODULE V AXIAL AND RADIAL FLOW TURBINES **9**

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the working principles and classification of turbomachines.

CO2: Analyze energy transfer between fluid and rotor using Euler's equation and velocity triangles.

CO3: Evaluate efficiencies, degree of reaction, and performance characteristics of compressors, turbines, fans, and blowers.

CO4: Compare axial and radial flow compressors, considering construction details and performance parameters.

CO5: Assess performance and efficiency of axial and radial flow turbines, including impulse and reaction stages.

TEXT BOOKS:

1. Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011.
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

REFERENCES:

1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, Butterworth Heinemann, 2014.
2. Gopala Krishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, SciTech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.
4. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1					1			1	3	2	
2	2	1	1	1					1			1	3	2	
3	2	1	1	1					1			1	3	2	
4	2	1	1	1					1			1	3	2	
5	2	1	1	1					1			1	3	2	
Avg.	**2**	**1**	**1**	**1**					**1**			**1**	**3**	**2**	

1-low, 2-medium, 3-high

VERTICAL 5

23ME	MANUFACTURING SCIENCES	L	T	P	C
		3	0	0	3

MODULE I CASTING DESIGN **11**

Pattern Design: Pattern allowances and types. Cores: Core print size and elements of the gating system. Gating System Design: Top, bottom, and middle gating systems; gating ratio; pressurized and unpressurized systems. Melting Practice: Fluidity of molten metal, pouring time, aspiration effect, friction, and velocity distribution. Solidification Mechanism: Progressive and directional solidification of pure metals and alloys. Riser Design: Riser design and placement considerations. Problems: Problem-solving related to casting design.

MODULE II FUNDAMENTALS OF METAL FORMING **8**

Elastic and Plastic Deformation: Theory of plasticity and yield criteria (Tresca's & Von Mises criteria). Forging Analysis: Sliding friction, sticking friction, high friction on rectangular and circular cross-sections, forging force calculations. Rolling Analysis: Friction effects, maximum draft, neutral point, and rolling forces. Problems: Problem-solving related to basic metal forming processes.

MODULE III ADVANCED METAL FORMING PROCESSES **7**

Extrusion Analysis: Friction in direct and indirect extrusion, shape factor, extrusion force as a function of billet size. Wire Drawing: Drawing force and optimal reduction in cross-sectional area. Sheet Metal Operations: Formability test, forming limit diagram, punch and die design, blank holding force, drawing force, design considerations. Problems: Problem-solving related to advanced metal forming processes.

MODULE IV MECHANICS OF MACHINING PROCESS **9**

Mechanics of chip formation – merchant diagram – cutting forces – relationship between frictions, shear and rake angle. Heat generation and cutting tool temperature analysis. Single and multi-point Tool nomenclature – tool signature - Failure of cutting tools, tool wear – tool life - cutting tool materials - Cutting fluid - machinability. Analysis of cutting forces in shaping, drilling, milling, and other multipoint machining processes – abrasive machining process – economics of machining process - problems

MODULE V WELD DESIGN **10**

Arc welding – emission and ionization of arc - characteristics and power, thermal and metallurgical aspects of welding - peak temperature – macro and microstructure of weld, HAZ and base metal. Residual stresses and distortion in welding – thermal expansion and contraction – transverse shrinkage – angular distortion and longitudinal bowing. Effect of heat distribution. Resistance welding – design for spot welding. Science in adhesive bonding.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Apply knowledge to design casting patterns and gating systems, determine core print sizes, and analyze the fluidity and solidification of molten metal, including designing and placing risers.

CO2: Evaluate elastic and plastic deformation and apply yield criteria (Tresca's & Von Mises) to

perform detailed evaluations of forging and rolling processes, including assessing the effects of friction and conducting force calculations.

CO3: Apply knowledge to extrusion and wire drawing processes, assess the impact of friction, and design and assess sheet metal operations, including performing formability tests and force calculations.

CO4: Utilize the mechanics of chip formation, cutting forces, heat generation, and tool wear, and use this knowledge to evaluate cutting forces in various machining processes and assess the economics of machining.

CO5: Apply principles of arc welding, assess residual stresses and distortions, design resistance welding processes, and apply scientific principles to adhesive bonding, evaluating their effectiveness in different contexts.

TEXT BOOKS:

1. Amitabha Ghosh and Asok Kumar Mallik, “Manufacturing Sciences”, 2nd Edition, East – West Press Pvt. Ltd., 2016.
2. Khan M. I. and Serajul Haque, “Manufacturing Sciences”, PHI Learning Pvt. Ltd., 2011

REFERENCES:

1. Groover, M. P., “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Wiley India Pvt. Ltd.,2019
2. R. K. Rajput "A Textbook of Manufacturing Technology: Manufacturing Processes", 3rd Edition, Laxmi publications, 2018.
3. Black J.T and Kosher R A, “DeGarmo’s Materials and Processes in Manufacturing”, India Edition, Wiley India, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	1							1	3	2	1
2	3	2	3	2	1							1	3	2	1
3	3	2	2	2	1							1	3	2	1
4	3	2	2	2	2							1	3	3	1
5	3	2	2	1	1							1	3	2	1
Avg.	3.0	2.2	2.4	2.0	1.2							1.0	3.0	2.2	1.0

1-low, 2-medium, 3-high

VERTICAL 5

23ME	PLASTIC PROCESSING TECHNIQUES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO PLASTICS PROCESSING 8

Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, and pelletization.

MODULE II COMPRESSION AND TRANSFER MOLDING 12

Compression moulding – principles of compression and transfer moulding - Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating. Machines used-Types of compression mould - moulding faults - Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding.

MODULE III EXTRUSION AND BLOW MOLDING 12

Extrusion: Principles - Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell & Defects - Extrusion of films - Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications and new developments.

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance

MODULE IV INJECTION MOLDING 8

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures Press capacity projected area - Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. Injection moulding techniques - trouble shooting.

MODULE V THERMOFORMING AND CASTING 5

Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Ability to find out the correlation between various processing techniques with product properties

CO2: Acquire knowledge on additives for plastic compounding and methods employed for the same

CO3: Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
CO4: Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques
CO5: Select an appropriate processing technique for the production of a plastic product

TEXT BOOKS:

1. Allen; W. S. and Baker; P. N., Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors, New Delhi (2004)

REFERENCES:

1. Donald V. Rosato, Dominick V. Rosato, “Plastics Processing Data Handbook”, Springer Dordrecht, 2012.
2. Anshuman Shrivastava, “Introduction to Plastics Engineering”, Elsevier, 2018.
3. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
4. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012)

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3	2	2	1	2	2	1	2	3	1	
2	3	3	2	2	3	2	2	1	2	2	1	2	2	1	
3	3	3	3	2	3	2	2	1	2	2	1	2	3	1	
4	3	3	2	2	3	2	2	1	2	2	1	2	2	1	
5	3	3	2	2	3	2	2	1	2	2	1	2	2	1	
Avg.	3	3	2.4	2	3	2	2	1	2	2	1	2	2.4	1	

1-low, 2-medium, 3-high

VERTICAL 5

23ME	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I NTRODUCTION **9**

Introduction to surface-thermodynamics of surface, Surface dependent properties-physical, Chemical and Mechanical; Surface dependent degradation and their characteristics, analysis of surface initiated degradation

MODULE II SURFACE MODIFICATIONS TECHNIQUES **9**

Surface modifications techniques-conventional Surface Modification Methods Applicable to Steel, Cast Iron, and Non-ferrous Metals/Alloys- Shot peening, Sand blasting, Flame, Induction hardening, Solid State Diffusion Assisted Surface Modifications; Emerging surface modification techniques- Chemical route (Electro less deposition, Sol-gel coating), Electro-chemical routes (electrodeposition, electro-phoretic deposition); Chemical conversion coatings – hot dipping, Thermal spraying; Surface Painting

MODULE III SURFACE CHARACTERIZATION TECHNIQUES **9**

Basic principles, components, applications of Optical microscope, Scanning electron microscopy, Transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive, Spectroscopy, X-ray diffraction techniques, Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform, infrared spectroscopy, Raman spectroscopy

MODULE IV CORROSION AND PROTECTION **9**

Electrochemical aspects of corrosion, EMF series and various corrosion cells, electrochemical polarization, passivation, types of corrosion, pitting and crevice corrosion, galvanic corrosion, stress corrosion cracking, cavitation and fretting, corrosion and fatigue, corrosion evaluation techniques, protection methods, inhibitors, cathodic and anodic protection techniques, high temperature oxidation and corrosion.

MODULE V SURFACE ENGINEERING MATERIALS **9**

High temperature alloys: Steels, Nickel – Cobalt – Tungsten and Zirconium based super alloys, Advances in high temperature alloys; Metal Matrix Composites, Characteristics of MMCs, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMCs. Limitations of MMCs, Metal Matrix, Reinforcements particles - fibers; Ceramic Matrix Composites - Ceramics Matrix Composites: Need for CMCs - Various types of CMCs – oxide ceramics - non oxide ceramics, Aluminium oxide - silicon nitride - reinforcements - particles - fibres - whiskers.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the science and importance of surfaces, surface dependent properties of engineering interest and evaluation

CO2: Understand the metallurgical changes occurring during a coating to improve a surface modification technique

CO3: Acquire knowledge on principles and operation of a range of advanced surface characterization techniques

CO4: Understand and utilize the appropriate the surface characterization technique for the suitable applications

CO5: Identify a type of corrosion and select a suitable surface coating techniques to prevent the surface from different environment

TEXT BOOKS:

1. Peter Martin, Introduction to Surface Engineering and Functionally Engineered Materials, WILEY, 2011
2. P. A. Dearnley, Introduction to Surface Engineering, Cambridge University Press, 2017

REFERENCES:

1. "Metals Handbook, Vol.5- Surface Engineering", ASM International, 1996.
2. Fontana, G., "Corrosion Engineering", McGraw-Hill, 2010
3. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008)
4. M.H.A. Kempster, Materials for Engineers, The English University Press, London, 1996.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	1	1	1	2	3	2	2	2		
2	2	3	2	3	1	1	1		2	2	2	2			
3	3	2	1	3	2	1	1		2	3	2	2	2		
4	3	3	2	3	1	1	1		2	2	2	2	2		
5	3	3	2	2	2	1	3	1	2	1	2	1	1		
Avg.	**2.8**	**2.8**	**1.8**	**2.6**	**1.4**	**1**	**1.4**	**1**	**2**	**2.2**	**2**	**1.8**	**1.75**		

1-low, 2-medium, 3-high

VERTICAL 5

23ME	ADVANCED STATISTICS AND DATA ANALYTICS	L	T	P	C
		3	0	0	3

MODULE I REGRESSION **9**

Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis – Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.

MODULE II EXPLORATORY DATA ANALYSIS **9**

Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction

MODULE III LOGISTIC AND MULTINOMIAL REGRESSION **9**

Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient

MODULE IV FORECASTING AND CASUAL MODELS **9**

Moving average, Exponential Smoothing, Casual Models.

MODULE V TIME SERIES ANALYSIS **9**

Auto regression (AR), Moving Average (MA) Models, ARMA, ARIMA models, Multivariate Models

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the concepts of linear and multiple regression analysis problems and to properly do a regression fit for the collected data.

CO2: Explore and visualize the data through explanatory data analysis.

CO3: Utilize key statistical tools such as Variance, the Wald Test, the Hosmer-Lemeshow Test, the Classification Table, and the Gini Coefficient for efficient modeling and assessment in logistic regression analysis

CO4: Develop the ability to effectively use these methodologies for predictive modeling and analysis forecasting techniques.

CO5: Acquiring proficiency in Auto-Regressive (AR) and Moving Average (MA) models, understanding their integration in ARMA models, applying ARIMA models, and gaining familiarity with Multivariate Models will equip you with a versatile skill set for the analysis and modeling of time series data.

TEXT BOOKS:

1. Douglas C Montgomery and George C Runges, “Applied Statistics and Probability for Engineers”, John Wiley &Sons, 2014.
2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, “Introduction to Time Series Analysis and Forecasting” ,Wiley,2015

REFERENCES:

1. Max Kuhn, Kjell Johnson, “Applied Predictive Modeling”, Springer, 2014.
2. Daniel T. Larose, Chantal D. Larose “Data Mining and Predictive Analytics”, Wiley,2015
3. Thomas W.Miller, “Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science”, Pearson Education, 2014.
4. Michael J. Evans, Jeffrey S. Rosenthal, ‘Probability and Statistics - The Science of Uncertainty’. W H Freeman & Co, 2010

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	1				1			1	3		
2	3	2	2	2	1				1			1	3		
3	3	3	2	2	1				1			1	3		
4	3	3	2	2	1				1			1	3		
5	3	2	2	2	1				1			1	3		
Avg.	**3**	**2.6**	**2**	**2**	**1**				**1**			**1**	**3**		

1-low, 2-medium, 3-high

VERTICAL 5

23ME	QUALITY CONTROL AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart- uses of control chart –X chart, R chart and – process capability - process capability studies and simple problems.

MODULE II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for non conformings – p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

MODULE III ACCEPTANCE SAMPLING 9

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

MODULE IV LIFE TESTING – RELIABILITY 9

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

MODULE V QUALITY AND RELIABILITY 9

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development–Product life cycles.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Demonstrate the concept of Quality and Process control for variables
CO2: Apply and analyze control charts for variables and attributes for various processes.
CO3: Solve problems by using OC curves with the concept of sampling.
CO4: Demonstrate the concept of Life testing for any product or process.
CO5: Analyze products by using the concept of Reliability and techniques involved.

TEXT BOOKS:

1. Douglas.C. Montgomery, "Introduction to Statistical quality control", 7th Edition, John Wiley 2019.
2. Srinath. L.S., "Reliability Engineering", Affiliated East west press, 2016.

REFERENCES:

1. Besterfield D.H., "Quality Control", Prentice Hall, 2013.
2. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2012

3. Danny Samson, “Manufacturing & Operations Strategy”, Prentice Hall, 1991
4. Gupta. R.C, “Statistical Quality control and Quality management”, Khanna Publishers, 2023.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1							1	2		
2	3	2	1	1	1							1	2		
3	2	2	2	2	1				1			1	1		
4	2	3	2	1	2			2				1	2		1
5	1	2	2	1	2			2					2		1
Avg.	**2.2**	**2.2**	**1.8**	**1.4**	**1.4**			**2**	**1**			**1**	**1.8**		**1**

1-low, 2-medium, 3-high

VERTICAL 5

23ME	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Supply Chain, Objectives & Stages, power of SCM - Process views of a supply chain – Strategic planning, Achieving a strategic fit in a supply chain and factors affecting the strategic fit - Value chain, supply chain flow lines - Understanding a product, Product life cycle, Fishers classification of products – Effective and efficient supply chain - case studies on products

MODULE II SUPPLY CHAIN PROCESS **9**

Forecasting in supply chain, forecast error distribution order quantity and reorder point characteristics & components of forecasting - time series methods of forecasting, Demand Management in MPC - MTS - ATO - MTO. Inventory, role of cycle inventory, Economies of scale to exploit fixed costs, Economies of scale to exploit quantity discounts, Short term discounting and trade promotions Managing multi-echelon cycle inventory - Bullwhip effect - Product substitution, Postponement

MODULE III PRODUCT PROCUREMENT AND TRANSPORTATION **9**

Procurement process, EOQ - Sourcing in a supply chain - deciding factors for in-house or outsourcing -Supplier selection - auctions and negotiations, risk management in sourcing Freight management, Transportation networks, Milk run, Cross Docking, tailored transportation, 3PL - 4 PL, Reverse Logistics, Risk management in transportation.

MODULE IV DESIGNING A SUPPLY CHAIN **9**

Supply chain drivers - Supply chain performance measures - SCOR Model - Network design in a supply chain, factors influencing design, Framework for network design network, models for facility location and capacity allocation - Uncertainty in network design - Discounted cash flow analysis, Decision trees in evaluating network design - Distribution, factors influencing distribution, design options for a distribution network. Warehouse management – metrics in warehouse management.

MODULE V IT IN SUPPLY CHAIN **9**

Lean Supply Chain, agile supply chain, Dynamic supply chain design, Impact of technology on SCM, Key trends in SCM, IT in supply chain coordination, IT in supply chain design - MRP, ERP, CRM, ISCM - Performance metrics. Discussion on supply chain adopted by primary industrial sectors and case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO 1: Master strategic planning in Supply Chain Management for competitive advantage by aligning with organizational goals.

CO 2: Adeptly apply forecasting, order quantity determination, and inventory management principles to optimize supply chain efficiency.

CO 3: Strategically optimize procurement processes, including EOQ, sourcing decisions, supplier

selection, and risk management in the supply chain.

CO 4: Analyze and optimize supply chain drivers, performance, and network design, emphasizing factors such as facility location, capacity, uncertainty, and distribution metrics.

CO 5: Adopt lean and agile supply chain principles, assess technology's impact, and evaluate performance metrics in diverse industrial sectors through case studies.

TEXT BOOKS:

1. Christopher M.,"Logistics and Supply Chain Management – Creating Value Adding Networks", 3rd Edition, FT Prentice Hall, 2005
2. Chopra S., Meindl P. and Kalra, D.V., "Supply Chain Management, Strategy, Planning and Operation", Pearson Education, Inc., 8th Edition 2018,

REFERENCES:

1. Burt N.D., Dobler. W.D. and Starling L.S., World Class Supply Chain Management, The Key to Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2005.
2. Fredendall D.L. and Hill E., "Basics of Supply Chain Management", the St. Lucie Press / APICS Series on Resource Management, 2001.
3. Vollmann T.E., Berry L.W., Whybark D.C. and Jacobs, R.F., "Manufacturing Planning and Control for Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2008
4. Suman Sarkar., The Supply Chain Revolution: Innovative Sourcing and Logistics for a Fiercely Competitive World, AMACOM, June 2017

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	2	2	1	1	1	1	1	2	2	1	1	1	2	
2	3	1		3	1	1	1	2	3	3	2	2	2	3	2
3	2	3	3	3	3	2	2	1	1	1	3	3	3		1
4	3	2	2	2	2	3	1		3	3		2	2	3	
5	1	3	1	3	3	1	1	1	1	1	1	1	3	1	3
Avg..	2.0	2.2	2.0	2.4	2.0	1.6	1.2	1.3	2.0	2.0	1.8	1.8	2.2	2.3	2.0

1-low, 2-medium, 3-high

VERTICAL 6

23ME	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Overview - Need – Issues in Prototyping - Prototype Cost Estimation - Cost Complexities - Prototype Design Methods - Prototype Design tools - Morphological Analysis - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - AM. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bioprinting - Food Printing- Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

MODULE II DESIGN FOR ADDITIVE MANUFACTURING **9**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- Controlling Part Accuracy in STL Format - Slicing the STL File - AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM

MODULE III VAT POLYMERISATION AND DIRECTED ENERGY DEPOSITION **9**

Photo polymerization: Stereolithography Apparatus (SLA) - Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits -Applications.

MODULE IV POWDER BED FUSION AND MATERIAL EXTRUSION **9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

MODULE V ALTERNATIVE ADDITIVE MANUFACTURING PROCESSES **9**

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications.

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation..

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Adeptly analyze prototyping challenges, estimate costs, master design methods, comprehend Additive Manufacturing (AM) technology, and assess its benefits and formulate its applications in engineering industries, including case studies in Automobile, Aerospace, and Healthcare.

CO2: Master Additive Manufacturing (AM) concepts, data processing, and design rules for part quality improvement in STL and AMF formats, emphasizing key aspects such as topology

optimization and lattice structures.

CO3: Analyse and apply resources and techniques like photo-polymerization, SLA, DLP, CLIP, and Directed Energy Deposition with LENS, emphasizing their advantages, limitations, and diverse applications for complex engineering situations

CO4: Expertise in Powder Bed Fusion techniques (SLS, SLM, EBM) and Material Extrusion (FDM), focusing on materials, processes, advantages, applications, as well as limitations in modern manufacturing.

CO5: Gain knowledge in Binder Jetting, Material Jetting (Multijet Modeling), and Sheet Lamination (LOM), focusing on materials, processes, benefits, limitations, and complex applications in additive manufacturing for societal use.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd Edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2016, ISBN: 978-1-56990-582-1.

REFERENCES:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2012, ISBN : 9783446425521.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", 2nd Edition, CRC Press., United States, 2019, ISBN: 9780849334092.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	1	1	1	3	1	1	1	2	1	2
2	1	2	1	1	1	1	2	2	1	1	2	3	1	2	2
3	1	2	1	2	1	3	1	3	3	1	2	2	1	1	0
4	1	2	1	2	1	3	1	1	0	2	1	1	1	1	1
5	1	1	1	2	1	1	1	3	2	1	1	1	1	1	2
Avg.	1.0	1.6	1.0	1.6	1.0	1.8	1.2	2.0	2.3	1.2	1.4	1.6	1.2	1.2	1.8

1-low, 2-medium, 3-high

VERTICAL 6

23ME	CREATIVITY AND INNOVATION IN ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

MODULE I CREATIVITY **9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities-Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

MODULE II CREATIVE INTELLIGENCE **9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training-- Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities-Strategies for Unblocking- Designing Creativity Enabling Environment.

MODULE III INNOVATION **9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change -Innovation as a system.

MODULE IV INNOVATION AND ENTREPRENEURSHIP **9**

Innovation and Entrepreneurship: Entrepreneurial Mindset, Motivations and Behaviours - Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

MODULE V INNOVATIVE BUSINESS MODELS **9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Learn the basics of creativity for developing Entrepreneurship
CO2: Understand the importance of creative intelligence for business growth
CO3: Understand the advances through Innovation in Industries
CO4: Learn about applications of innovation in building successful ventures
CO5: Acquaint with developing innovative business models to run the business efficiently

TEXT BOOKS:

1. Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
2. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

REFERENCES:

1. Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
2. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House,

2010.
3. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
4. Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3				2						1		3		
2	3				2						1		3		
3	3				2						1		3		
4	3				2						1		3		
5	3				2						1		3		
Avg.	3				2						1		3		

1-low, 2-medium, 3-high

VERTICAL 6

23ME	DESIGN FOR X	L	T	P	C
		3	0	0	3

MODULE 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 - Tolerance stacks.

Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

MODULE 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.

MODULE III COMPONENT DESIGN - MACHINING CONSIDERATION **9**

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 – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

MODULE IV COMPONENT DESIGN – CASTING CONSIDERATION **9**

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

MODULE V DESIGN FOR ADDITIVE MANUFACTURING **9**

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Apply the design principles for manufacturability
CO2: Identify and analyze the factors influencing in form design
CO3: Apply the component design features of various machines.
CO4: Discuss the design consideration principles of welding in the design of welded products.
CO5: Discuss the design consideration principles of additive manufacturing.

TEXT BOOKS:

1. James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 1998.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

REFERENCES:

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

Online Materials :

1. https://www.youtube.com/watch?v=xGzcKImw-Vo

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2		2	2				1		3		2
2	3	3	3	3		2	2						3		2
3	3	2	2	2			1				1		2		
4	3	3	3	3		2	2						3		2
5	3	3	3	3		2	2						3		2
Avg.	**3**	**2.6**	**2.6**	**2.6**		**2**	**2.25**				**1**		**2.6**		**2**

1-low, 2-medium, 3-high

VERTICAL 6

23ME	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

MODULE II ERGONOMICS AND PRODUCTION **9**

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

MODULE III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS **9**

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools.

MODULE IV ENVIRONMENTAL FACTORS **9**

Colour: Colour and light, Color and objects, Colour and the eye – after Image, Color blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to color and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style.

MODULE V AESTHETIC CONCEPTS **9**

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Appreciate ergonomics need in the industrial design
CO2: Apply ergonomics in creation of manufacturing system
CO3: Discuss on the design of controls and display
CO4: Consider environmental factors in ergonomics design
CO5: Report on the importance of aesthetics to manufacturing system and product

TEXT BOOKS:

1. Ergonomics in Product Design, 2018 by Sendpoints Publishing Co. Ltd.
2. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares , Francisco Rebelo, 2019 by CRC Press.

REFERENCES:

1. Mayall W.H., “Industrial Design for Engineers”, London Hiffee Books Ltd., 1988, ISBN 978-1-118-02227-6.
2. Brain Shakel (Edited), “Applied Ergonomics Hand Book”, Butterworth Scientific,1988. ISBN 123-1-118-027-6
3. R. C. Bridger, “Introduction to Ergonomics”,McGraw Hill Publications, 1995, ISBN 215-8-02227-6.
4. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006

Online Materials

1 https://ieda.ust.hk/dfaculty/ajay/courses/ieem101/lecs/ergonomics.pdf

2 https://ftp.idu.ac.id/wp-content/uploads/ebook/ip/BUKU%20ERGONOMI/BUKU%20INGGRIS/Ergonomics%20For%20Beginners.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		1	3		2		3		1			1	3	1	3
2		1	3		2		3		1			1	3	1	3
3		1	3		2		3		1			1	3	1	3
4		1	3		2		3		1			1	3	1	3
5		1	3		2		3		1			1	3	1	3
Avg.		**1**	**3**		**2**		**3**		**1**			**1**	**3**	**1**	**3**

1-low, 2-medium, 3-high

VERTICAL 6

23ME	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

MODULE I DEVELOPMENT PROCESS AND PRODUCT PLANNING 9

Product development process- concept development: front End process- adapting the generic product development process- product development process flow- product development organization. Product Planning Process – steps in planning process. Interpret raw data in terms of customers' needs, organize needs in hierarchy and establish the relative importance of needs.

MODULE II PRODUCT SPECIFICATIONS AND CONCEPT GENERATION 9

Establish target specifications, setting final specifications. Concept generation- clarify the problem. Overview- concept selection- screening and scoring. Activities of concept generation, clarifying problems, search both internally and externally, exploring the output. Concept testing- purpose of concept - survey and interpret the result.

MODULE III PRODUCT ARCHITECTURE 9

Product architecture, types of modularity- Implication of architecture- Establishing the architecture- differentiation plan, commonality plan- Related system – level design issues. Prototyping- Types of Prototypes, prototype technology, planning for prototype- prototype Cost Estimation - Fundamentals of cost concepts - Cost complexities

MODULE IV INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ECONOMIC 9

Assessing need for industrial design, industrial design process, management, assessing quality of industrial design. Elements of economic analysis- quantitative and qualitative analysis- economic analysis process - Build a base case financial model - perform sensitive analysis – trade-offs, influence of qualitative factors.

MODULE V INTELLECTUAL PROPERTY AND DESIGN FOR ENVIRONMENT 9

IPR - Elements and outline, patenting procedures, claim procedure- Intellectual Property Issues in Product Development. Design for Environment: Impact, regulations from government, ISO system.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Discuss fundamental concepts of development, planning and customer specific requirements of the New Product development

CO2: Establishing product specifications and concept generation and executing purposeful concept testing via surveys with competent result interpretation.

CO3: Create a product architecture, including prototyping methods, and estimate development costs.

CO4: Apply industrial design and economic analysis through both quantitative and qualitative methods.

CO5: Demonstrate a thorough understanding of Intellectual Property Rights (IPR) and acquiring comprehensive knowledge of Design for Environment, compliance with government regulations, and adherence to the ISO system.

TEXT BOOK:

1 Ulrich K.T., Eppinger, S D, “Product design and development; McGraw Hill; 2016

REFERENCES:

1 Otto, K.N., Wood, K L, “Product Design – Techniques in Reverse Engineering and New Product development, Prentice Hall, 2001

2 Pahl G., Beitz W., Feldhusen J, Grote K.H, Engineering Design - A systematic Approach, Springer 2007.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1			1			1			1			1	1		
2		2	3	2		1			2			2	2		
3	1	2	3	2		1			2			3	2		
4	1	2	3	2		2			2			3	2		
5		2	2	2		3		3	2			3	2		
Avg.	1.0	2.0	2.4	2.0		1.6		3.0	1.8			2.4	1.8		

1-low, 2-medium, 3-high

VERTICAL 6

23ME	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF PRODUCT LIFE CYCLE MANAGEMENT **9**

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (PDM), Collaborative Product Commerce (CPC), PLM/PDM Infrastructure – Networking and Communications.

MODULE II CONSTRUCTING PRODUCT LIFE CYCLE MANAGEMENT & DRIVING ENVIRONMENT **9**

PLM Life cycle model - plan, design, build, support & dispose. Threads of PLM in computer aided design (CAD), engineering data management (EDM), Product data management (PDM), and computer integrated manufacturing (CIM). Weaving the threads into PLM, comparison of PLM to Engineering resource planning (ERP). PLM characteristics - singularity, cohesion, traceability, reflectiveness, Information Mirroring Model. External drivers- scale, complexity, cycle times, globalization & regulation. Internal drivers - productivity, innovation, collaboration & quality.

MODULE III PRODUCT DATA MANAGEMENT (PDM): **9**

PDM : functions, system and importance, architecture, document management, representation of lifecycle of business objects, concepts on roles, users and project management, system administration, access control and its use in lifecycle.

MODULE IV PRODUCT VISUALIZATION: **9**

CAD neutral approach and visualization techniques in product development, capabilities of PLM visualization software - lightweight representations, markup method, representation information repository, use of visualization in different stages of lifecycle, case studies. Introduction to virtual reality, Digital Mock up and Prototype development. Virtual testing and collateral. Introduction to Digital Manufacturing.

MODULE V ROLE OF PLM IN INDUSTRIES **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Acquire a thorough grasp of the Product Life Cycle Management (PLM) process, covering its origin, future potential, and key infrastructure components, with a special emphasis on networking and communications.

CO2: Integrate PLM/PDM with legacy databases, CAD & ERP systems.

CO3: Interpret the implementation of PLM/PDM approaches for industrial applications.

CO4: Visualize the product for the PLM and digital driven manufacturing system.

CO5: Create an effective PLM vision, manage change in PLM, and represent the holistic benefits of PLM to the business.

TEXT BOOKS:

1 Jaya Krishna S, Product Lifecycle Management: Concepts and cases, ICFAI Publications 2004.

2 Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

REFERENCES:

1. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realization”, Springer Publisher, 2011 (2nd Edition).
2. SOA approach to Enterprise Integration for Product Lifecycle, IBM Red books, 2011
3. Saaksvouri, A. and Immonen, A., Product Lifecycle Management, 3rd Ed., Springer, 2008,

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	2				3			3	1		
2	1	2	3	3	2				3		2	3	2		
3	1	2	3	3	2				3		2	3	2		
4	1	2	1	2	2				3			3	1		
5	1	1	3	1	2				3			3	1		
Avg.	1.0	1.6	2.2	2.0	2.0				3.0		2.0	3.0	1.4		

1-low, 2-medium, 3-high

VERTICAL - 7

23ME	FUNDAMENTALS OF ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

MODULE I STATICS OF PARTICLES **9**

Principles of statics, Statics of Particles –System of forces, Moment of force, Varignon's Theorem, Couple, Transfer of Force to Parallel position,, Equilibrant of a force System, x and Y intercepts of resultant, Newton's First Law of Motion, Types of forces on a body, free body diagram.

MODULE II RIGID BODY EQUILIBRIUM **9**

Rigid body equilibrium in space – Equation for equilibrium. Application of energy method for equilibrium, stability of equilibrium. Analysis of force and moments of the system.

MODULE III SYSTEM OF PARTICLES **9**

First moment of mass/area of simple geometry using first principles – Centre of gravity – by moments. Centre of Mass of composite sections. Moment of Inertia – methods, by integration, polar moment of inertia, radius of gyration - Parallel and perpendicular axis theorem.

MODULE IV FRICTION **9**

Types of friction, static, dynamic and angle of friction, Systems with friction – the Laws of Dry Friction, Coefficients of Friction. Applications of frictions – ladder friction, wedge friction.

MODULE V KINEMATICS OF PARTICLES **9**

Analyze translatory and rotary motions, including displacement, velocity, and acceleration for motion in straight lines and projectiles.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the fundamental principles of statics, including the system of forces, moments of force, Varignon's Theorem, and the concept of a couple

CO2: Apply Newton's First Law of Motion to analyze the equilibrium of particles, including the transfer of force to parallel positions and determination of equilibrants.

CO3: Understand moment of inertia methods and apply parallel and perpendicular axis theorems.

CO4: Identify types of friction, including static, dynamic, and angle of friction.

CO5: Adopt the principles of mechanics, to analyze the motion of particles in different conditions for various practical situations.

TEXT BOOKS:

1. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I – Statics, Vol II, - Dynamics, 12th Edition, Tata McGraw Hill, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018

REFERENCES:

1. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 14th Edition, 2017

2. Dr.N.Kottiswaran, “Engineering Mechanics” Sri Balaji Publications, (16 November 2017)
3. R.S.Khurmi, “Engineering Mechanics” S. Chand & Company Ltd 2019.
4. S. S. Bhavikkatti, Engineering Mechanics, New age international, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2			1	1				1	2	1	2
2	3	3	3	1	1	1						2	3	1	3
3	3	2	2	1	1		1	1			1	1	3	3	3
4	3	2	3		1	1		1		1		1	3		2
5	3	3	3	3	2	1	2	1	1	1	1	1	2	2	2
Avg.	3	2.6	2.8	1.75	1.25	0	0	1	0	0	0	0	2.6	0	2.4

1-low, 2-medium, 3-high

VERTICAL - 7

23ME	FUNDAMENTALS OF THERMAL SCIENCES	L	T	P	C
		3	0	0	3

MODULE I THERMODYNAMICS – BASIC DEFINITIONS **9**

System - types, Property – classification, State, Process, Cycle, Specific heats – internal energy and enthalpy.

MODULE II I LAW OF THERMODYNAMICS **9**

I law for a process – I law for a cycle – Steady flow energy equation – Application to simple devices

MODULE III II LAW OF THERMODYNAMICS CARNOT DEVICES AND ENTROPY **9**

Statement of Second law, Carnot Cycle - Efficiency, Carnot refrigerators and heat pump – COP. Mathematical Definition Entropy.

MODULE IV HEAT TRANSFER **9**

Modes of Heat Transfer - Fourier's law - Newton's law of cooling - Stefan Boltzmann Law – Simple problems in 1 D multi-mode heat transfer.

MODULE V REFRIGERATION **9**

I law analysis - Simple Air refrigeration cycle - Basic Vapor Compression cycle

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Define basic thermodynamic terminologies and classify systems and properties
CO2: Apply I law of Thermodynamics to closed and open systems
CO3: State II law of Thermodynamics and evaluate performances of Carnot heat engines, refrigerators and heat pumps
CO4: Classify heat transfer and estimate its rate for simple 1 D multimode problems
CO5: Perform I law analysis of simple air refrigeration and basic vapor compression cycles

TEXT BOOKS:

1. Younus A Cengel and Michael A Boles, “Thermodynamics – An Engineering Approach”, 8th Edition, Mc Graw Hill, 2017.
2. Younus A Cengel, “Heat Transfer – A Practical Approach”, 2nd Edition, Mc Graw Hill, 2002.

REFERENCES:

1. Sawhney G.S., Fundamentals of Mechanical Engineering -Thermodynamics, Mechanics and Strength of Materials, Prentice-Hall of India Pvt. Limited, 2006.
2. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1								2	1		
2	3	3	3	3	1		1					3	3		
3	2	2	2	2	1		2					3	3		
4	2	2	1	1	1							3	2		
5	2	2	2	2	2		2					3	2		
Avg.	2	2	1.8	1.8	1.3		1.7					2.8	2.2		

1-low, 2-medium, 3-high

VERTICAL - 7

23ME	BASIC MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO MANUFACTURING PROCESSES **9**

Overview of manufacturing processes- Classification of manufacturing processes - Importance and role of manufacturing in various industries.

MODULE II CASTING PROCESSES **9**

Introduction to casting - Different types of casting processes (Sand casting, Investment casting, Die casting) - Steps involved in the casting process - Advantages and limitations of casting processes

MODULE III METAL FORMING PROCESSES **9**

Introduction to forming - Various forming techniques (Forging, rolling, extrusion) - Applications and advantages of forming processes - Material behavior during forming operations

MODULE IV JOINING PROCESSES **9**

Introduction to joining processes - Different welding techniques (Arc welding, gas welding, resistance welding) - Adhesive bonding and mechanical fastening methods - Factors influencing the selection of joining processes

MODULE V MACHINING PROCESSES **9**

Overview of machining - Common machining operations (turning, milling, drilling) - Machine tools and their functions - Parameters affecting machining processes (e.g., speed, feed, depth of cut)

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Know the various basic Manufacturing processes used in industry for converting raw materials into finished products.

CO2: Know the principles and science of various basic manufacturing processes.

CO3: Acquire fundamental knowledge and design widely used and very important primary manufacturing processes such as casting, joining and forming.

CO4: Acquire knowledge about the various tools, equipment, machinery and operations required for these basic manufacturing processes.

CO5: Understand the application, advantages and limitations of various manufacturing processes.

TEXT BOOKS:

1. Rao, P. N., “Manufacturing Technology - Volume 1&2, 5e”, McGraw Hill, 2019.
2. Kalpakjian, S. and Schmid, S. R, “Manufacturing Engineering and Technology” 7e, Pearson Education, 2018.

REFERENCES:

1. Groover, M. P., “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems”, Wiley India Pvt. Ltd.,2019
2. R. K. Rajput "A Textbook of Manufacturing Technology: Manufacturing Processes", 3rd Edition, Laxmi publications, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	2			2	1					1	1	2	2
2	2	1	2			2	1					1	1	2	2
3	2	1	2			2	1					1	1	2	2
4	2	1	2			2	1					1	1	2	2
5	2	1	2			2	1					1	1	2	2
Avg.	**2**	**1**	**2**			**2**	**1**					**1**	**1**	**2**	**2**

1-low, 2-medium, 3-high

VERTICAL - 7

23ME	ENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF ENERGY CONVERSION **9**

Introduction to energy sources and their significance- Basics of energy conversion processes - Energy efficiency and conservation principles.

MODULE II FOSSIL FUEL ENERGY CONVERSION **9**

Formation and extraction of fossil fuels - Combustion processes and heat generation - Steam turbines and gas turbines -Environmental impacts and mitigation strategies

MODULE III SOLAR AND WIND ENERGY TECHNOLOGIES **9**

Solar radiation and photovoltaic (PV) systems - Concentrated Solar Power (CSP) technologies - Wind energy resources and turbine technology - Power generation, grid integration, and storage options

MODULE IV HYDRO AND NUCLEAR ENERGY CONVERSION **9**

Types of hydroelectric power plants - Dam construction, turbines, and generators - Nuclear fission process and reactor types - Safety measures, waste management, and decommissioning.

MODULE V INTEGRATION AND FUTURE PERSPECTIVES **9**

Hybrid energy systems and smart grids - Role of energy storage technologies - Policy and regulatory frameworks - Emerging technologies and sustainability challenges.

COURSE OUTCOMES

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

CO1: Understand the fundamental concepts of energy sources, conversion processes, and principles of energy efficiency and conservation, providing them with a solid foundation in energy systems.

CO2: Analyze the production of fossil fuels, their combustion for energy, and the mechanics of turbines, while also evaluating the environmental impacts and strategies for mitigation.

CO3: Apprehend solar and wind energy, including how they're captured and used for power generation.

CO4: Acquire about hydroelectric power plants, dams, turbines, and nuclear reactors, focusing on safety and waste management.

CO5: Explore the integration of diverse energy sources, including smart grids, while also examining energy storage, regulatory frameworks, and emerging technologies, taking into account environmental challenges.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, Oxford University Press, 2012
2. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.

REFERENCES:

1. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	2			2	1					1	1	2	
2	2	1	2			2	1					1	1	2	
3	2	1	2			2	1					1	1	2	
4	2	1	2			2	1					1	1	2	
5	2	1	2			2	1					1	1	2	
Avg.	**2**	**1**	**2**			**2**	**1**					**1**	**1**	**2**	

1-low, 2-medium, 3-high

VERTICAL - 7

23ME	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

MODULE I INDUSTRIAL SAFETY **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

MODULE II MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

MODULE III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

MODULE IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipments like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

MODULE V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of:i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Explain the fundamental concept and principles of industrial safety. 4. 5.
CO2: Apply the principles of maintenance engineering
CO3: Analyze the wear and its reduction..
CO4: Evaluate faults in various tools, equipment’s and machines.
CO5: Apply periodic maintenance procedures in preventive maintenance.

TEXT BOOKS:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003

REFERENCES:

1. Edward Ghali, V. S. Sastri, M. Elboujdaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007..
2. Garg, HP, Maintenance Engineering, S. Chand Publishing

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	2			2	1					1	1	2	
2	2	1	2			2	1					1	1	2	
3	2	1	2			2	1					1	1	2	
4	2	1	2			2	1					1	1	2	
5	2	1	2			2	1					1	1	2	
Avg.	**2**	**1**	**2**			**2**	**1**					**1**	**1**	**2**	

1-low, 2-medium, 3-high

VERTICAL - 7

23ME	ELECTRIC AND HYBRID VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Overview of electric and hybrid vehicle history and evolution-Comparison of electric, hybrid, and conventional internal combustion engine vehicles-Environmental and societal impacts of electric and hybrid vehicle adoption-Introduction to key components and systems in electric and hybrid vehicles

MODULE II ELECTRIC DRIVE SYSTEMS **9**

Principles of electric propulsion and electric motor operation-Types of electric drive systems: AC, DC, and BLDC motors-Power electronics for electric drive systems: inverters, converters, and controllers-Analysis of electric drive system efficiency and performance characteristics

MODULE III HYBRID POWERTRAINS **9**

Hybrid vehicle architectures: series, parallel, series-parallel, and plug-in hybrids-Operation and control of hybrid powertrains: power split devices, regenerative braking, and energy management-Comparative analysis of hybrid powertrain configurations and their advantages/disadvantages-Integration of internal combustion engines, electric motors, and energy storage systems in hybrid vehicles

MODULE IV ENERGY STORAGE TECHNOLOGIES **9**

Overview of energy storage requirements and challenges in electric and hybrid vehicles-Battery technologies for electric vehicles: lithium-ion, nickel-metal hydride, and emerging technologies-Fuel cell technology and its application in fuel cell electric vehicles (FCEVs)-Capacitor-based energy storage systems: supercapacitors and ultracapacitors.

MODULE V CONTROL AND MANAGEMENT OF ELECTRIC AND HYBRID VEHICLES **9**

Control strategies for electric and hybrid vehicle propulsion systems-Energy management strategies: optimization algorithms, predictive control, and real-time decision-making-Charging infrastructure: AC and DC charging, fast charging, and wireless charging technologies-Vehicle-to-grid (V2G) integration and smart grid interaction for electric vehicle charging.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Recognize the significance of electric and hybrid vehicles in modern transportation.
CO2: Understand the operation and efficiency of electric propulsion systems.
CO3: Compare and contrast different hybrid powertrain configurations.
CO4: Evaluate various energy storage solutions for electric and hybrid vehicles.
CO5: Apply control and management strategies to optimize electric and hybrid vehicle performance.

TEXT BOOKS:

1. James D Halderman, Electric and Hybrid Electric Vehicles, 1st Edition Published by Pearson (February 3, 2022) © 2023
2. Husain, Iqbal. Electric and Hybrid Vehicles: Design Fundamentals. 2nd ed., CRC Press, 2018.

REFERENCES:

1. Jonathan F Gosse, Hybrid Electric Vehicle Technology. 1st Edition - 30 June 2010.
2. Mom, Gijs. Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market. 1st ed., Routledge, 2019.
3. Khajepour, Amir, et al. Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach. 1st ed., Wiley, 2018.
4. Emadi, Ali. Advanced Electric Drive Vehicles. 2nd ed., CRC Press, 2018.
5. Mi, Christopher. Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure, and the Market. 2nd ed., CRC Press, 2020.
6. Larminie, James, and John Lowry. Electric Vehicle Technology Explained. 2nd ed., Wiley, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3	2	2	2	2	2	1	2	2	2	
2	3	3	3	2	3	2	2	2	2	2	1	2	2	2	
3	3	3	3	2	3	2	2	2	2	2	1	2	2	2	
4	3	3	3	2	3	2	2	2	2	2	1	2	2	2	
5	3	3	3	2	3	2	2	2	2	2	1	2	2	2	
Avg.	3	3	3	2	3	2	2	2	2	2	1	2	2	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	3-D SCANNING TECHNOLOGY	L	T	P	C
		1	0	0	1

MODULE I INTRODUCTION OF 3-D SCANNING TECHNOLOGY AND SCANNING DEMONSTRATION **2**

3-D scanner working principle -types of 3-D scanners -technical specification -scanning software interface - applications - scanning demonstration.

MODULE II SOFTWARE INTERFACE **3**

Three zones of software interface - workspace panel - scanned model - 3-D window - control panel - functional menu -new project -open project -save project -file format -scan folder - snapshots or frames of object -solid polygonal model - model parameters - number of polygons - number of vertices - size of model in random access memory -visibility of scanned object on workspace -tool panel -scan – scanning mode -edit - registration algorithms -fusion algorithm -post processing algorithms -align -edges – repair - measures - multi-scan - texture - publish.

MODULE III BASIC PROCESSING **3**

Continuous scanning (auto-align) mode - manual alignment - global registration algorithms – geometry registration algorithm - polygonal modelling - sharp fusion algorithm - small object filter algorithm – mesh simplification algorithm - file formats for exporting model.

MODULE IV PRACTICE ON POST-PROCESSING OF SCANNED IMAGE FILES **7**

TOTAL = 15 PERIODS

COURSE OUTCOMES

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

CO1: Demonstrate mastery of techniques like continuous scanning, manual alignment, global registration, polygonal modeling, sharp fusion, and mesh simplification.

CO 2: Optimize 3-D models for accuracy, detail preservation, and integrity suitable for engineering applications.

CO 3: Manage and export 3-D models in various formats, understanding the impact on model quality and compatibility.

CO 4: Troubleshoot alignment discrepancies, mesh complexities, and other technical challenges in post-processing.

CO 5: Apply their knowledge to prepare scanned models for analysis, visualization, manufacturing, or integration into engineering projects.

REFERENCES:

1. https:lartecgroup.zendesk. com/hc/en-us/articles/201926472-Lesson-1-Installing-Artec-Studio
2. https:/lartecgroup.zendesk. com/hc/en-us/articles/201926482-Lesson-2-Artec-Studio-interface
3. https:lartecgroup.zendesk. com/hc/en-us/articles/202051201-Lesson-3-Basic-processing
4. https:/lartecgroup.zendesk. com/hc/en-us/articles/201837081-How-to-3D-body-scan-with-Artec-Eva

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	2	2	2	2	2	1	2	2	1	
2	3	3	3	3	3	2	2	2	2	2	1	2	2	1	
3	3	3	3	3	3	2	2	2	2	2	1	2	2	1	
4	3	3	3	3	3	2	2	2	2	2	1	2	2	1	
5	3	3	3	3	3	2	2	2	2	2	1	2	2	1	
Avg.	3	3	3	3	3	2	2	2	2	2	1	2	2	1	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	ADVANCED INDUSTRIAL AUTOMATION SYSTEMS	L	T	P	C
		1	0	0	1

MODULE I AUTOMATION IN MANUFACTURING INTRODUCTION: **4**

Importance of automation in the manufacturing industry. Use of mechatronics. Systems required. Design of an automated system: Building blocks of an automated system, working principle and examples.

MODULE II MECHANISMS **2**

Electronic cams, indexing mechanisms, tool magazines, and transfer systems.

MODULE III HYDRAULICS AND PNEUMATICS SYSTEMS **4**

Hydraulic systems: hydraulic power pack, pumps, valves. Hydraulic systems: designing of hydraulic circuits. Pneumatic systems: configurations, compressors, valves, distribution and conditioning.

MODULE IV MICROPROCESSOR TECHNOLOGY AND CNC **5**

Microprocessor Technology: signal conditioning and data acquisition, use of microprocessor or microcontroller. Configurations, Working. CNC technology: basic elements, interpolators and programming.

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO 1: Comprehend the importance of automation in the manufacturing industry, the role of mechatronics, and the design principles of automated systems.

CO 2: Gain knowledge about electronic cams, indexing mechanisms, tool magazines, and transfer systems used in manufacturing.

CO 3: Develop skills in designing hydraulic circuits and understanding the configurations and components of hydraulic and pneumatic systems.

CO 4: Acquire expertise in signal conditioning, data acquisition, and the use of microprocessors and microcontrollers in automation systems.

CO 5: Learn the basic elements of CNC technology, including interpolators and programming, and apply this knowledge to practical manufacturing scenarios.

REFERENCES BOOKS:

1. HMT Ltd. Mechatronics, Tata McGraw-Hill, New Delhi, 1988.
2. Bolton, W., “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering”, Longman, Singapore,1999.
3. Gaonkar, R. S., Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India), Delhi, 2000.
4. Bradley, D. A., Dawson D., Burd, N. C. and Loader A. J., Mechatronics: Electronics in products and processes, CRC Press, Florida, USA, 2010.
5. Parr, A. A., Hydraulics and Pneumatics, Elsevier, 1999.
6. Smid, P., CNC Programming Handbook, Industrial Press, New York, USA, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	2	2	2	2	2	1	2	3	2	
2	3	3	3	3	3	2	2	2	2	2	1	2	3	2	
3	3	3	3	3	3	2	2	2	2	2	1	2	3	2	
4	3	3	3	3	3	2	2	2	2	2	1	2	3	2	
5	3	3	3	3	3	2	2	2	2	2	1	2	3	2	
Avg.	3	3	3	3	3	2	2	2	2	2	1	2	3	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	AIRCRAFT MAINTENANCE	L	T	P	C
		1	0	0	1

MODULE I INTRODUCTION TO AIRCRAFT MAINTENANCE **5**

Fundamentals of Aircraft Maintenance - Types of Aircraft Maintenance Programs - Maintenance Manuals and Documentation - Procedures for Daily Inspections - Safety Protocols and Regulatory Compliance.

MODULE II AIRCRAFT SYSTEMS AND COMPONENTS **5**

Aircraft Power plant Systems - Maintenance Procedures for Aircraft Engines - Aircraft Airframe Systems - Inspection and Maintenance of Structural Components - Avionics and Electrical Systems in Aircraft.

MODULE III ADVANCED MAINTENANCE PRACTICES AND SAFETY **5**

Detailed Aircraft Inspections and Checks - Use of Non-Destructive Testing (NDT) Methods - Principles of Aircraft Maintenance Management - Planning, Scheduling, and Logistics in Maintenance - Safety and Human Factors in Aircraft Maintenance.

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO 1: Demonstrate knowledge of different types of aircraft maintenance programs and their significance in aviation.

CO 2: Analyze aircraft power plant systems, airframe structures, and avionics/electrical systems maintenance procedures.

CO 3: Apply detailed inspection procedures and non-destructive testing methods to ensure aircraft airworthiness.

CO 4: Implement principles of maintenance management including planning, scheduling, and logistical considerations.

CO 5: Evaluate the importance of safety protocols and human factors in aviation maintenance operations, adhering to regulatory standards.

Reference Books:

1. "Aircraft Maintenance and Repair" by Michael Kroes and William Watkins
2. "Aviation Maintenance Management" by Harry Kinnison and Tariq Siddiqui
3. "Aircraft Maintenance Engineering: A Practical Guide" by Dale Crane
4. "Introduction to Aircraft Maintenance" by J.R. Khan
5. "Aviation Maintenance Technician Handbook – General" (FAA-H-8083-30)

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3	2	2	2	2	2	1	2	2	1	
2	3	3	3	2	3	2	2	2	2	2	1	2	2	1	
3	3	3	3	2	3	2	2	2	2	2	1	2	2	1	
4	3	3	3	2	3	2	2	2	2	2	1	2	2	1	
5	3	3	3	2	3	2	2	2	2	2	1	2	2	1	
Avg.	3	3	3	2	3	2	2	2	2	2	1	2	2	1	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	BIOLOGY FOR ENGINEERS	L	T	P	C
		1	0	0	1

MODULE I: INTRODUCTION TO BIOLOGY AND ITS RELEVANCE TO ENGINEERING **5**

Basics of Biology: Overview of Biological Systems - Structure and Function of Cells DNA, RNA, and Proteins - Metabolism and Energy Transfer. Relevance of Biology to Engineering: Biological Inspiration in Engineering (Biomimetics) - Applications of Biology in Mechanical Engineering - Case Studies: Bio-inspired Design and Materials. Bio-materials and Their Properties: Introduction to Bio-materials - Mechanical Properties of Bio-materials - Bio-compatible Materials and Applications - Case Study: Use of Bio-materials in Medical Devices.

MODULE II: BIOMECHANICS AND BIO-SYSTEMS **5**

Basics of Biomechanics - Principles of Biomechanics - Mechanics of Biological Tissues (Bone, Muscle, Tendons) - Human Movement Analysis. Biomechanical Applications in Engineering - Design of Prosthetics and Orthotics - Robotic Surgery and Rehabilitation Engineering - Bio-robotics and Bio-mechatronics. Bio-systems and Control: Overview of Biological Control Systems - Feedback Mechanisms in Biological Systems - Bio-inspired Control Systems in Engineering.

MODULE III: BIO-INSPIRED ENGINEERING AND EMERGING TECHNOLOGIES **5**

Bio-inspired Design Principles: Fundamentals of Bio-inspired Design - Case Studies: Bio-inspired Structures and Mechanisms - Techniques for Implementing Bio-inspired Design. Emerging Technologies in Bio-engineering: Synthetic Biology and Genetic Engineering - 3D Bioprinting and its Applications - Advances in Tissue Engineering and Regenerative Medicine. Future Trends and Ethical Considerations - Future Trends in Bio-engineering - Ethical Considerations in Bio-engineering - Societal Impact of Bio-inspired Technologies.

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO 1: Comprehend the basic biological systems, including cellular structure and function, and how these principles can be applied in engineering.

CO 2: Analyze and apply the principles of biomechanics to design and evaluate mechanical systems that interact with biological tissues.

CO 3: Identify, analyze, and design bio-materials with specific mechanical properties for use in medical devices and other engineering applications.

CO 4: Develop skills in bio-inspired design principles, utilizing biological concepts to create innovative engineering solutions.

CO 5: Explore and understand emerging technologies in bio-engineering, such as synthetic biology, 3D bioprinting, and tissue engineering, and their potential applications in the field of mechanical engineering.

Reference Books:

1. "Biology for Engineers" by Arthur T. Johnson
2. "Biomechanics: Mechanical Properties of Living Tissues" by Y.C. Fung
3. "Biomaterials Science: An Introduction to Materials in Medicine" by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	2	2	2	2	2	2	1	2	2	2	
2	3	3	3	3	2	2	2	2	2	2	1	2	2	2	
3	3	3	3	3	2	2	2	2	2	2	1	2	2	2	
4	3	3	3	2	2	2	2	2	2	2	1	2	2	2	
5	3	3	3	2	2	2	2	2	2	2	1	2	2	2	
Avg.	3	3	3	2.4	2	2	2	2	2	2	1	2	2	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	CONSTITUTION OF INDIA	L	T	P	C
		1	0	0	1

MODULE I INTRODUCTION **5**

Historical Background – Constituent Assembly of India – Philosophical Foundations of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies For Citizens.

MODULE II UNION GOVERNMENT AND JUDICIAL REVIEW **5**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

MODULE III STATE GOVERNMENT AND JUDICIAL SYSTEMS **5**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

TOTAL = 15 PERIODS

COURSE OUTCOMES

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

CO 1: Gain a thorough understanding of the historical background, philosophical foundations, and key elements of the Indian Constitution, including Fundamental Rights, Directive Principles, and Constitutional Remedies**.**

CO 2: Familiar with the structure and functions of the Union Government, including the roles of the President, Prime Minister, Cabinet, and Parliament, as well as the concept and practice of judicial review by the Supreme Court.

CO 3: Acquire knowledge about the structure and functions of State Governments, including the roles of Governors, Chief Ministers, Cabinets, State Legislatures, and the judicial systems in states.

CO 4: Develop analytical skills to assess the interactions between different branches of government, including the executive, legislative, and judicial branches, and their implications for governance and constitutional rights.

CO 5: Apply their understanding of constitutional principles to analyze real-world issues and case studies, evaluating their impact on citizens' rights, governance, and legal remedies under the Indian Constitution.

Textbook:

1. Durga Das Basu, “Introduction to the Constitution of India “, Prentice Hall of India, New Delhi.
2. R.C.Agarwal, (1997) “Indian Political System”, S.Chand and Company, New Delhi.

Reference:

1. Sharma, Brij Kishore, “Introduction to the Constitution of India”, Prentice Hall of India, New Delhi

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3		2	2	2	2		1	2	2	1	
2	3	3	3	3		2	2	2	2		1	2	2	1	
3	3	3	3	3		2	2	2	2		1	2	2	1	
4	3	3	3	3		2	2	2	2		1	2	2	1	
5	3	3	3	3		2	2	2	2		1	2	2	1	
Avg.	3	3	3	3		2	2	2	2		1	2	2	1	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	E-COMMERCE SECURITY	L	T	P	C
		1	0	0	1

MODULE I INTRODUCTION TO WEB SECURITY **6**

Harmony Web Security - Basic web security model - Web attacks (e.g., SQL injection, XSS, CSRF) and defenses - Session management and user authentication - Certificates and PKI - HTTPS: Design and pitfalls

MODULE II SECURITY IN WEB PAYMENTS **4**

Payments - Legacy payment systems EMV protocol Attacks on EMV Securing CNP transactions and PCI compliance Tokenization

MODULE III CRYPTOCURRENCIES **5**

Cryptocurrencies Early digital currencies Building blocks - The Bitcoin block chain - Bitcoin mechanics - Bitcoin Storage and use - Bitcoin security threats - Regulating cryptocurrencies

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO 1: Gain a comprehensive understanding of web security principles, vulnerabilities, and defenses, including authentication, session management, HTTPS, and regulatory compliance.

CO 2: Demonstrate proficiency in securing web-based payment systems, including legacy protocols, CNP transactions, tokenization, and compliance with PCI DSS standards.

CO 3: Acquire in-depth knowledge of cryptocurrency fundamentals, blockchain technology, Bitcoin mechanics, security threats, and regulatory considerations.

CO 4: Apply advanced security practices to mitigate web threats, enhance payment security, and manage risks associated with cryptocurrency transactions.

CO 5: Critically analyze case studies, real-world scenarios, and regulatory frameworks to evaluate the effectiveness and implications of web security measures, payment security strategies, and cryptocurrency regulations.

TEXT BOOK

1. Bryan Sullivan and Vincent Liu. Web Application Security, A Beginner's Guide. McGraw Hill Education, Ist Edition

REFERENCES

1. Narayanan, Bonneau. Felton, Miller, Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press, Edition.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		3		2	2		2	2	1	2	2	1	
2	3	3		3		2	2		2	2	1	2	2	1	
3	3	3		3		2	2		2	2	1	2	2	1	
4	3	3		3		2	2		2	2	1	2	2	1	
5	3	3		3		2	2		2	2	1	2	2	1	
Avg.	3	3		3		2	2		2	2	1	2	2	1	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	FOUNDRY PRACTICE AND PROCEDURES	L	T	P	C
		1	0	0	1

MODULE I GATING **4**

Gating system design for pattern design – Method of calculation.

MODULE II MOULDING **1**

Moulding Process set – Alpha set

MODULE III MELTING **3**

Melting process – carbon steel and stainless steel (ASTM A216 and ASTM A351).

MODULE IV HEAT TREATMENT AND QUALITY **6**

Heat Treatment – for carbon steel and stainless steel. Quality - for Carbon steel and stainless steel – Destructive testing – NDT – Final Inspection.

MODULE V RECENT DEVELOPMENTS **1**

Recent developments in casting processes.

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO 1: Recall principles and methods for gating system design and moulding techniques in casting.

CO 2: Understand melting processes for carbon steel and stainless steel, distinguishing between ASTM A216 and ASTM A351 standards.

CO 3: Apply calculation methods for gating system design, evaluate heat treatment techniques, and implement quality assurance practices such as NDT and final inspection.

CO 4: Analyze the effectiveness of different moulding techniques and melting processes in achieving desired casting outcomes.

CO 5: Evaluate recent developments in casting processes, technologies, and materials, assessing their impact on casting efficiency and quality improvement.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2		2	2		2	2	1	2	2	1	
2	3	3	3	2		2	2		2	2	1	2	2	1	
3	3	3	3	2		2	2		2	2	1	2	2	1	
4	3	3	3	2		2	2		2	2	1	2	2	1	
5	3	3	3	2		2	2		2	2	1	2	2	1	
Avg.	3	3	3	2		2	2		2	2	1	2	2	1	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	INNOVATION AND ENTREPRENEURSHIP	L	T	P	C
		1	0	0	1

MODULE I INTRODUCTION **3**

Innovation and its Need - Entrepreneurial Stages

MODULE II INNOVATION **6**

Principles of Innovation, Do's and Don'ts - Sources for Innovation, unexpected success and failure. Demographics and perception - Motivation for Innovation, Societal and Environmental Needs, Incongruities between perceived and actual customer values and expectations - High-risk High-return Innovation.

MODULE III ENTREPRENEURSHIP **6**

Intrapreneurship vs Entrepreneurship - Business vs Entrepreneurship- Entrepreneurial Processes.

TOTAL = 15 PERIODS

COURSE OUTCOMES

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

CO 1: Explore the fundamentals of innovation, including its necessity and stages of entrepreneurial development.

CO 2: Understand the principles of innovation, including dos and don'ts, sources, unexpected outcomes, and demographic influences.

CO 3: Analyze the motivations behind innovation, focusing on societal and environmental needs, and the discrepancies between perceived and actual customer expectations.

CO 4: Compare and contrast intrapreneurship and entrepreneurship, and understand the entrepreneurial processes involved in transforming ideas into business ventures.

CO 5: Discuss high-risk, high-return innovations, their challenges, and potential rewards in the entrepreneurial landscape.

TEXT BOOK

1. Peter F Drucker, "Innovation and Entrepreneurship", Harper and Row Publishers Inc, USA, 2009

REFERENCE

1. Robert D Hisrich, Michael p peters and Dean A Shepherd, "Entrepreneurship", Tata Mc Graw Hill. IT Edition. 2017.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	2	2	2	2	2	1	2	2	2	
2	3	3	3	3	3	2	2	2	2	2	1	2	2	2	
3	3	3	3	3	3	2	2	2	2	2	1	2	2	2	
4	3	3	3	3	3	2	2	2	2	2	1	2	2	2	
5	3	3	3	3	3	2	2	2	2	2	1	2	2	2	
Avg.	3	3	3	3	3	2	2	2	2	2	1	2	2	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	INSPECTION AND QUALITY CONTROL IN MANUFACTURING	L	T	P	C
		1	0	0	1

MODULE I INSPECTION **2**

Introduction, Fundamental Concept of Quality, Role of Inspection and Measurement for Quality Control in Manufacturing, Need of Inspection, Inspection types and Principles, Design for Inspection, Destructive Inspection, Testing of Composite Materials. (3)

MODULE II QUALITY CONTROL **3**

Introduction, Aim and functions of quality control, Quality concepts - ISO 9001 - Customer requirements, Quality Tools, Deming awards, TQM - Kaizen and innovation – the Kaizen management practices – Total Quality Control (TQC).

MODULE III QUALITY CONCEPTS IN MANUFACTURING **4**

Just in time (JIT) Concept, Lean Manufacturing, Agile Manufacturing, World Class Manufacturing, Total Productive Maintenance (TPM), Bench Marking, Business Process Re-engineering (BPR)

MODULE IV QUALITY CONTROL TOOLS **4**

Small group activities – quality circles – Comparison of kaizen and Deming's approach. Affinity diagram – brainstorming – cause and effect analysis –checklist– flow charts – Pareto analysis – quality costing – Quality Function Deployment (QFD) – Training of quality – self managing teams.

MODULE V SIX SIGMA - CONCEPT AND IMPLEMENTATION **2**

Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO 1: Demonstrate a thorough understanding of fundamental quality concepts and their application in manufacturing contexts.

CO 2: Implement Total Quality Management (TQM), Kaizen, and ISO 9001 standards effectively to meet customer requirements and achieve organizational goals.

CO 3: Apply Lean Manufacturing, JIT, Agile Manufacturing, and TPM to optimize production processes and enhance manufacturing competitiveness.

CO 4: Utilize quality control tools such as Pareto analysis, QFD, and quality circles to prioritize improvements and empower self-managing teams in quality assurance.

CO 5: Apply Six Sigma principles to achieve process improvement, reduce defects, and enhance overall organizational performance in manufacturing.

TEXT BOOKS

1. Winchell William, "Inspection and Measurement in Manufacturing", Society of Manufacturing Engineers.
2. Juran J.M & Gryna F.M., Quality Planning and Analysis – From Product development through usell, Tata McGrawHill Publishing Limited, new Delhi, 3rd Edition, 1995

3. Pyzdek T and Berger R W, “Quality Engineering Handbook”, Tata-McGraw Hill, New Delhi, 1996.

REFERENCES

1. Taguchi G, Elsayed E A and Hsiang, T.C., “Quality Engineering in Production Systems”, Mc-Graw-Hill Book company, Singapore, 1989.
2. “Welding Inspection”, 3rd Edition, American Welding Society.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3		3	2	2		2	2	1	2	2	1	
2	3	3	3		3	2	2		2		1	2	2	1	
3	3	3			3	2			2		1	2	2	1	
4	3	3			3	2			2	2	1	2	2	1	
5	3	3	3		3	2	2		2	2	1	2	2	1	
Avg.	3	3	3		3	2	2		2	2	1	2	2	1	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	MATLAB PROGRAMMING	L	T	P	C
		1	0	0	1

MODULE I MATLAB FUNDAMENTALS **2**

Working with the MATLAB user interface, Entering commands and creating variables

MODULE II VECTORS AND MATRICES **3**

Analyzing vectors and matrices, visualizing vector and matrix data

MODULE III DATA FILES **3**

Working with data files, working with data types

MODULE IV SCRIPTS AND LOOPS **3**

Automating commands with scripts, writing programs with branching and loops, Writing functions.

MODULE V APPLICATIONS **3**

Engineering Mechanics, Theory of Machines and Robotics, Mechanical Vibrations and Control Systems using MATLAB.

TOTAL = 15 PERIODS

COURSE OUTCOMES

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

CO 1: Master the MATLAB user interface, execute commands, and create/manipulate variables.

CO 2: Analyze vectors and matrices, and visualize data using MATLAB's plotting functions.

CO 3: Work with various data file formats, understand data types, and perform data import/export operations.

CO 4: Write scripts, implement branching and loops, and create user-defined functions to automate tasks.

CO 5: Solve practical engineering problems in Engineering Mechanics, Theory of Machines, Robotics, Mechanical Vibrations, and Control Systems using MATLAB.

TEXTBOOKS

1. MATLAB Onramp - MATLAB & Simulink Tutorial, https://in.mathworks.com/learn/tutorials/matlab-onramp.html
2. Dan B. Marghitu, Mechanisms and robot analysis with MATLAB, Springer, 2009.
3. Rao V. Dukkipati, MATLAB an introduction with applications, New age international private limited, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		3	3	2		2	2		1	2	2	2	
2	3			3	3	2		2	2		1	2	2	2	
3	3			3		2		2	2		1	2	2	2	
4	3	3		3		2		2	2		1	2	2	2	
5	3	3		3	3	2		2	2		1	2	2	2	
Avg.	3	3		3	3	2		2	2		1	2	2	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	NON DESTRUCTIVE EVALUATION	L	T	P	C
		1	0	0	1

MODULE I INTRODUCTION TO NON-DESTRUCTIVE TESTS (NDT) **3**

Introduction to NDT, Visual Optical methods, Dye penetrant testing, Basic principle, Types of dye and methods of application

MODULE II MAGNETIC PARTICLE TESTING **3**

Magnetic particle testing. Basic theory of magnetism, Magnetization methods, Field indicators, Particle application, Inspection

MODULE III EDDY CURRENT TESTING **3**

Eddy current testing, Basic principle; Faraday's law, Inductance, Lenz's law, Self and Mutual Inductance.

MODULE IV ULTRASONIC TESTING **3**

Ultrasonic testing: Basics of ultrasonic waves, Pulse and beam shapes. Ultrasonic transducers. Test method, Distance and Area calibration Acoustic emission testing: Basic principle, Sources of acoustic emission, Source parameters

MODULE V RADIOGRAPHY **3**

Radiography: X-rays and their properties. X-ray generation, X-ray absorption and atomic scattering. Image formation, Image quality, Digital Radiography. Image interpretation. Radiation Shielding

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3		2		2	2	2	1	2	2	2	
2	3	3	3	3		2		2	2	2	1	2	2	2	
3	3		3			2		2	2		1	2	2	2	
4	3		3			2		2	2		1	2	2	2	
5	3	3	3	3		2		2	2	2	1	2	2	2	
Avg.	3	3	3	3		2		2	2	2	1	2	2	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	RECENT TRENDS IN QUALITY	L	T	P	C
		1	0	0	1

MODULE I: QUALITY MANAGEMENT SYSTEMS AND STANDARDS **5**

Introduction to Quality Management Systems: Overview of quality management principles - Evolution and importance of quality standards in manufacturing. ISO 9001:2015 and Beyond: Detailed exploration of ISO 9001:2015 requirements - Implementation challenges and benefits in mechanical engineering contexts. Emerging Quality Standards: Introduction to new and emerging quality standards in global markets - Comparative analysis with ISO standards: ISO 14001, ISO 45001, etc.

MODULE II: ADVANCED QUALITY TOOLS AND TECHNIQUES **5**

Six Sigma and Lean Manufacturing: Principles and methodologies of Six Sigma and Lean Manufacturing - Case studies on successful implementations in mechanical engineering - Quality Function Deployment (QFD) and Failure Mode and Effects Analysis (FMEA) - Application of QFD in product development and quality planning - Comprehensive understanding of FMEA and its importance in risk mitigation. Statistical Process Control (SPC) and Quality Improvement: Introduction to SPC techniques for monitoring and controlling processes - Strategies for continuous quality improvement using SPC methodologies.

MODULE III: INDUSTRY 4.0 AND QUALITY ASSURANCE **5**

Introduction to Industry 4.0: Overview of Industry 4.0 concepts and technologies - Integration of digitalization and automation in quality management. IoT and Big Data Analytics in Quality Assurance: Role of IoT (Internet of Things) in real-time quality monitoring - Utilization of big data analytics for predictive quality management. Quality 4.0: Future Trends and Case Studies: Exploration of Quality 4.0 initiatives in manufacturing - Case studies illustrating successful adoption of advanced technologies in quality assurance.

TOTAL = 15 PERIODS

COURSE OUTCOMES

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

CO 1: Understand quality management systems like ISO 9001:2015 and their application in mechanical engineering.

CO 2: Apply Six Sigma, Lean Manufacturing, QFD, FMEA, and SPC for process optimization and risk mitigation.

CO 3: Analyze Industry 4.0 technologies (IoT, big data) in real-time quality monitoring.

CO 4: Evaluate emerging quality standards and their impact on global manufacturing.

CO 5: Critically assess case studies and future trends in Quality 4.0 for mechanical engineering.

Text Books:

1. "Quality Management for Organizational Excellence: Introduction to Total Quality" by David L. Goetsch and Stanley Davis
2. "Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations" by Mikel Harry and Richard Schroeder
3. "Lean Thinking: Banish Waste and Create Wealth in Your Corporation" by James P. Womack and Daniel T. Jones
4. "Quality Control and Industrial Statistics" by Acheson J. Duncan

5. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3		3	2		2	2	2	1	2	2	2	
2	3	3	3		3	2		2	2	2	1	2	2	2	
3	3		3		3	2		2	2	2	1	2	2	2	
4	3		3		3	2		2	2	2	1	2	2	2	
5	3		3		3	2		2	2	2	1	2	2	2	
Avg.	3	3	3		3	2		2	2	2	1	2	2	2	

1-low, 2-medium, 3-high

VALUE ADDED COURSES

23ME	DESIGN OF ELECTRIC VEHICLE (FOUR WHEELER)	L	T	P	C
		1	0	0	1

MODULE I BASICS OF EV TECHNOLOGY **3**

Configuration of Electric Vehicles - Performance of Electric Vehicles.

MODULE II EV BATTERY DESIGN **3**

Energy storage requirements - Battery parameters - Types of Batteries - Modelling of Battery – Design aspects.

MODULE III DESIGN OF EV POWER TRAIN UNIT **3**

Components of power train unit – Design aspects - Architecture of Electric Drive Trains.

MODULE IV EV MODELING WITH VEHICLE DYNAMICS **3**

Dynamic Analysis of electric vehicle – A case study.

MODULE V INDUSTRIAL VISIT - EV UNIT **3**

TOTAL = 15 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1: Interpret working of different configurations of electric vehicles and its components

CO2 : Design batteries for specific application

CO3: Design and develop power train systems for electric vehicles

CO4: Model and analyze vehicle dynamic system

CO5 : Demonstrate various EV technologies and systems

Text Books:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Reference Books:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
2. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
3. Hybrid and electric vehicle solutions guide – released by Texas Instruments, 2011
4. https://nptel.ac.in/courses/108/102/108102121/#

CO PO MAPPING

CO	Programme Outcomes														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1					2								
CO2	3	3	3		2		2					1			2
CO3	3	3	3		2		2			1			3		2
CO4	3	3			3		2						3		2
CO5	1						2		3		3	3			3
Avg.	2.6	2.5	3		2.3		2		3	1	3	2	3		2.2

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

VALUE ADDED COURSES

23ME	HEATING VENTILATION AND AIR-CONDITIONING SYSTEM DESIGN	L	T	P	C
		1	0	0	1

INTRODUCTION TO HVAC **(5)**

Introduction to HVAC - Fundamental and scope of HVAC - Mode of heat transfer - Standards - Refrigeration cycle. Component of A/C - Refrigerants and types Classification of Air-Conditioning System. Chilled water system of air conditioning - Air water system of air conditioning - Direct refrigerant system of air conditioning.

AIR DISTRIBUTION AND DUCT DESIGN **(5)**

Air Distribution: Room air distribution - Types of supply air outlets - Mechanism of flow through outlets - Distribution patterns of outlets DUCT design.

LOAD CALCULATION **(5)**

Cooling and Heat Load Calculation - ASHRAE Standards - Calculation of sensible Heat Factor-ADP and Dehumidified CFM.

TOTAL = 15 PERIODS

Course Outcomes:

On successful completion of the course, the student will be able to

CO1: Demonstrate the basic components of Air Conditioning & Refrigeration machines, Basic Refrigeration cycle, Accessories & Refrigerants
CO2: Select different Air-Conditioning System for specific applications
CO3: Use Psychrometric Chart and understand various terminology
CO4: Calculate load for building, Ventilation requirement for IAQ, ESHF, ADP & Air Flow Rate (CFM)
CO5: Develop Hydronic System, Water Piping, Fittings used in the HVAC Piping System.

Reference:

1. Refrigeration and Air conditioning MANOHAR PRASAD, New Age publisher, 2018
2. Refrigeration and Air conditioning, R.C. ARORA, PHI publishers 2020, INDIA,

Reference Links:

1. ASHRAE Handbook Volumes 2020,Online
2. Ishrae Data Book 2017
3. Hvac Handbook 2020 by Rosaler, Robert
4. Heating and Cooling of Buildings: Design for Efficiency, Revised Second Edition 2018 (Mechanical Engineering Series)

Industrial visit:

1. VOLTAS Refrigeration, Chennai,
2. MR Referigerator, Coimbatore,

CO PO MAPPING

CO	Programme Outcomes														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2				3			3		2	3	2		
CO2		3		3											
CO3	3			3			3		3	3	3	2			
CO4	3	3	3					2		2		2		3	
CO5	2				3			3		2	3	2			
Avg.	2.7	2.6	3	3	3	3	3	2.5	3	2.3	2.6	2.2	2	3	

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

VALUE ADDED COURSES

23ME	GEOMETRIC DIMENSIONING AND TOLERANCING IN DESIGN	L	T	P	C
		1	0	0	1

MOULE I INTRODUCTION **5**

History, Introduction and understanding the need for GD & T - Fundamental rules of GD&T per ASME - Rule1 and Rule2 – Tolerance charting, Coordinate vs Geometric Tolerancing - Definitions of Terms and Symbols: Feature, FOS, FCF, MMC, LMC and RFS - DRF thro definition of datums and DOF restrained by primary, secondary and tertiary datums - Calculation of bonus tolerance per MMC / LMC

MODULE II FORM, ORIENTATION, LOCATION TOLERANCES AND APPLICATIONS **5**

Form tolerances and applications – Straightness, Flatness, Circularity, Cylindricity. Orientation tolerances and applications – Parallelism, Perpendicularity, Angularity - Location tolerances and applications – Position, Concentricity, Symmetry

MODULE III RUN OUT, PROFILE TOLERANCES AND APPLICATIONS **5**

Run out tolerances and applications - Circular run out, Total run out Profile tolerances and applications - Profile of a line, Profile of a surface Inspection Methodology for GD&T Parameters

TOTAL = 15 PERIODS

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1: Understand the concepts of GD&T features and correctly interpret GD&T symbols in Engineering Drawings

CO2: Learn about using Geometric tolerances at RFS, MMC and LMC conditions and Calculate Bonus tolerance

CO3: Interpretation of GD&T Parameters

CO4: Learn GD&T through Case Studies and Exercises

CO5: Gain an insight into inspection of GD&T features using conventional methods

Text Books:

1. David A. Madsen, Geometric Dimensioning and Tolerancing: Principles and Practices, 10th Edition, The Goodheart-Willcox Company, Inc., 2022.
2. Ashok Kumar, Simplified GD&T: Based on ASME-Y 14.5-2009, 2nd Edition, 2018.

Reference Books:

1. ASME Y14.5 – 1994 Dimensioning and Tolerancing
2. James D. Meadows, Geometric Dimensioning and Tolerancing: Workbook and Answerbook: 112 (Mechanical Engineering), CRC Press, 1997
3. CAD Desk, GEOMETRIC DIMENSIONING & TOLERANCE (GD&T) REFERENCE GUIDE BOOK, 2016
4. Alex Krulikowski, Fundamentals of Geometric Dimensioning and Tolerancing: Based on Asmey 14.5-2009, Delmar Cengage Learning, 3rd Edition, 2012.

Further Reading:

NPTEL

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

Online Materials

1. https://www.udemy.com/course/gd-t-and-stack-up-basic-to-expert-level/
   https://www.sae.org/learn/professional-development/gdt

CO PO MAPPING

CO	Programme Outcomes														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1:	3	3	3	3	1		2		2			2	3	2	1
CO2:	3	3	3	3	1		2		2			2	3	2	1
CO3:	3	3	3	3	1		2		2			2	3	2	1
CO4:	3	3	3	3	1		2		2			2	3	2	1
CO5:	3	3	3	3	1		2		2			2	3	2	1
Average	3	**3**	3	3	**1**		2		2			2	3	**2**	**1**

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

VALUE ADDED COURSES

23ME	ADVANCED SOLID STATE JOINING PROCESSES	L	T	P	C
		1	0	0	1

MODULE I DIFFUSION JOINING PROCESSES **5**

Principles and applications; Diffusion brazing, braze welding, diffusion welding; Diffusion bonding of metals to ceramics; Solid-state deposition welding processes; Pressure non-fusion welding processes: Cold welding, electromagnetic pulse welding, pressure gas welding.

MODULE II FRICTION WELDING (FW) PROCESSES **5**

Friction Welding (FW) process: Process parameters, applications, metallurgical, mechanical and tribological characterizations; Spin welding, rotary drive FW, inertia welding, friction taper stitch welding, radial FW; Friction seam welding, Study of friction welds and joint quality of FW.

FRICTION STIR WELDING (FSW) PROCESSES (5)

Friction Stir Welding (FSW) process: Fundamentals and Classifications, materials; Heat generation, metallurgical and mechanical characterizations, micro FSW and its applications; friction stir spot welding (FSSW) - process parameters, hybrid FSW, underwater FSW, ultrasonic assisted FSW, and electrically assisted FSW; Friction stir processing and friction surfacing.

TOTAL = 15 PERIODS

Course Outcomes:

On successful completion of the course, the student will be able to

CO1: Demonstrate knowledge on fundamental principles and overview of different types of solid-state joining processes.

CO2: Adopt suitable solid state welding processes to obtain sound weld with minimal heat input.

CO3: Apply friction welding technology for the suitable industrial applications.

CO4: Develop friction stir welding procedures to obtain defect free joints as well as pollution free environment.

CO5: Demonstrate and understanding of different methods of friction stir technologies.

Text Books:

1. R.S.Paramar , & quot; Welding Processes and Technology & quot;, 3rd Edition, Khanna Publishers, New Delhi, 2010.
2. Daniela Lohwasser, Zhan Chen, & quot; Friction Stir Welding from Basics to Applications & quot;, Woodhead Publishing, 2010.

Reference Books:

1. Rajiv Sharan Mishra, ParthaSarathi De, Nilesh Kumar, " Friction Stir Welding and Processing: Science and Engineering & quot;, 1st Edition, Springer International Publishing, 2014.
2. Bekir Sami Yilbas, Ahmet Z. Sahin, " Friction Welding: Thermal and Metallurgical Characteristics", Springer Science, 2014.
3. P.Asadi, M.K. Besharati-Givi , "Advances in Friction-Stir Welding and Processing & quot;, Woodhead Publishing, 2014.
4. Nilesh Kumar, Rajiv S. Mishra, Wei Yuan, " Friction Stir Welding of Dissimilar Alloys and Materials", Elsevier, 2015.

CO PO MAPPING

CO	Programme Outcomes														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1:	3	3	2	3			3	1	3	3		3	3	2	
CO2:	3	2	2	2			3	1	3	2		3	3	2	
CO3:	3	2	3	3			3	1	2	2		3	3	2	
CO4:	3	2	2	3			3	1	2	2		3	3	2	
CO5:	3	2	2	3			3	1	2	2		3	3	2	
Avg..	3	2.2	2.2	2.8			3	1	2.4	2.2		3	3	2	

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

OPEN ELECTIVE

23ME	DESIGN OF EXPERIEMENTS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **7**

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

MODULE II BASIC STATISTICAL CONCEPTS **9**

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples.

MODULE III EXPERIMENTAL DESIGN **12**

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

MODULE IV ANALYSIS AND INTERPRETATION METHODS **9**

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

MODULE V EXPERIMENT DESIGN USING TAGUCHI'S ORTHOGONAL ARRAYS **9**

Types of Orthogonal Arrays, selection of standard orthogonal arrays, linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand fundamental principles of experimental design and its strategic importance in research and development.

CO2: Apply statistical concepts and methods to analyze experimental data, including measures of central tendency, variability, and hypothesis testing.

CO3: Design factorial experiments and analyze factorial effects and interactions using ANOVA and regression analysis.

CO4: Implement Taguchi's orthogonal arrays for robust parameter design and optimization of processes.

CO5: Develop skills in interpreting experimental results, constructing mathematical models, and utilizing advanced statistical tools for process improvement and quality enhancement.

TEXT BOOKS:

1. C.F. Jeff Wu & Michael Hamada, “Experiments-Panning, Analysis, and Optimization”, 3rd Edition, John Wiley & Sons. Inc., 2021.
2. D.C. Montgomery, “Design and Analysis of Experiments”, 10th Edition, John Wiley & Sons. Inc. 2019.

REFERENCE:

1. T.B. Barker, Andrew Milivojevich, “Quality by Experimental Design”, 4th Edition, CRC Press, 2021.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1								2		
2	3	2	1	1	1								2		
3	2	2	2	2	1				1				1		
4	2	3	2	1	2			2					2		1
5	1	2	2	1	2			2					2		1
Avg..	2.2	2.2	1.8	1.4	1.4			2	1				1.8		1

1-low, 2-medium, 3-high

OPEN ELECTIVE

23ME	ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

MODULE I SHAPING PROCESSES FOR PLASTICS **9**

Properties of polymer melts - extrusion - production of sheet and film - fibre and filament production (spinning) – coating processes - injection moulding - compression and transfer moulding - blow moulding and rotational moulding - thermoforming. Casting - polymer foam processing and forming - product design considerations..

MODULE II RUBBER-PROCESSING TECHNOLOGY **9**

Rubber processing and shaping - manufacture of tyres and other rubber products - product design considerations.

MODULE III SHAPING PROCESSES FOR POLYMER MATRIX COMPOSITES **9**

Materials for PMC - open mold processes - closed mold processes - filament winding - pultrusion process - other PMC shaping processes.

MODULE IV PROCESSING OF CERAMICS AND CERMETS **9**

Processing of traditional ceramics - processing of new ceramics - processing of cermets - product design considerations.

MODULE V APPLICATION OF COMPOSITES **9**

Composites including Nano-composites for electrical, superconducting and device applications, fabrication of Nano-composites, secondary processing and joining of various composite materials for structural applications and their fracture behavior and safety.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Choose manufacturing processes for polymers and PMC materials to obtain required shapes by applying product design considerations

CO2: Find the processes to develop new ceramic and cermet materials for manufacturing of high temperature cutting tools by applying design considerations

CO3: Develop and characterize the Nano-composites, MMCs, CMCs and PMCs for the engineering applications using secondary processing methods.

CO4: Synthesize, characterize, compaction and sintering of metal powders for application of P/M parts using powder metallurgy techniques

CO5: Synthesize and characterize the nanostructured materials for fabricating electronic devices, MEMS, magnetic, electronic and optical sensors and fabricating carbon nano structured materials for fuel cell and energy storage applications

TEXT BOOKS:

1. Mikell P. Groover, "Fundamentals of Modern Manufacturing Materials, Processes and Systems", 4th Edition, John Wiley & sons, Inc. 2015.
2. Ajayan P. M., Schadler L. S., and Braun P. V, "Nano composite Science and Technology", John Wiley & Sons, Inc., 2014.

REFERENCES:

1. Charles A. Harper, "Modern Plastics Handbook", McGraw-Hill, 2010.
2. Sperling L.H., "Introduction to Physical Polymer Science", 3rd Edition, John Wiley & Sons, 2011.
3. Chawla K.K., "Ceramic matrix composites", 1st Edition, Chapman & Hall, 2013.
4. Randall M German, "A-Z of Powder Metallurgy (Metal Powders Technology)", Elsevier science, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		3	1		2		2			2	3	2	
2	3			3	1		2		2			2	3	2	
3	3			3	1		2		2			2		2	
4	3	3			1		2		2			2			
5	3	3			1		2		2			2	3		
Avg..	3	3		3	1		2		2			2	3	2	

1-low, 2-medium, 3-high

OPEN ELECTIVE

23ME	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO MANAGEMENT **9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

MODULE II FUNCTIONS OF MANAGEMENT - I **9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design

MODULE III FUNCTIONS OF MANAGEMENT - II **9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

MODULE IV ORGANIZATION THEORY **9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

MODULE V PRODUCTIVITY AND MODERN TOPICS **9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS), Industry 4.0.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Discuss basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.

CO2: Discuss the planning; organizing and staffing functions of management in professional organization.

CO3: Apply the leading; controlling and decision making functions of management in professional organization.

CO4: Discuss the organizational theory in professional organization.

CO5: Apply principles of productivity and modern concepts in management in professional

organization.

TEXT BOOKS:

1. M. Govindarajan and S. Natarajan, “Principles of Management”, Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Weihrich. H., “Essentials of Management: An International Perspective”, 8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCES:

1. Joseph J, Massie, “Essentials of Management”, 4th Edition, Pearson Education, 1987.
2. Saxena, P. K., “Principles of Management: A Modern Approach”, Global India Publications, 2009.
3. S.Chandran, “Organizational Behaviours”, Vikas Publishing House Pvt. Ltd., 1994.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3		3		1	1	2		2			2	2	2	
2	3		3		1	1			2			2	2	2	
3	3		3			1			2			2	2	2	
4	3	3				1	2		2			2	2	2	
5	3	3			1		2		2			2	2	2	
Avg..	3	**3**	3		**1**	**1**	2		2			2	**2**	**2**	

1-low, 2-medium, 3-high

OPEN ELECTIVE

23ME	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION & GEOMETRIC FORM **9**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

MODULE II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION **9**

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis – Manufacturing Process Verification.

MODULE III DATA PROCESSING **9**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

MODULE IV 3D SCANNING AND MODELLING **9**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

MODULE V INDUSTRIAL APPLICATIONS **9**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Apply the fundamental concepts and principles of reverse engineering in product design and development.

CO2: Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.

CO3: Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.

CO4: Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.

CO5: Applications of reverse engineering in product design and development.

TEXT BOOKS:

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014.
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011.

REFERENCES:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022.
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001.
3. Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	3			1		2		1	2		
2	3	3	3		3			1		2		1	2		
3	3		3		3			1		2		1	2		
4	3		2	2	3			1		2		1	2		
5	3		2	2	3			1		2		1	2		
Avg..	3	3	2.6	2	3			1		2		1	2		

1-low, 2-medium, 3-high

OPEN ELECTIVE

23ME	NANO TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

General definition and size effects–important nano structured materials and nano particles importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

MODULE II SYNTHESIS OF NANOMATERIALS **9**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

MODULE III NANO COMPOSITES **9**

Definition- importance of nanocomposites- nano composite materials-classification of composites metal/ metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based influence of size, shape and role of interface in composites applications.

MODULE IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES **9**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and super lattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

MODULE V APPLICATIONS OF NANO MATERIALS **9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots - Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.
CO2: Able to acquire knowledge about the different types of nano material synthesis.
CO3: Describes about the shape, size, structure of composite nano materials and their interference.
CO4: Understand the different characterization techniques for nanomaterials.
CO5: Develop a deeper knowledge in the application of nanomaterials in different fields.

TEXT BOOKS:

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press.
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" Imperial College Press, 2004.

REFERENCES:

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd Edition, 2005, Wiley VCH Verlag Gibtl & Co.
3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010.
4. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3rd Edition, CRC Taylor and Francis group 2012.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		2	3	3		1	2		1		2		
2	3			2	3	3		1	2		1		2		
3	3		3	2	3	3		1	2		1		2		
4	3	3	3	2	3	2		1	2		1		2		
5	3	3		2	3	2		1	2		1		2		
Avg..	3	3	3	2	3	2.6		1	2		1		2		

1-low, 2-medium, 3-high

OPEN ELECTIVE

23ME	BUSINESS PROCESS REENGINEERING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO BPR **9**

Definition; the paradigm shifts in production; the need for BPR, advantages and benefits of BPR, constraining factors, challenges, the positioning concept; the re-engineering visions; The BPR Lifecycle Methodology, Guidelines for BPR steps, Role of Information Technology in BPR; process Improvement and Process Redesign; BPR Experience in Indian Industry.

MODULE II METHODOLOGIES AND TOOLS FOR BPR **9**

Process management; dynamic business re-engineering change framework; steps to reengineer the process. Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering. Conceptual Foundation of Business Process Re-engineering;; Process Identification and Mapping; Role/Activity Diagrams.

MODULE III CHANGE MANAGEMENT **9**

Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering. Process Visioning and Benchmarking. Business process Improvement, Business Process Redesign; Man Management for BPR mplementation; Re-organizaing People and Managing Change.

MODULE IV GOVERNANCE & BPR **9**

Total Quality Management, Risk Management, Organizational Structures, BPR Project Management, The Power of Habit in organizations. The role of eLearning environments. Applications, gaming, BPR facilitation, BPR in Software Development, Basic principles, Relation to BPR.

MODULE V BEST PRACTICES IN BPR **9**

Research & Practice, Perspectives in BPR, Discussion on research challenges, and practice challenges for industry and governments Case studies: Nissan, Chrysler, Hewlett Packard etc. Work flow systems, Imaging technology, Floware, Business design facility tools, Risk and impact measurement.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Gain knowledge about BPR, Factors affecting BPR operations and design BPR techniques.

CO2: Use BPR tools, utilize concepts of BPR, analyse cost / Benefit and appreciate the need of IT in BPR.

CO3: Incorporate changes in the business operation based on market demand and implement same in manufacturing system.

CO4: Select an appropriate practice of the business re-engineering project by taking the practical situations into consideration.

CO5: Provide the most feasible practical solution to the problem keeping in mind the considerations of business automation, value, processes and risks in launching the business reengineering project.

TEXT BOOKS:

1. Davenport, “Process Innovation: Reengineering work through information technology”. Harvard Business School Press, 1993.
2. Hammer & Champy, “Reengineering the Corporation: A Manifesto for Business Revolution” Harper Business Books,1993.

REFERENCES:

1. Harmon, P, “Business Process Change : A Guide for Business Managers and BPM and Six Sigma Professionals”, Elsevier/ Morgan Kaufmann Publishers, 2007.
2. R. Anupindi et al., “Managing Business Process Flows: Principles of Operations Management”, Pearson Education Inc, 2006.
3. Walford, R.B., “Business Process Implementation for IT Professionals and Managers” Artech House, 1999..
4. Kock, N.F., “Process Improvement and Organizational Learning: The Role of Collaboration Technologies”, Idea Group, 1999.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		2		2		1		2	1		2		
2	3	3		2				1		2	1		2		
3	3	3						1		2	1		2		
4	3	2		2		2		1		2	1		2	2	
5	3	2		2		2		1		2	1		2	2	
Avg.	3	2.6		2		2		1		2	1		2	2	

1-low, 2-medium, 3-high