COURSE STRUCTURE AND SYLLABUS

OF

BACHELOR OF TECHNOLOGY

(MECHANICAL ENGINEERING)

Effective from

Session: 2020-2021

Department of Mechanical Engineering
Faculty of Engineering and Technology
Jamia Millia Islamia,
New Delhi, INDIA

PREFACE

VISION:

To Establish the Department as a hub of quality education, research with innovation and recognition at National and International level.

MISSION:

1. To transfer the knowledge through quality education which can develop skills, inculcate values and improve research with innovative methods.
2. To re-engineer the engineering education and to create leadership qualities with futuristic vision.
3. To produce young engineers who can be useful in New Technological Design, areas of Environment, space and sustainable technologies.
4. To develop Teaching-Learning methods which can produce socially committed good professional human being who can contribute effectively in Nation building and represent Country Internationally.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. The graduates will be well prepared for successful careers in industry/ consultancy/research & development/teaching/allied areas and will be academically prepared to lead organizations they join or start related to the subjects of mechanical engineering.
2. The graduates will engage in professional and extension activities in the field of mechanical engineering and its allied areas and contribute to the profession and society at large by pushing the frontiers in technology.
3. The graduates will be successful in higher education in mechanical and allied areas and in management, if pursued, leading to masters and research programs
4. The graduates will be, through this academic programme groomed as professional engineers enabling them to contribute effectively to the growth and development of the knowledge body.

PROGRAMME OUTCOMES (POs)

1. **Engineering Knowledge:** Apply the knowledge of Mathematics, Science and Engineering Fundamentals, and an engineering specialization to solution of complex engineering problems.
2. **Problem formulation and Analysis:** Identify, formulate, research literature, and analyze engineering problems so that substantiated conclusions can be reached using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/ development of solutions:** Design of solution for engineering problems and identify/design of system components or processes that meet the specified needs with appropriate considerations of public health and safety, and cultural, societal, and environmental considerations.
4. **Conduct investigation of Complex problems:** Use of research based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions.
5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling related engineering activities with an understanding of limitations.
6. **Engineer and Society**: Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and assume responsibilities of a professional engineering practitioner.
7. **Environment awareness and responsibility:** Understanding the impact of the professional engineering solutions in the environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments.
8. **Ethical behavior:** Apply ethical principle and show commitment towards professional ethics and responsibilities and norms of engineering practice.
9. **Individual and team work:** Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on different engineering activities with the engineering community and with society at large such as being able to comprehend and write effective report and design documentation, make effective oral presentations, and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and apply those to one’s own work as a member and leader of a team to manage projects 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 new development. Can take masters and research program in the area and allied areas.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Shall have acquired the ability of entrepreneurship to start an industry based on mechanical engineering in the areas of production, manufacturing and allied areas.

PSO2: After graduation the graduate shall have gained the experience to be attracted toward design and consultancy.

PSO3: Shall have gained the knowledge to pursue higher level of understanding by way of research in relevant areas of mechanical engineering.

PSO4: Shall have gained the knowledge base to enable employment in infrastructure development.

Credits per Semester at a Glance

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	28	27	28	29	23	20	21	20	**196**

* **L**: Lectures, **T**: Tutorials; **P**: Practical; **C**: Credits; **Hrs**: Hours

B.TECH. (MECHANICAL ENGG.) I SEMESTER (Common to all branches)

	S. No.	Course Number	COURSE NAME	Course Type	Credits	L*	T	P	Hrs
I SEMESTER	1	AS-101	Communication Skills	HS	3	3	0	0	3
	2	AS-102	Engineering Physics – I	BS	3	2	1	0	3
	3	AS-103	Engineering Chemistry – I	BS	3	2	1	0	3
	4	AS-104	Engineering Mathematics - I	BS (CBCS)	4	3	1	0	4
	5	ME-101	Basics of Mechanical Engineering	ES	3	3	0	0	3
	6	CE-101	Basics of Civil Engineering	ES	3	2	1	0	3
	7	EE-101	Basics of Electrical Engineering	ES	3	2	1	0	3
	i	AS-151	Language Lab	HS	1	0	0	2	2
	ii	AS-152	Engineering Physics LAB – I	BS	1	0	0	2	2
	iii	AS-153	Engineering Chemistry LAB – I	BS	1	0	0	2	2
	iv	ME-102	EM (Engineering Mechanics) Lab	ES	1	0	0	2	2
	v	ME-151	Workshop Practice	ES	2	0	0	4	4
				Total	**28**	**17**	**5**	**12**	**34**
II SEMESTER	1	AS-201	Human Resource Management (HRM)	HS	3	3	0	0	3
	2	AS-202	Engineering Physics – II	BS	3	2	1	0	3
	3	AS-203	Engineering Chemistry – II	BS	3	2	1	0	3
	4	AS-204	Engineering Mathematics -II	BS	4	3	1	0	4
	5	AS-105	Innovative Technology & Bio-Sciences	BS (CBCS)	4	3	1	0	4
	6	EC-201	Basic of Electronics & Comm. Engineering	ES	3	3	0	0	3
	7	CS-201	Fundamentals of Computing	ES	3	2	1	0	3
	i	AS - 252	Engineering Physics LAB – II	BS	1	0	0	2	2
	ii	AS - 253	Engineering Chemistry LAB – II	BS	1	0	0	2	2
	iii	ME-250	Engineering Graphics Lab	BS	2	0	0	4	4
				Total	**27**	**18**	**5**	**8**	**31**

B. Tech. (Mechanical Engineering) Course Structure as per AICTE norms:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
III SEMESTER	1	AS-301	Engineering mathematics-III	BS	4	3	1	0	4
	2	ME-301	Mechanics of Solids	ES	4	3	1	0	4
	3	ME-302	Manufacturing Processes	PC	3	2	1	0	3
	4	ME-303	Applied Thermodynamics	ES	3	2	1	0	3
	5	ME-304	Material Science	ES(CBCS)	4	3	1	0	4
	6	ME-306	Fluid Mechanics-I	ES	3	2	1	0	3
	7	ME-307	Instrumentation, Measurement and Control	PC	3	2	1	0	3
	i	ME-331	Applied Thermodynamics Laboratory	PC Lab	1	0	0	2	2
	ii	ME-334	Manufacturing Processes Laboratory	PC Lab	1	0	0	2	2
	iii	ME-335	Instrumentation, Measurement and Control Lab	PC Lab	1	0	0	2	2
	iv	ME-336	Material Science and Mechanics of Solid Laboratory	PC Lab	1	0	0	2	2
				Total	**28**	**17**	**7**	**8**	**32**
IV SEMESTER	1	ME-401	Heat and Mass Transfer	PC	3	2	1	0	3
	2	ME-402	Production Engineering-I	PC	4	3	1	0	4
	3	ME-403	CAD and FEM	PC (CBCS)	4	3	1	0	4
	4	ME-404	Engineering Economy	HSMC (OEC-II)	3	2	1	0	3
	5	ME-405	Kinematics of Machines	PC	3	2	1	0	3
	6	AS-401	Numerical and Scientific Computing	ES	4	3	1	0	4
	7	EE-401	Electromechanical Energy Conversion	ES	2	2	0	0	2
	i	ME-431	Heat and Mass Transfer Laboratory	PC Lab	1	0	0	2	2
	ii	ME-432	Production Engineering Laboratory	PC Lab	1	0	0	2	2
	iii	ME-433	CAD, FEM and Computer aided Machines Drawing Laboratory	PC Lab	2	0	0	4	4
	iv	ME-434	Kinematics of Machines Laboratory	PC Lab	1	0	0	2	2
	v	AS-431	Numeric and Scientific Computing Laboratory	BS Lab	1	0	0	2	2
				Total	**29**	**17**	**6**	**12**	**35**
V SEMESTER	1	ME-501	Fluid Mechanics-II	PC	3	2	1	0	3
	2	ME-502	Design of Mechanical Components	PC	3	2	1	0	3
	3	ME-504	Production Engineering-II	PC	3	2	1	0	3
	4	ME-505	Dynamics of Machines	PC	3	2	1	0	3
	5	ME-506	Internal Combustion Engines	PC	3	2	1	0	3
	6	ME-507	Mechatronics	CBCS	4	3	1	0	4
	i	ME-531	Fluid Mechanics Laboratory	PC Lab	1	0	0	2	2
	ii	ME-532	Design of Mechanical Components Laboratory	PC Lab	1	0	0	2	2
	iii	ME-533	Dynamics of Machines Laboratory	PC Lab	1	0	0	2	2
	iv	ME-535	Mechatronics Laboratory	PC Lab	1	0	0	2	2
				Total	**23**	**13**	**6**	**8**	**27**

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
VI SEMESTER	1	ME-601	Computer Aided Manufacturing	PC	3	2	1	0	3
	2	ME-602	Design of Mechanical System	PC	3	2	1	0	3
	3	ME-603	Operations Research	CBCS	4	3	1	0	4
	4	ME-604	Refrigeration and Air Conditioning	PC	3	2	1	0	3
	5	ME-605	Turbo Machines	PC	3	2	1	0	3
	i	ME-631	Computer Aided Manufacturing Laboratory	PC Lab	1	0	0	2	2
	ii	ME-632	Refrigeration and Air Conditioning Laboratory	PC Lab	1	0	0	2	2
	iii	ME-633	Design of Mechanical Systems Practice Laboratory	PC Lab	1	0	0	2	2
	iv	ME-634	Turbo Machines Laboratory	PC Lab	1	0	0	2	2
	v	ME-635	Industrial Training	Audit					
				Total	**20**	**11**	**5**	**8**	**24**
VII SEMESTER	1	ME-701	Mechanical Vibrations	PC	3	2	1	0	3
	2	ME-702	Industrial Engineering	PC	3	2	1	0	3
	3	ME-703	Automobile Engineering	PC	3	2	1	0	3
	4	ME-715	Program Elective I (Thermal & Fluid) (Separate list of elective courses attached)	PE	3	2	1	0	3
	i	ME-731	Automobile Engineering and IC Engine Laboratory	PC Lab	1	0	0	2	2
	ii	ME-732	Industrial Engineering Laboratory	PC Lab	1	0	0	2	2
	iii	ME-733	Mechanical Vibrations Laboratory	PC Lab	1	0	0	2	2
	iv	ME-734	Solar Energy Laboratory	PC Lab	1	0	0	2	2
	v	ME-735	Project-I	Project Work	5	0	0	10	10
				Total	**21**	**8**	**4**	**18**	**30**
VIII SEMESTER	1	ME-801	Program Elective II (Machine Design) (Separate list of elective courses attached)	PE	3	2	1	0	3
	2	ME-830	Program Elective III (Production & Industrial) (Separate list of elective courses attached)	PE	3	2	1	0	3
	3	ME-850	Special Topics (Optional Audit Course)	Optional Audit Course	0	3	0	0	3
	4	ME-814	Product Design	PE (CBCS)	4	3	1	0	4
	i	ME-851	Seminar on Industrial Training (Compulsory Audit Course)	Seminar	0	0	0	2	2
	ii	ME-852	Project-II	Project Work	10	0	0	20	20
				Total	**20**	**10**	**3**	**22**	**35**

PROGRAM ELECTIVES								
S. No.	**Course Number**	**COURSE NAME**	**Course Type**	**Credit**	**L**	**T**	**P**	**Hrs**
Machine Design								
1.	ME-801	Robotics	Program Elective II (Machine Design)	3	2	1	0	3
2.	ME-802	Engineering System Design Optimization						
3.	ME-803	Vehicle Dynamics						
4.	ME-804	Modal Analysis						
5.	ME-805	Introduction to Human Body Mechanics						
6.	ME-806	Innovative Product Design						
7.	ME-807	Fracture Mechanics						
8.	ME-808	Composite Materials						
9.	ME-809	Engineering Tribology						
10.	ME-810	Simulation of Mechanical Systems						
11.	ME-811	Artificial Intelligence and Robotics						
12.	ME-812	Machinery Fault Diagnostics & Signal Processing						
13.	ME-813	Applied Elasticity and Plasticity						
Thermal & Fluid								
1.	ME-704	Energy Sources	Program Elective I (Thermal & Fluid)	3	2	1	0	3
2.	ME-705	Environmental Pollution and Abatement						
3.	ME-706	Theory of Combustion and Emission						
4.	ME-707	Nuclear Power Generation and Supply						
5.	ME-708	Computational Fluid Dynamics						
6.	ME-709	Gas Dynamics						
7.	ME-710	Fuels and Combustion						
8.	ME-711	Cryogenics						
9.	ME-712	Design of Pump, Blowers and Fans						
10.	ME-713	Fluid Controls						
11.	ME-714	Design of Heat Exchanger Equipment						
12.	ME-715	Non-Conventional Energy Sources						
13.	ME-716	Environmental Engineering						
Production & Industrial								
1.	ME-830	Ergonomics	Program Elective III (Production & Industrial)	3	2	1	0	3
2.	ME-831	Welding Technology						
3.	ME-832	Supply Chain Management-Planning						
4.	ME-833	Quality Assurance and Reliability						
5.	ME-834	Non-Destructive Evaluation & Testing						
6.	ME-835	Technology of Surface Coating						
7.	ME-836	Quantity Production Methods						
8.	ME-837	Engineering Risk–Benefit Analysis						
9.	ME-838	Infrastructure Systems Planning						
10.	ME-839	Managing Innovation and Entrepreneurship						
11.	ME-840	Global Strategy and Technology						
12.	ME-841	Knowledge Management						
13.	ME-842	Mechanical Handling Systems & Equipment						
14.	ME-843	Maintenance Management						
15.	ME-844	Supportability and Life cycle analysis						

THIRD SEMESTER

Course Details:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
III SEMESTER	1	AS-301	Engineering mathematics-III	BS	4	3	1	0	4
	2	ME-301	Mechanics of Solids	ES	4	3	1	0	4
	3	ME-302	Manufacturing Processes	PC	3	2	1	0	3
	4	ME-303	Applied Thermodynamics	ES	3	2	1	0	3
	5	ME-304	Material Science	ES(CBCS)	4	3	1	0	4
	6	ME-306	Fluid Mechanics-I	ES	3	2	1	0	3
	7	ME-307	Instrumentation, Measurement and Control	PC	3	2	1	0	3
	i	ME-331	Applied Thermodynamics Laboratory	PC Lab	1	0	0	2	2
	ii	ME-334	Manufacturing Processes Laboratory	PC Lab	1	0	0	2	2
	iii	ME-335	Instrumentation, Measurement and Control Lab	PC Lab	1	0	0	2	2
	iv	ME-336	Material Science and Mechanics of Solid Laboratory	PC Lab	1	0	0	2	2
				Total	**28**	**17**	**7**	**8**	**32**

AS-301	Engineering Mathematics III	BSC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course explores advanced mathematical concepts, including multiple integrals, vector calculus, Laplace and Fourier transforms, difference equations, and higher calculus. It focuses on practical applications in physics and engineering, such as calculating areas, volumes, mass distribution, and solving differential and boundary value problems.

COURSE OBJECTIVES:

To understand Mathematics for Solving Engineering Problems

PREREQUISITES:

- Engineering Mathematics – I & II, AS-104 & IIT Objective, Mathematics and handling of Scientific Calculator

CONTENT:

Unit I	Application of Multiple integrals and Vector Calculus: Application of Double and Triple integrals (two dimensional Cartesian, polar Coordinates; three dimensional Cartesian, cylindrical and spherical coordinates) in finding the plane area, mass, centre of gravity, moment of inertia, product of inertia, centre of pressure, curved surface area and volume. Problems of Green's theorem in x-y plane, Gauss divergence theorem, stoke's curl theorem (Cartesian form without proofs)
Unit II	Application of Laplace Transforms: Application of Laplace Transforms in finding the particular solutions of ordinary linear differential equations of higher order with constant and variable coefficients, system of simultaneous differential equations, integral equations, integro-differential equations and differential equations.
Unit III	Fourier series and Fourier Transforms: Fourier's series (full range and half range) for arbitrary period, Representations of a function in terms of Fourier integral, Fourier Sine integral and Fourier Cosine integral, infinite complex Fourier transform, finite and infinite Fourier Sine and Cosine transforms and their inverse transforms, Properties of transforms and associated theorems and their application in integral equations and boundary value problems.
Unit IV	Difference Equations and Z-Transforms: Complementary function, particular integral and general solution of linear difference equations with constant and variable coefficients; Z-transforms, inverse Z-transforms and their application in particular solutions of linear difference equations with constant coefficients and simultaneous difference equations.
Unit V	Higher Calculus: Extremals of functional (by means of Euler-Poisson equations), Isoperimetric problems, Beta and Gamma functions, Fractional derivative, Dirichlet's and Lowville's multiple integrals, Representation of a definite integral in Legendre and Jacobi forms of Elliptic integrals of First, second and third kinds.

TEXTBOOKS:

1. A Textbook of Engineering Maths. & Advanced Engineering Mathematics by A.B. Mathur & V.P. Jaggi, Khanna Publisher

2. Elementary Engineering Maths & Higher Engineering Maths by B.S. Grewal, Khanna Publishers.
3. Advanced Engineering Mathematics by Erwin Kreyszig, John Willey and Sons, Inc.

REFERENCE BOOKS:

1. Higher Engineering Mathematics by B.V. Ramana, Tata Mc-Graw Hill
2. Advanced Engineering Mathematics by R.K. Jain and S.R.K. Vol. I & II BY Rakesh Dubey, Narosa, Publishing House.

Computer Usage / Software required:

- MATLAB, EXCEL, MAXIMA, MATHEMATICA, etc.

Other details regarding this course:

- Problem solving will enable students to become better engineers.

COURSE OUTCOMES (COs):

CO1	Will be able to apply multiple integrals and vector calculus to solve engineering problems.
CO2	Will be able to use Laplace Transforms in finding the particular solutions of ordinary linear differential equations of higher order.
CO3	Will be able to apply Fourier series and Fourier Transforms in analysis of Complex Functions.
CO4	Will be able to apply Z-transforms, inverse Z-transforms in finding particular solutions of linear difference equations with constant coefficients and simultaneous difference equations.
CO5	Will be able to apply the concepts of Higher Calculus in finding extremals of functional, and finding solutions to Isoperimetric problems, Beta and Gamma functions, Fractional derivative, Dirichlet's and Lowville's multiple integrals.

ME-301	Mechanics of Solids	PCC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course is to serve as an introduction to mechanics of deformable solid bodies. The primary course objective is to equip the students with the tools necessary to solve mechanics problems, which involves:

- Review and apply the principles of static equilibrium to the analysis of structures such as pressure vessels, beams, and torsion members;
- Evaluate stress and strain within various structures by applying the appropriate engineering theories;
- Formulate solutions to problems requiring the application of suitable engineering theories for stress and strain.

COURSE OBJECTIVES:

- Review and apply the principles of static equilibrium to the analysis of structures such as beams, and torsion members
- Formulate solutions to problems requiring the application of suitable stresses and strains.
- To acquire knowledge of mechanical testing and measurement of stresses and strains.

PREREQUISITES:

- Engineering Mechanics
- Elements of Civil Engineering

CONTENT:

Unit I	Introduction: Concept of stress at a point, Principal stress and strain due to combination of stresses. Torsion: Stresses and strains in pure torsion of solid circular shafts and hollow circular shafts. Power transmitted by shafts; combined bending and torsion. Composite shaft-series connection Material properties and Testing: Properties in tension, shear and compression.
Unit II	Shear force & Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, udl., uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam. Flexural Stresses: Theory of simple bending – Assumptions – Derivation of bending equation: $M/I = f/y = E/R$ Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections, Design of simple beam sections.
Unit III	Deflection of Beams: Area moment method. Application of area moment method to cantilever, simply supported and indeterminate beams. Advantages and disadvantage of fixed and continuous beams. Macaulay method. Castigliano’s theorem and calculations of deflection of beams under single and several loads.
Unit IV	Columns & Struts: Stability of columns. Critical loads for columns under different end conditions. Euler's and Secant formulae. Rankine formula. Design of columns under centric load Eccentrically loaded columns and their design. Kernel of a section. Laterally loaded columns.

Unit V	Experimental Stress Analysis: Effect of strain gradient. Requirements of a strain gauge Types of strain gauges; Mechanical, Optical, Acoustical and Electrical gauges, Strain sensitivity of a conductor. Temperature strains. Gauge factor. Introduction to Strain Rosette, Analysis of rectangular rosette, Δ rosette and T rosette. Material for strain gauge.

TEXTBOOKS:

1. Introduction to Solid Mechanics by Shames, Prentice Hall of India Pvt. Ltd
2. Mechanics of Solids by Abdul Mubeen, Pearson Education

REFERENCE BOOKS:

1. Experimental Stress Analysis by Abdul Mubeen, Dhanpat Rai and Sons.
2. Experimental Stress Analysis by Dally & Riley, McGraw -Hill Book Co.
3. Advanced Mechanics of Materials by Steel and Smith, John Wiley and Sons
4. Experimental Strength of Materials by Abdul Mubeen, Khanna Publishers

Computer Usage / Software required:

- ANSYS, SOLIDWORKS, MATLAB, CATIA.

Other details regarding this course

- This course is of predominant importance in understanding the advanced subjects relating to Machine Component Design and Dynamics

COURSE OUTCOMES (COs):

CO1	Will be able to determine different types of stresses and strains of various parts.
CO2	Will be able to determine shear force, bending moment, flexural and bending stresses of various parts.
CO3	Will be able to apply different theories of deflection to determine deflection of beams.
CO4	Will be able to analyze the columns under different loading and end conditions.
CO5	Will be able to determine strains using different experimental methods.

ME-302	Manufacturing Processes	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course offers a detailed study of machine tools, machining processes, welding, and casting techniques. It covers the classification, working principles, and operations of lathe, milling, drilling, and broaching machines. The course also explores machining parameters, surface finish, and indexing methods. Various welding techniques, including arc welding, TIG, MIG, and friction stir welding, are examined. Additionally, it covers casting processes, pattern design, moulding techniques, and gating system analysis.

COURSE OBJECTIVE:

To understand and analyse the major manufacturing processes including cutting, casting, joining and their supporting tools.

PREREQUISITES:

- Workshop Practice

CONTENT:

Unit I	Introduction: Machine tool: Classification and function, operations and working principles. Basic elements of machine tool; Machine tool drives. Types of Machine tools.
Unit II	Lathe and Milling: Tools, Classification, tool geometry, speed, feed and depth of cut, effect of machining parameters on surface roughness. Lathe operations; Facing, Turning, Shouldering of cylindrical shapes, drilling, reaming, boring, taper turning by different methods, thread cutting, method of cutting multiple thread. Milling Machine, working principle, milling operations (slab, end, slot milling), cutting speed and feed, estimating machining time, different types of indexing methods.
Unit III	Drilling: Types of drilling machines, Cutting speed, feed and depth of cut. Estimating machine time. Reaming: Types of reamers, Reaming operations. Broaching: Types of broaches, Types of broaching machines. Methods of broaching. Shaping, planning and slotting.
Unit IV	Welding: Different types of welding; welding principle, principles of fusion welding, Heat Source. Emission and ionization of electric arc, Arc structure, Characteristic and power of electric arc, Modes of metal transfer in Arc welding. TIG, MIG, Resistance, Electro-slag, spot, Thermit, Friction stir welding and Laser beam welding.
Unit V	Casting Processes: Introduction, Pattern and mould, Pattern allowances, types of pattern, types of mould, Testing of moulding sand, Preparation of mould, various stages in casting processes. Different types of casting processes (Die, Centrifugal, Continuous, and investment casting). Gating and rising system design with numerical problems.

TEXTBOOKS:

1. Manufacturing Science-A. Ghosh and A.K. Malik, Affiliated East Press, New-Delhi.

REFERENCE BOOKS:

1. Campbell, J.S., Principles of Manufacturing Materials and Processes, McGraw-Hill, New-York,
2. De Garmo, E.P., Materials and Processes in Manufacturing, Collier Macmillan, New York.
3. Lindberg, R.A., Processes and Materials of Manufacturing, Allyn and Bacon, Boston, 1
4. Schey, J.A., Introduction to Manufacturing Processes, McGraw-Hill, New-York.

Other details regarding this course:

- Visit to manufacturing organization will help broaden the horizon.

COURSE OUTCOMES (COs):

CO1	Will be able to comprehend various metal cutting operations and working principles of machine tools.
CO2	Will be able to identify and apply the different machining operations using lathe and milling machines in producing a product.
CO3	Will be able to identify and apply the material joining process using different welding processes.
CO4	Will be able to understand the different casting processes and recommend suitable process for different products.
CO5	Will be able to design gating and rising system for different types of mould and apply the post treatments.

ME-303	Applied Thermodynamics	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers fundamental and advanced concepts in thermodynamics and its applications in power cycles, turbines, compressors, and internal combustion engines. It begins with a review of thermodynamic laws, energy conservation, and entropy analysis. Various thermodynamic cycles, including Carnot, Otto, Diesel, and Rankine cycles, are explored along with steam power plant operations. The course also examines steam turbines, condensers, compressors, and their performance characteristics. Additionally, it discusses internal combustion engines, combustion phenomena, fuel requirements, and engine performance calculations.

COURSE OBJECTIVES:

This course is designed to teach mechanical engineering students the application of thermodynamic principles to the design and optimization of Thermal Engineering Systems. Specifically, students will be taught how to apply the laws of thermodynamics to vapor power and refrigeration systems, gas power systems, applications concerning humidification, dehumidification, evaporative cooling, and thermodynamics of combustion systems such as furnaces, flow reactors etc.

PREREQUISITES:

- Basic Thermodynamics

CONTENT:

Unit I	Review of basic concept of Thermodynamics, Law of conservation of energy and First law of Thermodynamics for a closed/open system undergoing a cycle; Steady flow energy equation, Second law of thermodynamics, Energy and entropy, Reversible and irreversible processes, Second law analysis; Availability and irreversibility, Gibb's function, Helmholtz function, Clausius and Clayperon equation.
Unit II	Thermodynamic cycles, Carnot Cycle, Joule cycle, Air standard cycle, Otto cycle, Diesel cycle, Dual cycle, Rankine cycle, Modified Rankine cycle, Thermal refinements in Rankine cycle, working of steam power plant, Binary vapour cycle.
Unit III	Steam turbine, Types and application, Impulse and reaction turbine, compounding of impulse turbine, pressure and velocity diagrams, reaction turbines, Work output, Losses and efficiencies, Reaction turbine, velocity diagram, degree of reaction, work output, governing of turbine, Nozzles, isometric flow through nozzles, critical pressure, pressure ratio, maximum discharge, stagnation condition
Unit IV	Condensers, types of condensers, jet and surface condensers, Compressors, Types, reciprocating, centrifugal, axial flow, single and multistage compressors, effect of inter-cooling, surging, choking and stalling
Unit V	I.C. Engines, types, Air fuel mixture requirement, normal/abnormal combustion in S.I. and C.I. Engines, Calculation of engine performance, requirement and suitability of fuels in I.C. Engines.

TEXTBOOKS:

1. Applies Thermodynamics: P. K. Nag, Tata McGraw Hill Publications.

REFERENCE BOOKS:

1. Applied Thermodynamics Engineering technology by T. D. Eastop & McConkey, Pearson Education.
2. Applies Thermodynamic Sciences. Principle Applications. S. K. Agrawal, Viva Book.
3. Turbine Compressors and Fans, S.M. Yahya, Mc-Graw Hill.
4. Thermal Engineering by R. K. Rajput, Laxmi Publication, Delhi.

Computer Usage/Software required:

- Students can be introduced to basic simulation software such as FLUENT.

Other details regarding this course:

- This is a basic course necessary for further studies in Thermal Engineering and Sciences

COURSE OUTCOMES (COs):

CO1	Able to understand the laws and limitation of thermodynamics and will be able to sort out realistic and unrealistic thermodynamic claims.
CO2	Able to analyze a vapor power cycle given a set of operational parameters and constraints, determine cycle efficiency, its power output, and required heat input.
CO3	Able to understand cycle efficiency for the steam power cycle.
CO4	Able to analyze the performance characteristics of condenser and compressor.
CO5	Able to analyze and determine cycle efficiency, work output and required heat input for a Petrol/Diesel Engine with a given set of operating parameters.

ME-304	Material Science	PCC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course covers fundamental and advanced concepts in thermodynamics and its applications in power cycles, turbines, compressors, and internal combustion engines. It begins with a review of thermodynamic laws, energy conservation, and entropy analysis. Various thermodynamic cycles, including Carnot, Otto, Diesel, and Rankine cycles, are explored along with steam power plant operations. The course also examines steam turbines, condensers, compressors, and their performance characteristics. Additionally, it discusses internal combustion engines, combustion phenomena, fuel requirements, and engine performance calculations.

COURSE OBJECTIVES:

- To establish the basic structure/property relationships in materials through an exploration of bonding, crystalline structure, defects and diffusion phenomena. •
- To gain an understanding of properties, processing, and applications of metallic, ceramic, polymeric and electronic materials.

PREREQUISITES:

- Physics and Chemistry

CONTENT:

Unit I	**Introduction:** Historical perspective, importance of materials in the modern development. Crystallography and Imperfections: Concept of unit cell space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices. Imperfections, Defects & Dislocations concept of slip in pure and real crystals, Schmids factors.
Unit II	**Mechanical properties and Testing:** True and Engineering Stress strain diagrams, Ductile & brittle material, Stress vs. strength. Toughness, Hardness, Fracture, Fatigue and Creep. Testing of Strength testing, Hardness testing, Impact testing, Fatigue testing Creep testing, Non-destructive testing (NDT) Micro structural Exam: Principle of optical Microscopy Preparation of samples and Microstructure examination and grain size determination. Comparative study of microstructure of various metals & alloys such as Mild steel, CI, Brass. Phase Diagram and Equilibrium Diagram: Uniary and Binary diagrams, Phase rules. Types of equilibrium diagrams: Solid solution type, eutectic type and combination type. Iron-carbon equilibrium diagram.
Unit III	**Ferrous materials:** Brief introduction of iron and steel making furnaces. Various types of carbon steels, alloy steels and cast irons, its properties and uses. Heat Treatment: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams. Non-Ferrous metals and alloys: Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. and their applications. Various type Brass, Bronze, bearing materials, their properties and uses. Aluminum alloys.
Unit IV	**Magnetic properties:** Concept of magnetism – Dia, para, ferro, magnetism Hysteresis. Soft and hard magnetic materials, Magnetic storages. Electric properties: Energy band concept of conductor, insulator and semi-conductor. Intrinsic & extrinsic semi-conductors. P-n junction and transistors.

Unit V	**Ceramics:** Structure types and properties and applications of ceramics. Mechanical/Electrical behaviour and processing of Ceramics. Plastics: Various types of polymers/plastics and their applications. Mechanical behavior and processing of plastics. Future of plastics. Other materials: Brief description of other material such as optical and thermal materials, concrete, Composite Materials, fibre and particle reinforced composites and their uses. Brief introduction to Smart materials and Nano-materials and their potential applications.

TEXTBOOKS:

1. W.D. Callister, Jr, – Material Science & Engineering Addition-Wesley Publication.

REFERENCE BOOKS:

1. Van Vlash – Elements of Material Science & Engineering John Wiley & Sons.
2. V. Raghvan – Material Science, Prentice Hall.
3. Narula – Material Science, TMH.

COURSE OUTCOMES (COs):

CO1	Will be able to understand the different materials and correlate material structure with the properties.
CO2	Will be able to conduct comparative analysis of different ferrous and non-ferrous metal and alloys for suitability for a particular application.
CO3	Will be able to perform various material property tests.
CO4	Will be able to conduct comparative analysis of different types of ceramics, polymers, composite materials and refractory.
CO5	Will be able to understand and interpret different material properties (magnetic, electric) on the performance.

ME-307	Instrumentation, Measurement and Control	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers fundamental principles and applications of measurement, instrumentation, and control engineering. It introduces measurement methods, instrumentation standards, classification of instruments, and error analysis, including uncertainty propagation and performance parameters. The study of dynamic characteristics of instruments includes system equations, transducers, amplifiers, data converters, and transmission elements. Various measurement techniques for force, torque, power, pressure, temperature, flow, liquid level, biometrics, and air pollution parameters are examined. The course also provides an introduction to control engineering, covering feedback control systems, transfer functions, system response, stability analysis, and their practical applications.

COURSE OBJECTIVES:

- To provide knowledge of Measurable quantities, their detection, acquisition, control and analysis of measurement data this is important phenomena in almost all areas of Science Engineering and Technology.
- To be aware with instrument characteristics, the measurement principles, methods, constructional feature, advantages and limitations of the instruments.
- To study control engineering, small and compact type control systems, their working principles and applications.

PREREQUISITES:

- Basic courses of Physics, Electronics and Electrical Engineering

CONTENT:

Unit I	**General Concepts**: Measurement, Instrumentation, significance, standards, Methods, Methods and Modes of Measurement. **Instruments**: Classification and functional elements of a Measurement System. Static performance characteristics-Errors and Uncertainties, Propagation of Uncertainties, Performance Parameters, Impedance. Loading and Matching. Graphical representation and curve fitting of Data- Equations of Approximating curves. Determination of Parameters in linear relationship. Method of Least square and linear least square curve fitting. Related Numerical problems.
Unit II	**Dynamic characteristics of Instruments:** Dynamic Inputs, Formulation of system equations, Dynamic Response. Transducer Elements. Intermediate Elements-Amplifiers, A-D and D-A converters, filters, Terminology and conversions, Data Transmission Elements, Related Numerical Problems
Unit III	**Measurements, Methods and Applications:** Force Measurement, Torque and Power Measurements, Presume Measurement (High Pressure Moderate and vacuum) Related Numerical Problems.
Unit IV	**Temperature Measurement:** Non-electrical, electrical and Radiation Methods of Temperature Measurement. Flow measurement-Primary, Secondary and special Methods of flow Measurement, Measurement of liquid Level, Biometrics and Air pollution parameters. Related Numerical Problems.

Unit V	**Control Engineering:** Classification, Applications of control Engineering, Feedback control system with their block diagrams, Transfer functions of elements, systems and processes. Transient and Steady State Response of control systems, stability of control systems. Related Numerical Problems.

TEXTBOOKS:

1. Measurement Systems by Ernest O. Doebelim, Tata McGraw Hill Publication.
2. Instrumentation, Measurement and Analysis by Nakra and Choudhary, Tata McGraw Hill Publication.

REFERENCE BOOKS:

1. Mechanical Measurement by Beckwith and Buck, Oxford and IBH.
2. Instrumentation for engineering measurement by Dally, William and Mc Connell, John Wiley & Sons.

Computer Usage / Software required:

- ANSYS, Excel, MATLAB and similar software, Lab view

Other details regarding this course:

- This course is of predominant importance for machine control integrating mechanical systems and futuristic development

COURSE OUTCOMES (COs):

CO1	Recognise the instrument systems, their principles, methods of measuring different physical variables and analysis of data.
CO2	Formulation of system equations and extending the knowledge of dynamic inputs and response.
CO3	Solve problems related to measurement of Force, Torque, Power and Pressure.
CO4	Acquire knowledge of recent developments in instrumentation and measurement of Temperature.
CO5	Recognise the control engineering, their types, different systems and processes, their applications in Industries and House hold appliances.

ME-306	Fluid Mechanics	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course provides a comprehensive study of fluid mechanics, encompassing fundamental principles, analytical methods, and engineering applications. It covers the classification and properties of fluids, fluid statics, buoyancy, and rigid-body motion. Fluid kinematics and kinetics are examined through velocity fields, stream functions, vorticity, and governing equations such as Euler's and Bernoulli's equations. The course further explores flow measurement techniques, pipe flow analysis, dimensional analysis using Buckingham Pi theorem, and similitude. Additionally, open-channel flow concepts, including Chezy's formula, specific energy, and hydraulic jump, are discussed to develop a foundational understanding of fluid behavior in various engineering applications.

COURSE OBJECTIVES:

Knowledge and understanding of the basic principles and concepts of fluid mechanics are essential to analyse any system in which a fluid is the working medium. The design of all means of transportation requires application of the principles of fluid mechanics. In recent years Vehicle manufacturers have given more consideration to aerodynamic design. The design of propulsion systems for space flight is based on the principles of fluid mechanics. It is commonplace today to perform model studies to determine the aerodynamic forces on, and flow fields around, buildings and structures.

PREREQUISITES:

- Vector algebra and calculus,
- Differential equations,
- Particle and rigid body dynamics, and
- Thermodynamics.

CONTENT:

Unit I	**Introduction**: Definition of a fluid, Scope of Fluid Mechanics, Basic equations, Methods of analysis. **Fundamental concepts**: Fluid as a continuum, Velocity field, Description and classification of fluid motions. **Fluid properties**: Density, specific weight, specific volume, specific gravity, viscosity, vapour pressure, bulk modulus of elasticity/compressibility, surface tension/capillarity, thermal conductivity, specific heats. **Fluid Statics**: Basic equation of fluid statics, The standard Atmosphere, pressure variation in a static fluid; incompressible liquids and gases, manometers, hydrostatic force on submerged surfaces; horizontal, vertical, inclined and curved. **Buoyancy and floatation**: Buoyant force, centre of buoyancy and centre of gravity, Stability of floating and submerged bodies. **Fluids in Rigid-Body motion**: d'Alembert's principle, fluid mass subjected to uniform acceleration and rotation.
Unit II	**Fluid Kinematics:** The substantial derivative, Acceleration field of a fluid (convective and local), The stream function, Equation of streamline, Translation, Rotation and Rate of Deformation, Angular velocity, Vorticity, Circulation, Velocity potential function, properties of ψ and ϕ, Irrotational flows. Reynolds Transport Theorem, Basic equations of fluid flow.

Unit III	**Fluid Kinetics:** Equation of motion- Euler's equation, Bernoulli's equation; assumptions and limitations, comparison of SFEE and Bernoulli equation. Hydraulic grade line (HGL) and total energy line (TEL). **Applications of Bernoulli's Equation**: Flow through orifice and mouthpiece, Pitot-static tube, Discharge measurement: Pipelines (venture-meter, nozzle-meter, orifice-meter, rotameter and elbow meter), Open channel (flow over notches and weirs), Impact of free jets.
Unit IV	**Flow through pipes:** Fully developed flow, The Reynolds number, Laminar and turbulent flows, Laminar flow in pipe, Smooth and rough pipes, Pressure drop and head loss, Major and minor losses, The Moody's chart, Pipes in series and parallel, Hydraulic power transmission, Pipe flow problems.
Unit V	**Dimensional analysis and similitude:** Nature of dimensional analysis, Buckingham Pi theorem, determining the Pi groups, Significant dimensionless groups in FM, Flow similarity and model studies. **Open-channel flow**: Chezy's formula, specific energy, critical depth, hydraulic jump.

TEXTBOOKS:

1. Introduction to Fluid Mechanics by Fox & McDonald, John Wiley & Sons, Inc.
2. Fluid Mechanics by Frank M White, Tata McGraw-Hill Pub. Company Ltd.

REFERENCE BOOKS:

1. Fluid Mechanics and Its Applications by Vijay Gupta & Santosh K Gupta, New Age Int. Publishers.
2. Introduction to Fluid Mechanics and Fluid Machines by S K Som& G Biswas, Tata McGraw-Hill Pub.
3. Foundations of Fluid Mechanics by S. W. Yuan, Prentice-Hall of India Pvt. Ltd.
4. Fluid Mechanics by Yunus A. Cengel& John M. Cimbala, McGraw-Hill Education Pvt. Ltd.
5. Fluid Mechanics and Fluid Power Engg. by D. S. Kumar, S. K. Kataria& Sons.
6. Fluid Mechanics by John F. Douglas, Gasiorek, Swaffield and Jack, Pearson Education.

Computer Usage / Software required:

- MATLAB, EXCEL, EES etc.

Other details regarding this course:

- This is a basic course on fluid mechanics

COURSE OUTCOMES (COs):

CO1	Definition and properties of fluids (as distinct from solids), Units and dimensions, Classification of fluids, Fluid Statics.
CO2	Kinematics of Fluid, Vorticity and circulation, Differential equation of conservation of mass.
CO3	Dynamics of Ideal Fluid Flow: Euler's equation of motion, Bernoulli's equation and its applications, Flow measuring devices, Major and minor losses in pipe flow, Power transmission by a pipeline.
CO4	The Integral Analysis of Flow, The Transport Theorem, Moment of momentum equation, Energy equation and their applications.
CO5	Understanding the knowledge of various flows on the free surface.

ME-331	Applied Thermodynamics Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in the fundamental principles of internal combustion engines. Students will study engine components, valve timing diagrams, air-fuel ratio analysis, fuel injection, and ignition systems. Performance evaluation under varying loads and efficiency determination using the Williams line plot will also be conducted to enhance practical understanding of engine operation and diagnostics.

COURSE OBJECTIVES:

- To gain practical knowledge of the various components of an Internal Combustion Engine (ICE) and their functions, helping them understand the principles of engine operation and performance.
- To learn and interpret the valve timing diagrams for both Two-stroke and Four- stroke engines, enabling them to analyze the effects of engine cycles on performance and efficiency.
- To explore the air-fuel ratio in the carburetor, fuel injection systems, and ignition systems in an ICE, gaining insight into how fuel delivery and ignition mechanisms impact engine performance and emissions.
- To conduct load tests on a single-cylinder engine, assess performance under varying loads, and determine mechanical efficiency using methods like the Williams line plot, providing hands-on experience in engine testing and performance analysis.

LIST OF EXPERIMENTS:

1. To study the various components of an Internal Combustion Engine.
2. To study the Two stroke and Four stroke engine and their valve timing diagram.
3. To study the air-fuel ratio in the carburetor in an Internal Combustion engine.
4. To study the fuel injection system.
5. To study the ignition system.
6. To conduct a load test on a single cylinder engine and study its performance under varying loads.
7. To determine the mechanical efficiency of a diesel engine by Williams line plot.

REFERENCE BOOKS:

1. Internal Combustion Engines by V. Ganesan.
2. Internal Combustion Engine Fundamentals by John B. Heywood.

COURSE OUTCOMES (COs):

CO1	To study the various components of an I.C. Engine and understand the working of 2-stroke Engines.
CO2	To study the fuel system of petrol & diesel Engines.
CO3	To determine the mechanical efficiency of a Ruston diesel engine.
CO4	To conduct performance test on Kirloskar diesel engine.
CO5	To conduct performance test on two-stage reciprocating air compressor.

ME-334	Manufacturing Processes Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course focuses on machining operations, process planning, and tool analysis. Students will estimate and compare machining times for turning and shaping processes, perform thread cutting, drilling, and boring on a lathe machine, and analyze work and tool holding devices. Practical exercises include measuring tool angles, classifying ferrous materials using spark tests, and studying single and multipoint cutting tools to develop a comprehensive understanding of machining principles.

COURSE OBJECTIVES:

- Acquire hands-on skills in performing various metal cutting operations using machine tools.
- Develop the ability to estimate machining time and measure key tool geometry parameters.
- Identify ferrous materials through spark testing and understand the use of work/tool holding devices

LIST OF EXPERIMENTS:

1. To estimate machining time for turning using two different process plans and to compare it with the actual machining time.
2. To estimate machining time for shaper machine using two different process plans and to compare it with the actual machining time.
3. To Perform single start and multi start thread cutting operation on lathe machine.
4. To perform drilling and boring operations on lathe machine.
5. To study in detail the various work and tool holding devices.
6. To measure different angels of a single Point cutting tool with the help of combination sets.
7. To classify given specimens of ferrous materials by spark test on a grinding machine.
8. To study the different types of single point and multipoint cutting tools.

REFERENCE BOOKS:

1. Manufacturing Engineering and Technology, Serope Kalpakjian , Pearson Education; Seventh edition (2018)
2. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Mikell P. Groover, John Wiley & Sons; 4th Edition (2010)

COURSE OUTCOMES (COs):

CO1	Will be able to estimate the machining time for different machining operations.
CO2	Will be able to perform different metal cutting operations on different machine tool.
CO3	Will be able to conduct measurements of different tool angles of single point/Multi-point cutting tool.
CO4	Will be able to classify given specimen of ferrous materials by spark test.
CO5	Will be able to understand the application of various work and tool holding devices.

ME-335	Instrumentation, Measurement & Control Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in precision measurement techniques and sensor applications. Students will perform error estimation in dimensional measurements, study displacement sensors like LVDT and LDR, and analyze torque, speed, and pressure using transducers. Experiments also include strain gauge characteristics, angular position error detection, and performance evaluation of a feedback light intensity control system, fostering a practical understanding of modern measurement and instrumentation methods.

COURSE OBJECTIVES:

- Gain the knowledge and skills to accurately measure physical parameters such as diameter, thickness, displacement, torque, speed, and pressure using advanced instruments like vernier calipers, screw gauges, LVDTs, strain gauge-based transducers, and pressure transducers.
- Develop the ability to analyze experimental data, plot performance characteristics, and evaluate errors through experiments involving devices like dial gauge indicators, photoelectric pick-ups, LDRs, and potentiometers, ensuring precise calibration and error estimation.
- Understand the feedback and control systems by studying configurations like feedback light intensity control systems and angular position error detectors, enabling students to evaluate performance characteristics and apply these concepts to real-world engineering problems.

LIST OF EXPERIMENTS:

1. To calculate the internal estimate of error in the measurement of the diameter of given object like rod, ball & gear/slab using vernier calipers and screw gauge.
2. To determine the thickness of one paper using dial gauge indicator mounted on a pillar stand.
3. To study linear variable differentiable transformer (LVDT) and draw the graph between displacement v/s digital panel meter (DPM) reading.
4. To study the light detecting resistor (LDR) and draw the graph between displacement and DPM reading.
5. To calculate the measurement of torque using strain gauge based torque transducer.
6. To calculate the speed measurement using magnetic pick-up and photo-electric pick-up and draw the graph between photoelectric pick-up reading and error between them.
7. To make the pressure measurement using pressure transducer.
8. To study the characteristics of strain gauge transducer.
9. To study the performance characteristics of an angular position error detector using two potentiometers.
10. To study the configuration and evaluate the performance characteristics of a feedback light intensity control system.

REFERENCE BOOKS:

1. Instrumentation Measurement and Analysis, 4th Edn by B. C. Nakra, K. K. Chaudhary, ISBN No 978-9385880629, McGraw Hill Education India Private Limited, 2016
2. Instrumentation for Engineering Measurements by James W. Dally, William F. Riley, Kenneth G. McConnell, ISBN No 978-047155192, John Wiley & Sons, 1993.

COURSE OUTCOMES (COs):

CO1	Will be able to acquire knowledge pertaining to measurement, error and calculate length, diameter and thickness using various measuring instruments.
CO2	Will be able to study about the LVDT and LDR and analyse the displacement and DPM reading.
CO3	Will be able to measure torque and speed using various measuring instruments and also will be able to calculate errors.
CO4	Will perform study about the pressure measurement using pressure transducer and also study various characteristics of strain gauge transducer.
CO5	Will be able to assess performance characteristics of an angular position error detector and evaluate the performance characteristics of a feedback light intensity control system.

ME-336	Material Science and Mechanics of Solids Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course explores the fundamental properties and behavior of engineering materials. Students will analyze crystal structures, Bravais lattices, and microstructures, evaluate hardness using Rockwell testing, and study the effects of heat treatment on mild steel. Experiments include impact strength determination via Charpy and Izod tests, torsional rigidity measurement, and tensile testing using a Tensometer. Additionally, the Universal Testing Machine is studied for comprehensive mechanical property evaluation.

COURSE OBJECTIVES:

- Understand crystal structures, Bravais lattices, and their influence on material properties.
- Examine microstructures and the effects of heat treatment on material properties.
- Develop practical skills in operating mechanical testing equipment for evaluating material behavior.

LIST OF EXPERIMENTS:

1. To study the crystal structure of Simple Cubic Crystal (SCC), Body Centered Cubic Crystal (BCC), and Face centered Cubic Crystal (FCC) and also study their atomic packing factor and coordination number.
2. To study the Bravais Lattices and evaluate the Miller Indices of the given plane.
3. To find out the hardness of given specimens (MS, CI, HCS, Brass, Cu, Al) using Rockwell hardness testing machine.
4. To prepare the microstructural sample and study the microstructure of a given specimen (MS, Al, Cu, Brass) with the help of metallurgical microscope.
5. To study the effect of the following heat treatment processes on hardness of a mild steel specimen:
    (i) Annealing
    (ii) Water quenching
    (iii) Oil quenching
    (iv) Normalising
6. To study the Iron-Carbon equilibrium diagram.
7. To determine the impact strength of mild steel and cast-iron specimen using Charpy test
8. To determine the impact strength of mild steel and cast-iron specimen using Izod test
9. To find the rigidity modulus of given material by using torsion testing machine.
10. To find the modulus of elasticity of a standard specimen using Tensometer. Also, to find:
    (i) Yield stress
    (ii) Ultimate stress
    (iii) Breaking Stress (iv)Percentage elongation
    (iv) Percentage reduction in cross sectional area.
11. To study the Universal testing Machine.

COURSE OUTCOMES (COs):

CO1	Will be able to calculate APF and CN and identify Bravais lattices and Miller indices for materials with different crystalline structures.
CO2	Will be able to prepare specimens, analyze microstructure characteristics, and determine hardness of different metal alloys using standard metallographic procedures.
CO3	Will be able to perform various heat treatment processes and to analyze the effect of rates of cooling on the hardness of steel
CO4	Will be able to evaluate fundamental mechanical properties such as impact strength, tensile strength, and hardness of various materials through standardized tests (Charpy, Izod, tensile, Rockwell hardness), and interpret material behavior under different loading conditions.
CO5	Will be able to apply practical techniques to analyze material deformation, including stress-strain behavior, compressive strength, and deflection, using universal testing machines and strain gauges, to assess structural responses and integrity in engineering applications.

FOURTH SEMESTER

Course Details:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
IV SEMESTER	1	ME-401	Heat and Mass Transfer	PC	3	2	1	0	3
	2	ME-402	Production Engineering-I	PC	4	3	1	0	4
	3	ME-403	CAD and FEM	PC (CBCS)	4	3	1	0	4
	4	ME-404	Engineering Economy	HSMC (OEC-II)	3	2	1	0	3
	5	ME-405	Kinematics of Machines	PC	3	2	1	0	3
	6	AS-401	Numerical and Scientific Computing	ES	4	3	1	0	4
	7	EE-401	Electromechanical Energy Conversion	ES	2	2	0	0	2
	i	ME-431	Heat and Mass Transfer Laboratory	PC Lab	1	0	0	2	2
	ii	ME-432	Production Engineering Laboratory	PC Lab	1	0	0	2	2
	iii	ME-433	CAD, FEM and Computer aided Machines Drawing Laboratory	PC Lab	2	0	0	4	4
	iv	ME-434	Kinematics of Machines Laboratory	PC Lab	1	0	0	2	2
	v	AS-431	Numeric and Scientific Computing Laboratory	BS Lab	1	0	0	2	2

ME-401	Heat and Mass Transfer	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course explores the core principles of heat and mass transfer. Topics include Steady and Unsteady heat conduction, governing equations and Heat flow through walls. Both free and forced modes convection will be thoroughly examined, along with its impact on heat transfer. Boiling heat transfer, heat exchangers classification and methods for calculating overall heat transfer coefficients using LMTD and NTU approaches will also be addressed. This course provides a comprehensive understanding of radiation, covering emissive power, absorptivity, and view factors. Additionally, mass transfer will be explored, drawing parallels with heat transfer principles and examining diffusion through different media.

COURSE OBJECTIVES:

- Students will understand the basic concepts of conduction, convection and radiation heat transfer.
- Students will understand how to formulate and be able to solve one and two-dimensional conduction heat transfer problems. Solution techniques will include both closed form and numerical methods. Convection effects will be included as boundary conditions.
- Students will understand the fundamentals of the relationship between fluid flow, convection heat transfer and mass transfer.
- Students will apply empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient. They will then calculate heat transfer rates using the coefficients.
- Students will understand the basic concepts of radiation heat transfer to include both black body radiation and gray body radiation.
- Students will be able to evaluate radiation view factors using tables and the view factor relationships.

PREREQUISITES:

- Thermodynamics, Applied Thermodynamics

CONTENT:

Unit I	**Modes of Heat Transfer:** Transfer of One dimensional, Heat Conduction, Resistance Concept, Electrical Analogy. Fourier's Law of Conduction, Thermal Conductivity of Solids, Liquids and Gases, General Conduction Equation in Cartesian Coordinates and Cylindrical Coordinates, One Dimensional steady heat flow through plane wall cylinders and spheres, Heat flow through composite wall, cylinder and sphere, critical thickness of insulation. Different type of fins. Heat transfer from fin of uniform cross-section, Two-dimensional conduction through plane walls.
Unit II	**Convection:** Free and forced convection, hydrodynamics and thermal boundary layers, similarity conditions of Heat Transfer Process. Equation of Momentum and Energy, Application of dimensional analysis, Empirical equation of convection Heat Transfer, condensation heat transfer, Drop-wise and film wise condensation; Laminar film on a vertical surface.

Unit III	Boiling Heat Transfer, Pool boiling regimes, Heat Exchangers, Classification of Heat Exchange Overall Heat Transfer Coefficient, LMTD method for parallel flow & counter flow, The NTU method. Pressure Drop.
Unit IV	**Radiation**: Black body radiation, Definitions, Emissive Power, Emissivity. Absorptive, Reflectivity and Transmissivity, Black, Gray, White & real Surfaces, Planck's Distribution law, Kirchoff's law, Wien's Displacement Law, Stefan Boltzman Law, Radiation Shape factor.
Unit V	**Mass Transfer:** Analogy between Mass Transfer and Heat Transfer, The conservation of Chemical Species, diffusion Mass Flux, Fick's Law, diffusion Molar Concentration and Flux, diffusion through a stationary medium, steady state diffusion through a plane membrane. Reference Mass Coefficient, Convective Mass Transfer, Boundary Layer Concentration, Governing equations.

TEXTBOOKS:

1. Fundamentals of Heat and Mass Transfer, Incropera and Dewitt, Sixth Edition, John Wiley.
2. Heat Transfer, Y Cengel, Mcgraw-Hill.

REFERENCE BOOKS:

1. Fundamentals of Momentum, Heat and Mass Transfer, by James R. Welly, Chark E. Wicks and Robert E. Wilson, & Sons.
2. Principles of Heat Transfer, by, Frank P. Kreith and Mark S. Bhonharpar& Row Publisher.
3. Basic Heat and Mass Transfer, by A.F. Mills, Prentice Hall of India.
4. Heat and Mass Transfer, A P. Singh, Macmillan India Ltd.
5. Fundamental of Heat and Mass Transfer, C.P. Kothandaraman, New Age international Publisher.
6. Heat transfer principles & application, B.K. Dutta

Computer Usage / Software required:

Students can be introduced to basic simulation and modelling software. Also, student can be introduced with numerical heat transfer and CFD.

COURSE OUTCOMES (COs):

CO1	Students will understand the basic concepts of conduction, convection and radiation heat transfer. Students will understand how to formulate and be able to solve one and two-dimensional conduction heat transfer problems. Solution techniques will include both closed form and numerical methods. Convection effects will be included as boundary conditions.
CO2	Students will understand the fundamentals of the relationship between fluid flow, convection heat transfer and mass transfer.
CO3	Students will apply empirical correlations for both forced and free convection to determine values for the convection heat transfer coefficient. They will then calculate heat transfer rates using the coefficients.
CO4	Students will understand the basic concepts of radiation heat transfer to include both black body radiation and gray body radiation. Students will be able to evaluate radiation view factors using tables and the view factor relationships.
CO5	Students will be able to understand mass transfer using analogy with heat transfer.

ME-402	Production Engineering-I	PCC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course provides a comprehensive study of metal cutting principles, including tool geometry, cutting mechanics, and machining performance. It covers chip formation, strain analysis, shear angle determination, force equilibrium, and heat generation during machining. The influence of tool materials, tool wear, machinability of engineering alloys, and the application of cutting fluids are examined. Additionally, the course explores plastic deformation, yield criteria, and formability in manufacturing processes such as rolling, forging, extrusion, and sheet metal forming, including deep drawing, blanking, and punching, with a focus on process mechanics, defects, and their mitigation.

COURSE OBJECTIVES:

- To demonstrate the fundamentals of machining processes and machine tools.
- To develop knowledge and importance of metal cutting parameters.
- To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
- To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.
- To develop fundamental knowledge on metal forming processes.

PREREQUISITES:

- Material Science
- Manufacturing Processes
- Workshop Practice-I & II

CONTENT:

Unit I	Principles of Metal cutting. Requirements of tool (Properties and geometry) and motions: Geometry of a single point cutting tools, effect of tool geometry elements on machining performance. Surface integrity, Orthogonal cutting. Mechanics of chip formation. Strain during machining, velocity triangle. Shear angle, Types of chips.
Unit II	Merchant's circle for metal cutting, force balance during orthogonal machining. Machining power. Temperature rise during machining. Effect of heat and forces on the machining performance.
Unit III	Cutting tool material. Tool wear and tool life, machinability of common engineering alloys, cutting fluid. Plastic deformation: Role of shear, behaviour of material during plastic deformation, Yield criteria.
Unit IV	Formability, effect of heating. Hot, warm and cold working. Technology of Rolling, types of rolling stands, defects during rolling and their alleviation. Forging, types of forging. Calculation of forging force.
Unit V	Extrusion, and drawing. sheet metal forming: Deep Drawing, Blanking Punching.

TEXTBOOKS:

1. Manufacturing Science, by Malik A and Ghosh, Affiliated East- West Press Pvt., Ltd.

REFERENCE BOOKS:

1. Fundamentals of Metal Machining and Machine Tools, by Geoffrey Boothroyd, McGraw-Hill International Book Co.
2. Fundamentals of Tools Design by Wilson, Prentice Hall.
3. Manufacturing Technology by John R. Lindbergh Molly W. Williams and Robert M. Wygant.
4. Technician Manufacturing Technology by M. Hazlehurst (English Language Book Society).
5. Introduction to the theory of Plasticity for Engineers by Hoffman and George Sachs McGraw-Hill.

Other details regarding this course:

- This course is predominantly important for manufacturing Industry visit will help.

COURSE OUTCOMES (COs):

CO1	Will be able to apply fundamental concepts of machining, cutting tools, and quality parameters for machining parts.
CO2	Will be able to investigate and determine the machining parameter and estimate the tool life and wear for practical machining applications.
CO3	Will be able to apply the fundamental concepts of yielding and deformation during various metal forming processes.
CO4	Will be able to apply the fundamental concepts of metal forming in forging and rolling operations.
CO5	Will be able to apply the fundamental concepts of extrusion, drawing and deep drawing.

ME-403	CAD and FEM	PCC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course introducing various concepts of CAD (Computer Aided Design) as applied to Engineering design problems. Topics include solid modelling, assembly, creating detailed drawing of solid models Computer-aided design (CAD) is the use of computer in design processes. It is the science of using computer-based software to create, modify, analyze, and optimize product designs. Computer-aided design (CAD) is defined as the process of digitally creating design simulations of real-world goods and products in 2D or 3D, complete with scale, precision, and physics properties, to optimize and perfect the design – often in a collaborative manner – before manufacturing.

COURSE OBJECTIVES:

Computers play an important role in Engineering design and analysis. This course gives an overview of analytical treatment on of the use of computers in design and analysis to increase the overall performance of the system

PREREQUISITES:

- Mathematical background through ordinary differential equations,
- Matrix & Vector algebra,
- Engineering Graphics, computer.

CONTENT:

Unit I	**Introduction:** Definition of CAD/CAM, Industrial Look at CAD/CAM, CAD/CAM System Evaluation Criteria, CAD/CAM Input/output devices. Basic Definitions, Software Module, CAD/CAM Software. **Geometric transformations:** Introduction, Transformation of Geometric Models, Translation, Scaling, Reflection, Rotation, Homogeneous Representation, Concatenated Transformation.
Unit II	**Wire frame Modelling:** Introduction, Wire-frame Model, Wire-frame Entities, Curve Representation, Parametric Representation of Analytic curves- Line, Circle, and Ellipse. Parametric Representation of Synthetic curves-Hermite Cubic Spline, Bezier curve, B-Spline curve. **Surface Modelling:** Introduction, Surface Models, Surface Entities, Surface Representation. Parametric Representation of Analytic Surface-Plane Surface Ruled Surface, Surface of revolution. Parametric Representation of Synthetic Surface-Hermite Bi cubic Surface, Bezier Surface, B-Spline Surface
Unit III	**Solid Modelling:** Introduction, Solid Models, Solid Entities, Boundary Representation-Introduction, Basic elements, Euler Equation Application. Constructive Solid Geometry-Introduction, CSG Tree. Sweep Representation- Introduction to Linear, Non Linear& Hybrid Sweep. **Visual Realism & CAD data exchange files:** Introduction to Model-Cleanup, Hidden line and surface removal, Shading & colouring Models. Evolution of Data Exchange formats, Shape-Based Format, Product Data Based Format, ISO Standards-IGES.
Unit IV	**Introduction of FEM & Concepts**: Basic steps in FEM. Elements, nodes and degree of freedom. Element characteristic matrix. Different methods to derive an element characteristic matrix. Direct method to develop element stiffness matrix. Types of elements, one-dimensional elements, two-dimensional elements and their

	classification. Three-dimensional elements. Related problems. Isoparametric concepts. Shape functions of one dimensional element, Linear, Quadratic, cubic and quadric bar elements, shape functions of two-dimensional elements (Lagrangian and Serendipity family), shape functions of triangular elements, Derivative of shape. functions, Jacobian matrix [J].
Unit V	**Analysis of Plane Truss and Heat Transfer Using FEML**: Solution of the plane truss, Deriving element stiffness matrix (Truss Element) [k], Global stiffness matrix [K] and its physical meaning, Properties of [K] matrix. Solution of unknowns. Simple problem of truss having 3 bars, Potential energy approach, One dimensional problem in stress analysis and heat transfer.

TEXTBOOKS:

1. Ibrahim. Zeid, "CAD/CAM: Theory and Practice", TMH.
2. Rogers D. F. and J. A. Adams, "Mathematical Elements of Computer Graphics", McGraw-Hill, New York.

REFERENCE BOOKS:

1. Beasant C. B. and Lui C. W. K. "Computer Aided Design and Manufacturing", 3rd Edition, Affiliated East West Press Ltd., New Delhi.
2. Mortenson M. E., "Geometric Modeling", John Wiley, New York.

Computer Usage / Software required:

- ANSYS, SOLID WORKS, CATIA, Pro/E and other CAD/FEM software

Other details regarding this course:

- This needs extensive practice with available software used in industry

COURSE OUTCOMES (COs):

CO1	Will be able to understand the fundamental principles of hardware and software requirements in CAD/CAM and conduct geometric transformation.
CO2	Will be able to design and draft simple and complex machine parts using CAD through wireframe and surface modelling.
CO3	Will be able to create solid models and carry out visualization of parts using solid modeling.
CO4	Will be able to understand the basic concepts of FEM and its various applications.
CO5	Will be able to analyze plane Truss and Heat transfer problem using FEM.

ME-404	ENGINEERING ECONOMY	HSMC (OEC-II)	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

The course introduces concepts and economic analysis procedures to assist with decision making in engineering analysis. Concepts include demand and supply, time value of money and cash flow diagrams; simple, compound, nominal, and effective interest rate; single and series payments. Methods to compare project alternatives include present, future, and annual worth, and rate of return analysis. Methods to forecast demand include extrapolative, explanatory and judgemental methods. It also provides an introduction to different depreciation methods.

COURSE OBJECTIVES:

1. To explain the basic principles of engineering economy and analysis tools relevant to engineering/business projects so as to take economically sound decisions.
2. To acquaint engineering students with different demand forecasting methods.
3. To provide engineering students with an appreciation and understanding of the time value of money and its importance in making engineering decisions.
4. To develop skills to use tools for economic analysis of both business projects and public-sector projects.
5. To acquire and independently apply concepts and techniques of economic analysis used to form engineering decisions.

PREREQUISITES:

- Basic Mathematics

CONTENT:

Unit I	Introduction to engineering economy: Definition, the economic environment, methodology and application, Principles of engineering economy, Steps in engineering economic analysis, Cost concepts and its application to break-even analysis, Basics of demand, supply and equilibrium, Price elasticity of demand, Income elasticity of demand, Cross elasticity of demand, Market structure: Perfect competition, Monopoly, Monopolistic competition and Oligopoly.
Unit II	Interest and money-time relationship: Simple and compound interest, notation and cash flow diagram, the concept of equivalence. Interests formulas for discrete compounding and discrete cash flows relating present and future worth of single cash flows and uniform time series (annuity), deferred annuities, annuities with beginning of period cash flows, equivalent present worth, future worth and annual worth, Interest formulas relating an arithmetic gradient series to its present and annual worth, Nominal and effective interest rates, interest problems with uniform cash flows occurring less often and more often than compounding periods, Increasing and decreasing gradients.
Unit III	Basic methods of making economic studies: Present worth (P.W. method, annual worth (A.W.) method, future worth (F.W.) method, internal rate of return (I.R.R.) method, external rate of return (E.R.R.) method, explicit reinvestment rate of return (E.R.R.R.) method

Unit IV	Selection among alternatives: alternatives having identical (or not known) revenues and lives, Alternatives having identical revenues and different lives, Selection among independent alternatives.
Unit V	Demand estimation and forecasting: Basic categories of forecasting method, Extrapolative methods, simple average, moving average and exponential smoothing, Errors involved in forecast. Explanatory methods, regression analysis for linear forecaster, coefficient of determination and correlation. Qualitative method, Delphi approach, Market survey, Depreciation and depletion: Definition and purpose, types of depreciation, and depreciation methods.

TEXTBOOKS:

1. Principles of Engineering Economics with Applications, Zahid A. Khan, Arshad Noor Siddiquee, Brajesh Kumar, Mustufa H. Abidi. Cambridge University Press, New Delhi, India.

REFERENCE BOOKS:

1. Engineering Economy, Degarmo E. Paul, Sullivan William G. And Bontadelli James A. Macmillan Co. of Singapore.
2. Engineering Economy, Leyland Blank T. and Tarquin Anthony J. (1989), McGraw Hill Publishing Company Ltd., India.
3. Engineering Economy, Panneerselvam R. Prentice Hall of India.

Computer Usage / Software required: MS. EXCEL etc.

COURSE OUTCOMES (COs):

CO1	Will be able to interpret the significance of engineering economy, demand and supply, and market structure.
CO2	Will be able to apply the basic principles of the time value of money and its application to draw the cash-flow diagrams (CFD) and to compute equivalent values for time based cash flows of varying complexities.
CO3	Will be able to select and apply different standard methods for economy studies.
CO4	Will be able to evaluate different alternatives using the economy study methods to design the best one for considered application.
CO5	Will be able to suggest, customize and implement the most suitable forecasting, depletion and depreciation methods.

ME-405	Kinematics of Machines	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course provides a comprehensive study of the fundamentals of mechanisms and machines, including kinematic chains, linkages, and mobility analysis. It covers velocity and acceleration analysis using analytical and graphical methods, including the instantaneous center method and Klein's construction. Kinematic synthesis techniques, such as function, path, and motion generation, are introduced using both analytical and graphical approaches. The course explores gear design, including nomenclature, interference, and different types of gears, along with the analysis of gear trains. Additionally, the effects of friction in mechanical systems, including screws, belts, clutches, and slider-crank mechanisms, are examined.

COURSE OBJECTIVES:

- Identify mechanisms and predict their motion
- Calculate the degrees of freedom of mechanisms
- Design mechanisms to fulfil motion generation and quick return requirements.
- Determine the positions, velocities and accelerations of links and points on mechanisms
- Derive SVAJ functions to fulfil cam design specifications
- Calculate dynamic joint forces of mechanisms
- Balance simple rotating objects and pin-jointed four bar linkages
- Use related computer programs to design, model and analyse mechanisms

PREREQUISITES:

- Mechanics of solid, Mathematical differentiation and integration

CONTENT:

Unit I	Basic Concept of Mechanisms and Machines: Link, kinematic pairs and their classifications. Kinematic chain, Mechanism and their inversions. D.O F of a mechanism. Motion and its types. Four bar chain and its inversions. Slider-crank chain. Double slider crank chain. Compound kinetic chain. Quick return motion mechanisms. Mobility of four bar linkage (Grashof's criterion) Mechanisms with lower pairs.
Unit II	Velocity and Acceleration Analysis in Mechanisms: Analytical method for velocity and acceleration of a mechanism. Relative velocity and instantaneous center method for determination of velocities of links of a mechanism. Velocity and acceleration diagrams for different mechanisms. Klein's construction for a reciprocating engine. Coriolis component of acceleration.
Unit III	Kinematic Synthesis of Plane Mechanism: Types of Kinematic Synthesis, Type, dimensional, number synthesis, function generation, path generation & motion generation. Analytical Method of Dimensional Synthesis Four bar, slider crank function generator with three accuracy points, method for complex variables, four bar linkage for specified instantaneous condition using Freudenstein's Equation. Bloch's synthesis, Graphical Methods.

Unit IV	Gears: Motion transmitted by two-curved surface in contact. Gear nomenclature. Types of teeth. Interference and undercutting. Minimum number of teeth on gear wheel/pinion to avoid interference. Arc and path of contact in the case of straight tooth spur gears. Introduction to helical and bevel gears.
Unit V	Gear Trains: Types of gear trains. Epicyclic and compound gear trains for change in speed. Torques and tooth loads in epicyclic gear trains. Friction: Friction in square threaded screw, Collars and pivots: Power transmitted through friction in belts, ropes and clutches. Friction axis of a link and friction axis of a connecting rod in the slider-crank mechanism. Effect of friction in slider-crank mechanism. Gear Trains: Types of gear trains. Epicyclic and compound gear trains for change in speed. Torques and tooth loads in epicyclic gear trains.

TEXTBOOKS:

1. Theory of Mechanisms and Machines by Dr. Jagdish Lal, Metropolitan Book, Co. Pvt. Ltd.,
2. The Theory of machines by Thomas Bevan, CBS Publishers and distributors

REFERENCE BOOKS:

1. Theory of Machines and Mechanisms by J. E. Shigley and J. J. Vicker, McGraw Hill Book co.
2. Mechanisms and Machine theory by J.S. Rao and R.Y. Dukkipati, Wiley Eastern Ltd.
3. Design of Machinery by Robert L Norton, McGraw-Hill Publishing Co.

Computer Usage / Software required:

Simulation Software are required to be learned.

Other details regarding this course: This is a basic course for Machine Dynamics.

COURSE OUTCOMES (COs):

CO1	Will be able to carry out synthesis of planar mechanisms.
CO2	Will be able to conduct displacement, velocity and acceleration analysis of different mechanisms.
CO3	Will be able to conduct inertia force analysis of mechanisms and analyze the performance of different type of governors.
CO4	Will be able to design cam and follower mechanism for a given application.
CO5	Will be able to understand the mechanism of gear pair and gear train.

AS-401	Numeric and Scientific Computing	ESC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course covers fundamental numerical techniques for interpolation, differentiation, integration, equation solving, and differential equations. It includes interpolation methods for equal and unequal intervals, numerical differentiation and integration using various quadrature rules, and solution techniques for algebraic and transcendental equations such as Bisection, Regula-Falsi, and Newton-Raphson. Numerical solutions for linear equation systems, curve fitting using least squares, and methods for solving initial and boundary value problems, including Runge-Kutta and finite difference methods, are also explored.

COURSE OBJECTIVES:

- To understand basic Mathematics for solving Engineering Problems

PREREQUISITES:

- Engineering Mathematics-I, II &IIT Objective Mathematics and handling the Scientific Calculator

CONTENT:

Unit I	Interpolation with Equal and Unequal Intervals of the Arguments: Newton-Gregory, Gauss, Stirling and Bessel Formulae, Aitken & cubic spline interpolation methods for equal intervals; Newton's divided difference and Lagrange's formulae for unequal intervals; Inverse interpolation using Lagrange's formula, method of successive approximations and double, triple interpolation.
Unit II	Numerical Differentiation and Numerical Integration: Numerical successive differentiation using forward, backward, central differences interpolation formulae, Lagrange's and Newton's divided difference interpolation formula. Numerical integration using Simpson's 3/8 rule, Boole's rule, Weddle's rule, Romberg integration, Gauss-Legendre, Lobatto, Radau and Guass–Chebyshev rules. Errors in Quadrature formulae and numerical double integration
Unit III	Numerical Solutions of Algebraic and Transcendental Equations: Bisection, Regula-False position, Newton-Raphson, Graeffe's root-squaring methods for the solution of non-linear algebraic & transcendental equations involving one variable, rate of convergence and error analysis of the methods, Newton-Raphson method for the solution of a system of non-linear equations of two and three variables.
Unit IV	Numerical Solution of a System of Simultaneous Linear Equations and Curve Fitting: Gauss elimination & Gauss-Jordan methods, Ill conditioned linear system, Gauss-Seidel and Crout methods for the solution of a system of linear equations in four unknowns; General curve (linear, quadratic, exponential and other non-linear functions) fitting using method of least squares.
Unit V	Numerical Solutions of Initial and Boundary Value Problems: Numerical approximate solutions of a system of simultaneous and higher order ordinary differential equations using Taylor's series method, Picard's method and Runge-Kutta fourth order method; Runge-Kutta- Fehlberg method, Euler's modified and Milne's methods; Numerical solution of boundary value problems using finite difference method, shooting method and cubic spline method.

TEXTBOOKS:

1. Numerical methods for Scientific and Engineering Computation, M.K. Jain, S.R.K. Iyengar& R. K. Jain, New Age International (P) Ltd.
2. Introductory Methods of Numerical Analysis, Sastry, S S, Prentice Hall of India Pvt. Ltd.

REFERENCE BOOKS:

1. Numerical Methods for Engineers Steven C. Chapra & Raymond P. Canale, Tata McGraw Hill Book Co.
2. Computer Oriented Numerical Methods, Rajaraman; V, Prentice Hall of India Pvt. Ltd.
3. Elements of numerical analysis, Radhey S. Gupta, Macmillan India Ltd.

Computer Usage / Software required:
Numerical Solutions of Initial and Boundary Value Problems.

Other details regarding this course: Problem solving will enable students to solve Mechanical Engineering Problems.

COURSE OUTCOMES (COs):

CO1	Will be able to apply the concept of errors and mathematical accuracy.
CO2	Will be able to apply the basic concept of numerical solution of algebraic and linear equations.
CO3	Will be able to apply the concept of finite differences and numerical differential and integration.
CO4	Will be able to find the numerical solution of ordinary and partial differential equations.
CO5	Will be able to find the numerical solution of system of linear equations & curve fitting.

EE-401	Electro-Mechanical Energy Conversion	PEC	L	T	P	C
		2Hrs	2	0	0	2

COURSE DESCRIPTION:
This course covers the principles, construction, and performance characteristics of electrical machines, including three-phase induction motors, synchronous generators, and synchronous motors. It explores single-phase motors, stepper motors, switched reluctance motors, and PMMC motors, along with their characteristics and control methods. Standard voltage levels in generation and transmission, generating stations, substations, and their components are discussed. Additionally, the course introduces switchgear, relays, timers, PLCs, ADCs, and DACs. Fundamental power electronics concepts, including SCR characteristics, switching methods, rectifiers, inverters, choppers, AC voltage controllers, and motor speed control, are also covered.

COURSE OBJECTIVES:
To transfer the basic knowledge of electrical engineering to the students of Mechanical engineering, and also for allied Mechanical Engineering Jobs.

PREREQUISITES:
- Elements of Electrical and Electronics Engineering

CONTENT:

Unit I	Three Phase Induction Motor: Construction, Principle of operation, torque-slip characteristics, relation between slip and speed, losses, speed control.
Unit II	Synchronous Generator: Principle of operation, emf equation, voltage regulation by synchronous impedance method, efficiency. Synchronous Motor: Principle of operation, effect of excitation, V-curves.
Unit III	Single phase induction motor, Stepper motor, Switch reluctance motor, PMMC motor their characteristic and control. Standard voltages used in generation, transmission. Generating station, sub-station: equipment and layout.
Unit IV	Switchgear, relays, timers: their types, Introduction to PLC, ADC (Analog to digital converter), DAC (Digital to Analog converter).
Unit V	Power Electronics and application: Characteristics of SCR, Turn ON-Off methods, rectifier, inverter, chopper, AC voltage controller, speed control of ac and dc motor.

TEXTBOOKS:

1. Robert Boylested, Louis Nashelky, “Electronic Devices and Circuit Theory” Sixth Edition, Prentice Hall of India Pvt. Ltd. New Delhi, India.

REFERENCE BOOKS:

1. Electric Machinery Fundamentals, Stephen J. Chapman, McGraw Hill Book Co.
2. Digital Circuits and Logic Design, Morris Manno, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Electrical Machines, NagrathI.J. and D.P. Kothari, Tata McGraw Hill, New Delhi.
4. Introduction to Power Electronics Rashid, M. H, Prentice Hall, India, New Delhi.

Computer Usage / Software required:

- MATLAB, etc.

COURSE OUTCOMES (COs):

CO1	Understand the concepts, principles and operation of three phase induction motor.
CO2	Learn the working principle and characteristics of synchronous motor and generator.
CO3	Expand the knowledge of various types of motors and their characteristics.
CO4	Learn the principle and design of switchgear and their types.
CO5	Learn the basics of power electronic and its application.

ME-431	Heat & Mass Transfer Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course focuses on the experimental analysis of heat transfer mechanisms, including conduction, convection, and radiation. Students will determine the thermal conductivity of various materials, evaluate heat transfer coefficients in natural and forced convection, and analyze radiation properties such as emissivity and Boltzmann's constant. Experiments also include studying heat exchangers and heat dissipation in pin-fins to reinforce theoretical concepts with practical applications.

COURSE OBJECTIVES:

- To develop a foundational understanding of thermal conductivity and resistance in various materials, such as metals and insulating powders.
- To investigate and evaluate heat transfer coefficients in natural and forced convection regimes, as well as radiative heat transfer properties, including emissivity and Boltzmann's constant.
- To explore heat transfer processes in practical applications such as parallel and counterflow heat exchangers and study the performance and effectiveness of extended surfaces.

LIST OF EXPERIMENTS:

1. To determine the thermal conductivity of the highly conducting metal rod.
2. To determine the thermal resistance of composite wall and plot the temperature gradient across the different materials
3. To determine the thermal conductivity of the insulating powder.
4. To determine the thermal conductivity of the insulating pads/glasswool
5. To evaluate heat transfer coefficient in natural convection regime
6. To evaluate heat transfer coefficient in forced convection heat transfer regime.
7. To determine the emissivity of the Gray surface.
8. To determine Boltzmann's Constant of radiation heat transfer.
9. Parallel and counter flow heat exchanger.
10. Heat transfer in pin-fin.

REFERENCE BOOKS:

1. Heat and Mass Transfer by P.K. Nag (McGraw Hill Education).
2. Fundamentals of Heat and Mass Transfer by Frank P. Incropera and David P. DeWitt (Wiley).

COURSE OUTCOMES (COs):

CO1	Students will be able to determine the thermal conductivity of highly conductive metal rods, demonstrating proficiency in assessing materials for their efficiency in conducting heat.
CO2	By evaluating thermal resistance in composite walls and plotting temperature gradients across different materials, students will acquire the skill to analyse and optimize heat flow in complex, multi-layered structures.
CO3	Through the determination of thermal conductivity in insulating powders, students will develop the ability to assess and select materials for their effectiveness in minimizing heat transfer.

CO4	Student will be proficient in evaluating Heat Transfer Coefficient in natural and forced convection regime.
CO5	Students will gain the expertise to determine the emissivity of grey surfaces and Boltzmann’s Constant for radiation heat transfer.

ME-432	Production Engineering Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course introduces students to conventional and CNC machining techniques. It covers machining principles, tool alignment, chip formation, and the effects of cutting parameters on surface quality and material removal. Students will gain hands-on experience with lathe, shaper, and CNC machines, including precision measurement, machining process analysis, and basic CNC operations.

COURSE OBJECTIVES:

- Perform alignment tests on lathe machines using suitable instruments.
- Analyze the effect of cutting conditions on chip morphology, surface roughness, and MRR.
- Study the parts and working of CNC machine and perform milling operation on CNC milling machine.
- Find cutting ratios and shear angles in lathe and shaper machines.

LIST OF EXPERIMENTS:

1. To perform the alignment test on a lathe Machine.
2. To study chips morphology with respect to various cutting conditions (such as speed feed depth of cuts etc.
3. To investigate the effect of cutting parameter (such as speed, feed, and depth of cut on the surface roughness & MRR.
4. To study the CNC VMC machine and perform a pocket milling of 25X25X5mm on a given work material.
5. To determine the cutting ratio and shear angle for orthogonal machining operations on a lathe machine.
6. To determine the cutting ratio and shear angle for machining operations on a shaper machine.
7. To study slides, drives and power sources of a CNC machine tool.

REFERENCE BOOKS:

1. Manufacturing Engineering and Technology, Serope Kalpakjian, Pearson Education; Seventh edition (2018).
2. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Mikell P. Groover, John Wiley & Sons; 4th Edition (2010).

COURSE OUTCOMES (COs):

CO1	To be able to use suitable instruments and perform alignment test for lathe Machine.
CO2	To be able to recognize impact of to various cutting conditions on chips morphology.
CO3	To be able to assess the effect of cutting parameter on surface roughness & MRR.
CO4	To be able to appreciate systems of CNC machines such as slides, drives and power sources and understand its operation.
CO5	To determine the cutting ratio and shear angle for orthogonal machining operations.

ME-433	CAD, FEM and Computer aided Machine Drawing Laboratory	PCC	L	T	P	C
		4Hrs	0	0	4	2

COURSE DESCRIPTION:

This laboratory course provides practical training in both computer-aided and manual drafting techniques. Students will use CAD software such as Pro/E, CATIA, or SolidWorks for geometric modeling, part design, assembly drawing, and load analysis. Additionally, manual drafting skills will be developed through detailed engineering drawings of mechanical components, with proper dimensions, tolerances, and annotations.

COURSE OBJECTIVES:

- Prepare assembly drawings of simple machine components.
- Learn CAD software and perform part modeling and assembly of different machine parts.
- Perform static load analysis using CAD software.

LIST OF EXPERIMENTS:

1. To study the elements of CAD workstation.
2. To study in detail the geometric modelling method.
3. To draw the part models of the given machine components using Pro/E or CATIA or Solid Works.
4. To draw the assembly for the given parts of a machine components using Pro/E or CATIA or Solid Works.
5. To perform the load analysis of a given machine component using CATIA or ANSYS.
6. Draw a detailed assembly drawing of a Cotter Joint with front views of the socket, spigot, and cotter with proper dimensions.
7. Create a detailed assembly drawing of a Knuckle Joint featuring front views of the eye, fork, collar, and pin with proper dimensions.
8. Prepare assembly and detailed drawings of a Universal Coupling, incorporating all parts with proper dimensions, tolerances, annotations, and half sectioning where necessary.
9. Develop assembly and detailed drawings of Cross Heads, including all components with accurate dimensions.
10. Generate detailed half section view drawings of the Stuffing Box, illustrating all relevant parts with clear internal features.

REFERENCE BOOKS:

Machine Drawing, N.D. Bhatt, V. M. Panchal, Charotar Publication, 51st edition.

COURSE OUTCOMES (COs):

CO1	Will be able to identify and ascertain the hardware and software required for a CAD system.
CO2	Will be able to use the geometric modelling method.
CO3	Will be able to do part modelling and assembly.
CO4	Will be able to create the assembly drawing of different machine components.
CO5	Will be able to create sectional views of different machine components.

<table>
<tr><td rowspan="2">ME-434</td><td rowspan="2">Kinematics of Machines Laboratory</td><td>PCC</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2Hrs</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
</table>

COURSE DESCRIPTION:
This laboratory course provides practical insights into the analysis and application of kinematic mechanisms. Students will study various kinematic pairs, chains, and inversions, apply Grashof's criterion, and analyze planar mechanisms using GIM software. The course also covers velocity diagrams, straight-line motion mechanisms, gear tooth profiles, and different types of gear trains to enhance understanding of machine motion and mechanical linkages.

COURSE OBJECTIVES:
- Study mobility characteristics, inversion and kinematic analysis of different planar mechanisms
- Learn kinematic design software to perform kinematic analysis of planar mechanism
- Study gear tooth profiles
- Study of the different gear trains

LIST OF EXPERIMENTS:

1. Study of the different types of kinematic pairs
2. Study of the application of Grashof's criterion to different kinematic chains
3. Study of the inversions of the four-bar kinematic chain
4. Study of the inversions of the four-bar single slider kinematic chain
5. Study of the inversions of the four-bar double slider kinematic chain
6. Study of the motion kinematics of different planar mechanisms using GIM software
7. Study of the straight-line motion mechanisms
8. Study of velocity diagram of four bar kinematic chain and slider crank mechanism
9. Study of the gear tooth profiles
10. Study of the different gear trains

REFERENCE BOOKS:

1. Theory of Machines and Mechanisms by J. E. Shigley and J. J. Vicker, McGraw Hill Book co.
2. Mechanisms and Machine theory by J.S. Rao and R.Y. Dukkipati, Wiley Eastern Ltd.
3. Machines and Mechanisms, Applied Kinematic Analysis by David H. Myzka, Pearson.

COURSE OUTCOMES (COs):

CO1	Will be able to Identify different types of kinematic links, pairs and chains, and analyze their motion kinematics.
CO2	Will be able design and analyze the mechanisms for the specified application in a machine.
CO3	Will be able to apply inversions of different four bar kinematic chains in applications.
CO4	Will be able to use software for the kinematics analysis of different planar mechanisms with revolute and sliding pairs.
CO5	Will be able to understand different gear profiles and gear trains.

<table>
<tr><td rowspan="2">AS-431</td><td rowspan="2">Numeric and Scientific Computing Lab.</td><td>ESC</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2Hrs</td><td>0</td><td>0</td><td>2</td><td>1</td></tr>
</table>

COURSE DESCRIPTION:

This laboratory course focuses on numerical techniques for solving mathematical problems using programming. Students will develop and implement algorithms for root-finding methods, system of equations, interpolation, numerical integration, and differential equations. Techniques such as Bisection, Regula-Falsi, Newton-Raphson, Gauss Elimination, and Runge-Kutta methods will be programmed and applied to solve real-world numerical problems.

COURSE OBJECTIVES:

The course is intended to help students learn programming codes for solving various numerical problems.

LIST OF EXPERIMENTS:

1. To develop a program for Bisection Method and also implement it to solve numerical problems.
2. To develop a program for Regula-false Method and also implement it to solve numerical problems.
3. To develop a program for Newton Raphson Method and also implement it to solve numerical problems.
4. To develop a program for Gauss Elimination Method and also implement it to solve numerical problems.
5. To develop a program for Gauss-Jordan Method and also implement it to solve numerical problems.
6. To develop a program for Newton’s Forward Interpolation formula and also implement it to solve numerical problems.
7. To develop a program for Newton’s Backward Interpolation formula, Simpson's three-eight rule and also implement it to solve numerical problems.
8. To develop a program for Simpson's three-eight rule and also implement it to solve numerical problems.
9. To develop a program for Trapezoidal Rule and also implement it to solve numerical problems.
10. To develop a program for Runge Kutta Method and also implement it to solve numerical problems.

REFERENCE BOOKS:

1. Numerical Methods for Engineers Steven C. Chapra & Raymond P. Canale, Tata McGraw Hill Book Co.
2. Computer Oriented Numerical Methods, Rajaraman; V, Prentice Hall of India Pvt. Ltd.

COURSE OUTCOMES (COs):

CO1	Will be able to apply numerical methods to obtain approximate solutions to mathematical problems.
CO2	Will be able to derive numerical methods for various mathematical operations such as interpolation, differentiation,integration, the solution of linear and nonlinear equations, and the solution of differential equations.
CO3	Will be able to analyse and evaluate the accuracy of common numerical methods.
CO4	Will be able to implement numerical methods in computer programming C/C++.

CO5	Will be able to write efficient, well-documented C/C++ code and present numerical results in an informative way.

FIFTH SEMESTER

Course Details:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
V SEMESTER	1	ME-501	Fluid Mechanics-II	PC	3	2	1	0	3
	2	ME-502	Design of Mechanical Components	PC	3	2	1	0	3
	3	ME-504	Production Engineering-II	PC	3	2	1	0	3
	4	ME-505	Dynamics of Machines	PC	3	2	1	0	3
	5	ME-506	Internal Combustion Engines	PC	3	2	1	0	3
	6	ME-507	Mechatronics	CBCS	4	3	1	0	4
	i	ME-531	Fluid Mechanics Laboratory	PC Lab	1	0	0	2	2
	ii	ME-532	Design of Mechanical Components Laboratory	PC Lab	1	0	0	2	2
	iii	ME-533	Dynamics of Machines Laboratory	PC Lab	1	0	0	2	2
	iv	ME-535	Mechatronics Laboratory	PC Lab	1	0	0	2	2
				Total	**23**	**13**	**6**	**8**	**27**

ME-501	Fluid Mechanics-II	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers advanced topics in fluid mechanics, beginning with ideal fluid flow, including Bernoulli's equation, velocity potential, and superposition of elementary plane flows such as source, sink, vortex, and doublet, along with applications like flow past a cylinder and the Magnus effect. It explores laminar flow in viscous incompressible fluids, solving the Navier-Stokes equations for Couette and Hagen-Poiseuille flows, and studying creeping flows relevant to lubrication. Boundary layer theory is examined, including thickness parameters, Blasius solution, and boundary layer control for aerodynamic efficiency. The fundamentals of turbulence are introduced, covering Reynolds stresses, shear stress models, and turbulent boundary layers. Finally, compressible flow concepts are addressed, focusing on Mach number effects, isentropic nozzle flows, shock waves, and flows with friction or heat transfer such as Fanno and Rayleigh flow.

COURSE OBJECTIVES:

- Knowledge and understanding of the basic principles and concepts of fluid mechanics are essential to analyse any system in which a fluid is the working medium.
- The design of all means of transportation requires application of the principles of fluid mechanics. In recent years automobile manufacturers have given more consideration to aerodynamic design.
- The design of propulsion systems for space flight is based on the principles of fluid mechanics.
- It is commonplace today to perform model studies to determine the aerodynamic forces on, and flow fields around, buildings and structures.

PREREQUISITES:

- Fluid Mechanics-I

CONTENT:

Unit I	**Ideal fluid flows:** Bernoulli equation applied to irrotational flow, The velocity potential, Elementary plane potential flows; uniform flow, source, sink, vortex and doublet, Superposition of elementary plane flows; flow past a half-body, flow past a Rankine body, flow past a cylinder, flow past a rotating cylinder, Magnus effect, Aerofoil theory.
Unit II	**Laminar flow of Viscous Incompressible Fluids:** Basic equations; continuity equation, momentum equation (N-S equations), Exact solution of N-S equations; Couette flow, Hagen-Poiseuille flow, Flow between two coaxial cylinders, Flow between two concentric rotating cylinders, Low Reynolds number flows (Creeping flows); hydrodynamics of bearing lubrication.
Unit III	**Boundary layer theory and external flows:** Boundary-layer concept, Boundary layer along a flat plate; boundary layer thickness, displacement thickness, momentum thickness, Boundary layer equations, Blasius solution, Momentum integral boundary layer equation, Boundary layer control. Lift and drag, Streamlining.
Unit IV	**Turbulent flow:** Characteristics of turbulent flow, Laminar-turbulent transition, Mean motion and fluctuations, Governing equations for turbulent flow, Reynolds stresses, Shear stress models, Universal velocity distribution law, Turbulent flow in pipes, Turbulent boundary layer.

Unit V	**Compressible flow:** Review of thermodynamics, thermodynamic relations of perfect gases, Propagation of sound waves; speed of sound, types of flow, the Mach cone, Adiabatic and isentropic flow; stagnation properties, Isentropic flow through a variable area, Isentropic flow through a convergent-divergent nozzle; critical properties, shock waves, Flow through constant area duct with friction (Fanno flow), Flow through constant area duct with heat transfer (Rayleigh flow).

TEXTBOOKS/ REFERENCE BOOKS:

1. Introduction to Fluid Mechanics by Fox & McDonald, John Wiley & Sons, Inc.
2. Foundations of Fluid Mechanics by S. W. Yuan, Prentice-Hall of India Pvt. Ltd.
3. Fluid Mechanics and Its Applications by Vijay Gupta & Santosh K Gupta, New Age Int. Publishers.
4. Introduction to Fluid Mechanics and Fluid Machines by S K Som& G Biswas, Tata McGraw-Hill Pub.
5. Fluid Mechanics byPijush K. Kundu & Ira M. Cohen, ELSEVIER, ACADEMIC PRESS.
6. Fluid Mechanics by Yunus A. Cengel& John M. Cimbala, McGraw-Hill Education Pvt. Ltd.
7. Fluid Mechanics by Frank M White, Tata McGraw-Hill Pub. Company Ltd.

Computer Usage / Software required: MATLAB, EXCEL, EES etc.

COURSE OUTCOMES (COs):

CO1	Will be able to understand basic concepts of laminar follow of viscous incompressible fluids.
CO2	Will be able to understand and apply boundary layer theory and determine lift and drag.
CO3	Will be able to understand turbulent follow in pipes etc.
CO4	Will be able to understand the basic concepts of different compressible flows like Fanno and Rayleigh flow.
CO5	Will be able to implement various control and measurements techniques for different fluid flow.

ME-502	Design of Mechanical Components	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course is to serve as an introduction to mechanics of deformable solid bodies.

COURSE OBJECTIVES:

To prepare a student of mechanical engineering to apply theory and practice of Design of Mechanical Elements. It is an introductory course laying foundation on design fundamentals, application of strength of material principles, selection of components and selection of materials for a given application. The objective also includes working with CATIA and other design software.

PREREQUISITES:

- Machine Drawing, Mechanics of solid and Engineering Materials

CONTENT:

Unit I	**Introduction**: Introduction to Design Process & Phases of design. Design factors. Margin of safety. Working stresses. Properties of the materials, Manufacturing Consideration in design, BIS Codes for Steels, Theories of Failure. Types of joints. Types of riveted joints. Design of riveted joints. Design of welded joints. Eccentrically loaded riveted and welded joint. Cotter and Knuckle joint design.
Unit II	**Design against Fatigue**: Fatigue strength. Factors affecting fatigue behavior. Influence of superimposed static stress. Stress concentration. Notch sensitivity. Factor of safety. Cumulative damage in fatigue, Soderberg and Goodman lines, Gerber's Parabola, Modification of Goodman's Line. Practical measures to combat fatigue.
Unit III	**Screws**: Design of screw joints under tension and shear, initial loading, consideration of stiffness. Eccentrically loaded screws joints. Standard threads. Power Transmission by screws. Friction and efficiency. Examples of application: screw jack, C-Clamp, lead screw, broach actuator etc. Design of nut-screw pair for axial load and torque. Impact load on bolts.
Unit IV	**Clutches and Brakes**: Function of Clutches, Friction and limiting torque. Theories of uniform pressure and wear. Classification-single & multiple plate clutches. Cone clutch. Centrifugal Clutch. Energy loss during clutching. Consideration of heat dissipation in brakes and clutches. Description of power controlled clutches. Brakes-function, types, lining material, Band, Shoe, Band and Shoe. Actuating mechanism. Maximum and average pressure. Leading and trailing shoe brakes. Disc Brakes.
Unit V	**Springs**: Types of close and open coil Helical springs. Tension & compression spring. Design of helical spring. Combination in series and parallel. Leaf springs and design of leaf spring. Load on the clip bolts. Flat spiral springs. Material for springs. Method of improvement of life and strength. **Thin & Thick Cylinders**: Thin cylinders, Thick cylinders, Lames Equation, Compound cylinders, Spherical Vessels.

TEXTBOOKS:

1. Mechanical Engineering. Design by J.E. Shigley, C.R. Mischke, McGraw HI Book Co.
2. Design of Machine Elements by Bhandari V B McGraw HI Book Co. 5th Ed

REFERENCE BOOKS:

1. Fundamentals of Machine Component Design by R.C. Juvinall, John Wiley & Sons
2. Design of Machine Elements by Spots, Prentice Hall of India.
3. Fundamentals of Mechanical Component Design by Edwards and McKee, McGraw-Hill.
4. Machine Design by Robert L. Norton, Prentice Hall, USA

Computer Usage / Software required:

- Language- C, C++, Fusion 360, SolidWorks, Pro/E, CATIA, ANSYS

Other details regarding this course:

- Mini projects as assignments for improving the practice of design of mechanical components should be done.

COURSE OUTCOMES (COs):

CO1	Will be able to design riveted, welded and other types of joints under different loading conditions.
CO2	Will be able to design machine parts under variable loading.
CO3	Will be able t design bolted joints and power screws.
CO4	Will be able to analyze and design brakes and clutches for give loading conditions.
CO5	Will be able to design springs and pressure vessels.

ME-504	Production Engineering-II	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course provides an in-depth understanding of precision measurement techniques, manufacturing processes, and material processing methods. It covers linear and angular measurements, interferometry, and gear measurement techniques. The principles and design of jigs and fixtures, surface measurement methods, and grinding operations are explored. Advanced manufacturing techniques such as EDM, ECM, ultrasonic, laser, and plasma machining are introduced, along with high-velocity metal forming methods. The course also includes an overview of plastic materials, their properties, and various processing techniques.

COURSE OBJECTIVES:

- To demonstrate the fundamentals of metrology and inspection.
- To develop knowledge and importance of jigs and fixtures.
- To develop fundamental knowledge on grinding of materials.
- To develop knowledge and importance of non-conventional manufacturing processes.
- To demonstrate the fundamentals of properties and processing of plastics.

PREREQUISITES:

- Material Science
- Production Engineering-I
- Manufacturing Processes
- Workshop Practice-I & II.

CONTENT:

Unit I	Linear and angular measurements- Precision gauge block, Angle gauge, Sine bar. ISO system of Limits and fits. Interferometry -e.g. optical flats. Measurement of major diameter, minor diameter and effective diameter by bench micrometer. Errors in pitch and thread form by optical method. Measurement of gears to determine errors in run out, profile. Pitch, pressure angle and tooth thickness by anyone method. C.N.C. Measuring equipment of gears.
Unit II	Usefulness of Jigs and Fixtures. Principles of jigs and fixtures design. Principles and types of locating and clamping devices. Elements of a drilling jig and types of jigs. Elements of a milling fixtures and types of milling fixtures. Jig and fixture economic analysis.
Unit III	Surface measurements e.g. surface roughness, Grinding Process, Grinding operations, Modelling of plunge and surface grinding operations, Grinding wheels- materials and designation, wheel truing and dressing.
Unit IV	Need of Unconventional manufacturing methods, Electro discharge machining, electro-chemical machining, abrasive jet machining, ultrasonic machining. Electron beam machining, Laser beam machining. Plasma Arc Machining. High velocity forming of metals- Explosive forming. Electro-hydraulic forming.
Unit V	Structure, properties of Plastics and factors affecting properties, Plastic processing-Casting of Plastics, Compression Molding, Injection Moulding, Rotomoulding, Blow Moulding, Reinforced Plastic Moulding, Pultrusion, Filament Winding, Machining of Plastics.

TEXTBOOKS:

1. Manufacturing Science, by Mallik A and Ghosh, Affiliated East- West Press Pvt., Ltd.

REFERENCE BOOKS:

1. Fundamentals of Metal Machining and Machine Tools, by Geoffrey Boothroyd, McGraw-Hill International Book Co.
2. Fundamentals of Tools Design by Wilson, Prentice Hall.
3. Processes and Materials of Manufacture, by Roy A. Lindberg, PHI Learning.
4. Manufacturing Technology by John R. Lindbeck Molly W. Williams and Robert M. Wygant.
5. Technician Manufacturing Technology by M. Hazlehurst (English Language Book Society.
6. Introduction to the theory of Plasticity for Engineers by Hoffman and George Sachs McGraw-Hill.

Other details regarding this course:

The course is of predominantly important in industry and requires industry interaction

COURSE OUTCOMES (COs):

CO1	Will be able to conduct measurement and inspection of gears, threads, etc. using metrological instrument including coordinate measuring machine.
CO2	Will be able to design jigs and fixtures for industrial applications.
CO3	Will be well versed with and identify the finishing and superfinishing processes for given application.
CO4	Will be able to decide the non-conventional and modern manufacturing processes for developing a product.
CO5	Will be able to identify the properties of different plastics and prescribes processing methods for different product.

ME-505	Dynamics of Machines	PEC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers the fundamental principles of cams, inertia force analysis, balancing, gyroscopes, and governors. It explores different types of cams and followers, motion analysis, and cam profile design. Inertia force analysis includes dynamically equivalent systems, reciprocating engine forces, and flywheels. The balancing section addresses static and dynamic balancing of rotating and reciprocating masses, including multi-cylinder engines. Gyroscopic effects on various vehicles and machinery are analyzed, including applications in ships and aircraft. Finally, the course examines different types of governors, their performance characteristics, and governing equations to ensure speed regulation in engines.

COURSE OBJECTIVES:

The student is to learn and demonstrate proficiency in mechanism kinematics, graphical and analytical linkage synthesis, linkage position analysis, linkage velocity analysis, linkage acceleration analysis, and dynamic linkage force Analysis.

PREREQUISITES:

- Theory of Machines

CONTENT:

Unit I	Cams: Types of cams and followers. Displacement, velocity, and acceleration diagrams for usual motion of followers. Cam profiles for knife-edge, roller and flat-faced followers. Cam size determination. Determination of motion of the follower for specified cam profiles.
Unit II	Inertia Force Analysis: Simple and compound pendulums. Inertia force and inertia couple. Dynamically equivalent systems. Equilibrium of a link in a mechanism. Inertia force in reciprocating engines. Inertia forces in a four bar linkage. Turning moment diagrams. Fluctuation of speed and energy. Flywheel.
Unit III	Balancing: Introduction to static and dynamic balancing. Balancing of a single and a number of rotating weights by another weight rotating in the same plane. Balancing of a number of weights rotating in different planes. Balancing of reciprocating parts of an engine. Partial balancing of primary forces. Balancing of two and four cylinder in a line engine. Balancing of V /radial engines. Direct and reverse crank method. Balancing machines.
Unit IV	Gyroscope: Gyroscopic couple and processional motion. Effect of gyroscopic couple on a movement of aero planes, Naval ships, four wheel and two wheel vehicles. Gyroscopic Analysis for rotating shaft with inclined disc and Grinding Mills. Introduction to Gyro dynamics.
Unit V	Governors: Function of a governor, governor's types, working of Watt Porter, Proell and Hartnell governor with and without the effect of friction at the sleeves. Qualities of a governor- sensitiveness, stability, isochronisms and hunting. Effort and power. Controlling force of a governor.

TEXTBOOKS BOOKS:

1. Theory of Mechanism and Machines by Ghosh &Malick, Affiliated East-West Publications.
2. Theory of Machines by Thomas Bevan CBS Publishers and Distributor, N. Delhi.

REFERENCE BOOKS:

1. Theory of Machines and mechanisms, Shigley, MGH
2. Mechanism and Machine Theory by J.S. Rao and R. V Dukkipati, Wiley Eastern

COURSE OUTCOMES (COs):

CO1	Understand the concepts of cams and followers.
CO2	Analyze the inertial force for simple and compound pendulums.
CO3	Learn static and dynamic balancing.
CO4	Learn gyroscopic couple and processional motion and various applications of gyroscope.
CO5	Understand working and function of different types of governors.

ME-506	Internal Combustion Engines	PEC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course provides a comprehensive study of Internal Combustion (I.C.) Engines, including their classification, applications, and fundamental working principles. It covers air standard cycles, the operation of S.I. and C.I. engines, and a comparison of 2-stroke and 4-stroke engines, including scavenging and supercharging. The combustion process in S.I. and C.I. engines is analyzed, focusing on abnormal combustion, knocking, and fuel metering systems. Gas turbines and jet propulsion systems are introduced, along with their thermodynamic analysis. The course also explores conventional and alternative fuels, their characteristics, and emission control strategies for environmental sustainability.

COURSE OBJECTIVES:

- To impart knowledge and understanding of basic concept and working of different types of Engines.
- To make the student capable enough to be employed by Engine Manufacturers.

PREREQUISITES:

- Applied Thermodynamics
- Fluid Mechanics
- Heat and Mass Transfer

CONTENT:

Unit I	I.C. Engines: Introduction and Engine classification; Major Applications; Air Standard Cycles and their Analysis; S.I. and C.I. Engines operation; Working principles, merits and demerits of 2-Stroke and 4-Stroke engines; Scavenging of Two Stroke Engines; Introduction of Supercharging & Turbo charging.
Unit II	S.I. Engines: Introduction- Stages of Combustion in S.I Engines, Abnormal Combustion, Effect of Engine Variables on Knock; Fuel metering, Carburetion and Fuel injection systems.
Unit III	C.I. Engines: Introduction- Stages of Combustion in C. I. Engines, Significance of Delay Period on Knocking phenomena, Influence of Various Factors on Delay Period, Comparison of Knock in SI and CI Engines.
Unit IV	Gas Turbine & Jet Propulsion: Thermodynamics analysis of Actual Gas Turbine Cycle; Introduction of Turbojet, Turboprop, Turbofan, Ramjet and Rocket Engines.
Unit V	Fuels: Fuels used in S.I., C.I. Engines & Gas Turbines, Non-conventional Fuels, its Fuel characteristics and their rating. Alternative Fuels. Exhaust Emissions from S.I& C I Engines & its Control.

TEXTBOOKS:

1. Internal Combustion Engine by V. Ganesan; Tata McGraw Hill Publication

REFERENCE BOOKS:

1. Internal Combustion Engines Fundamentals by John B. Heywood; McGraw Hill
2. Internal Combustion Engines and Air Pollution, by Edward F. Obert Harper & Row Publishers

3. Internal Combustion Engine by Sharma &Mathur; Dhanpat Rai& Sons

Computer Usage / Software required: Dynomation-5; Engine simulation and other related software

COURSE OUTCOMES (COs):

CO1	Will be able to analyze different thermodynamic cycles employed in operation of SI and CI engines.
CO2	Will be able to analyze the conditions leading to abnormal combustion and carry out the analysis of fuel metering of an SI engine.
CO3	Will be able to analyze the conditions leading to knocking in CI engine.
CO4	Will be able to conduct the measurement and analysis of exhaust gas emissions for SI and CI engines.
CO5	Will be able to formulate and select suitable fuel for operations of IC engines.

ME-507	Mechatronics	PEC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

Mechatronics (ME-507) is a graduate level basic course in robotics. This course is open to all engineering graduate students. Mechatronics engineering is a field which consists of a combination of computer, electrical, electronic and mechanical engineering that serves the purpose of controlling advanced hybrid systems. Mechatronics Engineers maintain, manage, design and develop engineering systems. Mechatronics Engineering has applications in numerous industries such as Automation, Oceanography, Robotics, Transport, Nanotechnology, Aircraft Engineering, Oil and Gas, Biomedical Systems, and Computer-aided design.

COURSE OBJECTIVES:

The Objective of this course is to impart the skills and knowledge that are not confined to a single subject area, but a range of engineering disciplines. Students completing a course will be capable of working in a number of interesting areas i.e. process engineering, product design, manufacturing, automation, quality and business process, green engineering and research and development.

PREREQUISITES:

- Theory of Machines,
- Manufacturing Process,
- Basic Electrical & Electronics Engineering,
- Instrumentation and Control.

CONTENT:

Unit I	**Introduction to Mechatronics:** Origin& evolution of Mechatronics. Objectives, Advantages, And Disadvantages of Mechatronics, System Interfacing, Instrumentation and Control Systems, open and closed Loop Systems, Sequential Systems. Elements of Mechatronics: Sensors and Transducers, Timers. Signal Conditioning, Signal Nomenclature, Signal Processing. Digital Logic. Microprocessor-based Digital Control, Basic Elements of control systems, Microprocessor Architecture, Terminology, instruction Types, Addressing Models, Intel 8085A Microprocessor, Microcontrollers, Relay and Programmable Logic Controller.
Unit II	**Pneumatics & Electro Pneumatics:** Introduction to Pneumatics, Air Compression, Distribution and Treatment. Directional Control valves. Electro Pneumatic Components. Circuit Design. Pneumatic Actuation System, Practical Exercises.
Unit III	**Actuators and Mechanisms:** Actuator Types and application Areas, Electromechanical Actuators, DC Motors, AC Motors, Fluid Power Actuators, Piezoelectric Actuators, Magnetostrictive Actuators, Memory-metal Actuator, Ion-Exchange Polymer-metal Composites, Chemical Actuator, Mechanisms, Bearings, Belt, Chain, Pulleys, Gears, Rack and Pinion, Ratchet, Pawl and Crank, Slider and Crank, Cams and Follower, Chain and Sprocket, Geneva Wheel, Four-bar Linkages.
Unit IV	**Modelling:** Systems, Modelling, Mechanical System, Electrical Systems, Fluid Systems, Thermal Systems, Engineering System, Translational Mechanical System with spring, Damper and Mass. Rotational Mechanical Systems with Spring, Damper and Mass, Modelling Electric Motor, Modelling Chamber Filled with Fluid, Modelling Pneumatic Actuator.

Unit V	**Intelligent Systems and Their Applications-** Advance Actuators, Consumer Mechatronics Products, Hydraulic Fingers, Surgical Equipment, Industrial Robot, Autonomous Guided Vehicle (AGV), Drilling Machine, Conveyor-based Material Handling Systems. Mechatronics in Manufacturing Production Unit, Input/output and Challenges in Mechatronics Production Units, Knowledge Required For Mechatronics in Manufacturing, Main Features of Mechatronics in Manufacturing, Computer Integrated Manufacturing, just- in-Time Production Systems, Mechatronics and Allied Systems.

TEXTBOOKS:

1. W. Bolton, 'Mechatronics', Pearson Education New Delhi.
2. N P Mahalik, 'Mechatronics Principle, concept & Application, ' Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS:

1. Robert H. Bishop, 'Mechatronics Hand Book', CRC Press, New York
2. J.R Groot, ‘Introduction to Pneumatics’, Fluid Power Education Foundation, Milwaukee.

Computer Usage / Software required:

- MATLAB, AutoSIM

COURSE OUTCOMES (COs):

CO1	Will be able to understand the basic concepts of Mechatronics and actuation mechanisms.
CO2	Will be able to understand the working principle of different types of sensors and microcontrollers.
CO3	Will be able to understand the basic concept of pneumatic and electro-pneumatic, hydraulic and electro-hydraulics.
CO4	Will be able to conduct system modeling and signal conditions.
CO5	Will be able to understand the modern machinery and intelligent systems used in industries, like AGVs, etc.

ME-531	Fluid Mechanics Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides practical exposure to fundamental fluid mechanics concepts and flow measurement techniques. Students will visualize fluid flow behavior, study metacentric stability, and verify Bernoulli's theorem. Experiments include determining discharge coefficients for flow meters and notches, analyzing velocity profiles, studying pipe flow frictional characteristics, and evaluating jet flow parameters. The course enhances understanding of fluid dynamics through hands-on experimentation.

COURSE OBJECTIVES:

- To reinforce the understanding of the basic principles of the various fluid phenomenon.
- To help the students comprehend different fluid flows and use different type of instruments.
- To correlate theory and experiment and estimate the uncertainty in measurement.

LIST OF EXPERIMENTS:

1. To visualize a fluid flow using Reynolds experiment and distinguish a laminar and turbulent flow.
2. To study the stability of a floating body and determine its metacentric height.
3. To verify the Bernoulli's theorem by evaluating different components of mechanical energy possessed by flowing fluid
4. To find the coefficient of discharge for a Venturi-meter and draw its calibration chart.
5. To find the coefficient of discharge for an Orifice-meter and draw its calibration chart.
6. To find the coefficient of discharge for a Triangular notch and draw its calibration chart.
7. To find the coefficient of discharge for a rectangular notch and draw its calibration chart.
8. To draw a velocity profile in pipe flow for laminar and turbulent conditions using Pitot-static tube.
9. To study the frictional characteristics of a fully developed laminar and turbulent flow in pipeline.
10. To evaluate the performance parameters, namely, coefficient of velocity, coefficient of discharge and coefficient of contraction for a free jet flowing through an orifice.

REFERENCE BOOKS:

1. Fluid Mechanics with Laboratory Manual by B Majumdar, PHI.
2. Fluid Mechanics by Yunus A. Cengel, John M. Cimbala, McGraw Hills.

COURSE OUTCOMES (COs):

CO1	Will be able to visualize the different fluid flows using Reynolds experiment and will be able to distinguish between laminar and Turbulent flows.
CO2	Will be able to establish the stability condition of floating bodies using the concept of meta-centric height.
CO3	Will be able to verify the Bernoulli's theorem.
CO4	Will be able to experimentally determine the coefficient of discharge for venturi meter, orifice meter, triangular notch and rectangular notch.
CO5	Will be able to generate velocity profile and determine the functional characteristics of flow in pipes.

ME-532	Design of Mechanical Components Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides practical exposure to the design and analysis of mechanical components using engineering principles and simulation tools. Students will apply theories of failure, design welded and riveted joints, and analyze fatigue behavior. Experiments include designing and evaluating screw joints, power screws, clutches, brakes, springs, and pressure vessels using Fusion 360 and simulation software. The course integrates theoretical knowledge with computational tools for real-world mechanical design applications.

COURSE OBJECTIVES:

- To apply theories of failure in designing machine components.
- To design and analyze welded, riveted, knuckle, and cotter joints using Fusion 360.
- To study fatigue behavior and solve design problems related to screw joints and power screws.
- To design and simulate clutches, brakes, helical and leaf springs using simulation software.
- To study and design thin and thick cylinders based on ASME codes.

LIST OF EXPERIMENTS:

1. To study the applications of various Theories of Failures.
2. Design of Welded & Riveted Joints, Eccentrically loaded joints.
3. To design Knuckle and Cotter Joint using Fusion 360.
4. To study problems on Fatigue Behavior of machine components and solve them.
5. To study problems on Design of screw joints under tension and shear, initial loading, consideration of stiffness. Eccentrically loaded screws joints. Standard threads.
6. Design of nut-screw pair for axial load and torque. Impact load on bolts.
7. To design a and analyse the working of the following power screws: screw jack, C-Clamp, lead screw, broach actuator etc.
8. To solve problems on design of different types of Clutches and Brakes using simulation software.
9. To design and analyze problems on Helical and Leaf springs using simulation.
10. To study the design of thin & Thick Cylinders Using ASME Codes.

REFERENCE BOOKS:

1. Mechanical Engineering. Design by J.E. Shigley, C.R. Mischke, McGraw HI Book Co.
2. Design of Machine Elements by Bhandari V B McGraw HI Book Co. 5th Ed

COURSE OUTCOMES (COs):

CO1	Will be able to determine the forces in welds and riveted joints and formulate design solution for size of weld and size of rivet.
CO2	Will be able to design against fatigue for mechanical systems.
CO3	Will be able to design screw and bolted joints and power screws for various applications.
CO4	Will be able to design of different types of brakes and clutches.
CO5	Will be able to different types of springs and thin and thick cylinders.

ME-533	Dynamics of Machines Laboratory	PEC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in analyzing the dynamic behavior of mechanical systems. Students will study cam and follower mechanisms, governor performance characteristics, rotor balancing, and gyroscopic effects. The experiments focus on understanding motion control, force balancing, and stability in mechanical systems, reinforcing theoretical concepts with practical applications.

COURSE OBJECTIVES:

- Gain a comprehensive understanding of various types of cam and follower mechanisms, their configurations, analyze cam dynamics, and applications in mechanical systems.
- Examine the characteristics of different types of governors to understand their role in speed regulation and system stability.
- Learn and apply principles of static and dynamic balancing to minimize vibrations in rotating systems.
- Understand the principles and practical implications of gyroscopic effects in mechanical systems.

LIST OF EXPERIMENTS:

1. Study various types of cam & follower mechanisms.
2. Study the follower displacement versus cam rotation for various cam follower mechanisms.
3. Study the profile and stroke/lift of a cam & follower mechanism.
4. Study the jumping phenomena of cam & follower mechanism.
5. Study of the performance characteristics of a simple Watt governor.
6. Study of the performance characteristics of a Porter governor.
7. Study of the performance of Proell governor.
8. Study of the performance of Hartnell governor.
9. Study of a dynamic/static balancing machine for rotor.
10. Study of gyroscopic effects on a disc.

REFERENCE BOOKS:

1. Theory of Machines and Mechanisms by Ghosh & Malik (Oxford University Press).
2. Theory of Machines by S. S. Rattan (McGraw Hill Education).
3. Engineering Mechanics: Dynamics by J. L. Meriam, L. G. Kraige (Wiley India).

COURSE OUTCOMES (COs):

CO1	Analyze the kinematic behavior of cam and follower mechanism.
CO2	Analyze the dynamic behavior of cam and follower mechanism.
CO3	Analyze and contrast the performance characteristics of different types of governors through experimental testing and data analysis.
CO4	Demonstrate the gyroscopic couple and precessional motion phenomena through experimental observation and analysis.
CO5	Operate a dynamic balancing machine to balance rotors.

ME-535	Mechatronics Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in sensor calibration, actuator performance analysis, and data acquisition system configuration using software tools like LabVIEW or MATLAB. Students will develop microcontroller programs for simple applications, study industrial automation components such as robotic manipulators and conveyor systems, and design hydraulic and pneumatic circuits for motion control. The course integrates mechanical, electrical, and control systems to enhance practical understanding of mechatronics applications.

COURSE OBJECTIVES:

- To calibrate and verify the accuracy of various sensors, including temperature, pressure, and light sensors.
- To analyze the performance characteristics of actuators such as DC motors, servo motors, and solenoid valves.
- To configure data acquisition systems and interface sensors and actuators using software tools.
- To develop microcontroller programs for basic automation tasks.
- To study and identify key components of industrial mechatronics, including robotic manipulators and conveyor systems.
- To design and implement hydraulic and pneumatic control circuits for motion control applications.

LIST OF EXPERIMENTS:

1. To calibrate different types of sensors (e.g., temperature, pressure, light) using calibration standards and verify their accuracy.
2. To measure the performance characteristics of actuators (e.g., DC motors, servo motors, solenoid valves) including speed, torque, and response time.
3. To configure a data acquisition system to interface with sensors and actuators and collect data using software tools such as LabVIEW or MATLAB.
4. To develop the Program different Micro controllers for simple applications.
5. To study & operate the Production line conveyor & Identify the different components of mechatronics.
6. To study the Robotic Manipulator& Identify the different components of mechatronics.
7. To study the operation of directional control valves (e.g., spool valves, poppet valves) by controlling the direction of fluid flow and actuating hydraulic cylinders in different directions.
8. To design and implement hydraulic circuits for various applications such as actuating cylinders, controlling pneumatic grippers, and sequencing operations using control valves.
9. To study the operation of directional control valves (e.g., spool valves, poppet valves) by controlling the direction of air flow and actuating hydraulic cylinders in different directions.
10. To design and implement pneumatic circuits for various applications such as actuating cylinders, controlling pneumatic grippers, and sequencing operations using control valves.

REFERENCE BOOKS:

1. W. Bolton, 'Mechatronics', Pearson Education New Delhi.
2. N P Mahalik, 'Mechatronics Principle, concept & Application, ' Tata McGraw-Hill, New Delhi.

COURSE OUTCOMES (COs):

CO1	Will be able to understand the working of different sensors.
CO2	Will be able to develop Program of different Microcontrollers.
CO3	Will be able to understand the application of PLC & develop ladder Program.
CO4	Will be able to develop the pneumatic circuits for different applications.
CO5	Will be able to develop the Hydraulic circuits for different applications.

SIXTH SEMESTER

Course Details:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
VI SEMESTER	1	ME-601	Computer Aided Manufacturing	PC	3	2	1	0	3
	2	ME-602	Design of Mechanical System	PC	3	2	1	0	3
	3	ME-603	Operations Research	CBCS	4	3	1	0	4
	4	ME-604	Refrigeration and Air Conditioning	PC	3	2	1	0	3
	5	ME-605	Turbo Machines	PC	3	2	1	0	3
	i	ME-631	Computer Aided Manufacturing Laboratory	PC Lab	1	0	0	2	2
	ii	ME-632	Refrigeration and Air Conditioning Laboratory	PC Lab	1	0	0	2	2
	iii	ME-633	Design of Mechanical Systems Practice Laboratory	PC Lab	1	0	0	2	2
	iv	ME-634	Turbo Machines Laboratory	PC Lab	1	0	0	2	2
	v	ME-635	Industrial Training	Audit					
				Total	**20**	**11**	**5**	**8**	**24**

ME-601	Computer Aided Manufacturing	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

Computer-Aided Manufacturing, often abbreviated as CAM, is a technology-driven process that uses computer software and machinery to facilitate and automate manufacturing processes. Employed in various industries, CAM enables the translation of computer-aided design (CAD) into manufacturing instructions for computer numerical control (CNC) machines. Computer-aided manufacturing (CAM) has become mainstay in today's industry. Therefore, they should be an important part in the current teaching plan of the graduate Mechanical engineers.

COURSE OBJECTIVES:

Computer aided manufacturing is an interdisciplinary subject area. This course tries to build fundamentals and working knowledge of the subject.

PREREQUISITES:

- Production Engineering
- Computer Aided Design
- Fundamental of Computers

CONTENT:

Unit I	Introduction: Overview of automation in industry. Type of production: continuous, mass, batch and job shop and automation achievements therein. Concept of computer aided engineering. Product cycle and CAD/, CAM influence CAD/CAM on product cycle. Computer Aided Process Planning (CAPP), Material requirement planning (M.R.P) Numerical Control: History of NC/CNC Machines. Numerical control and its basics. Coordinate system of NC machines Axis designation. NC motion control systems: point-to-point, straight-cut and continuous path control systems. Applications of NC in metal-cutting and non-metal cutting areas.
Unit II	Computer numerical control: devices, drives and control circuits, PLCs, Block diagrams of CNC operations. Nomenclature, types and features of CNC machine tools. Elements of CNC machines and systems. Machine control unit. Position control and its significance. Engineering analysis of NC positioning systems. Open loop and closed loop systems. Precision in NC positioning systems: control resolution, accuracy and repeatability. Actuators: DC servomotor, ac servomotor, stepper motor. Transducers and feedback elements: resolvers, inductosyns optical grating and encoders.
Unit III	Part programming: Introduction to Process planning and flow chart for part programming. Tooling systems, tool nomenclature and tool geometries of modern indexable carbide tools. Tool presetting& Modular Tooling. Selection of tools based on machining capacity, accuracy and surface finish. Elements of programming for turning and milling. NC code generation Preparatory codes G, Miscellaneous functions M. Interpolation, Tool compensations, cycles for simplifying programming. Part programming for typical components on turning machines and machining centres. Computer aided programming: APT Part Programming. Introduction to computer aided programming through Pro-E.
Unit IV	Modern CNC machines: CNC lathes. Turning centres. Machining centres. Automatic pallet changers. Automatic tool changers. Direct numerical control and applications.

	CNC machine design features. Supporting structures. Guide ways. Ball screw-and-nut mechanisms. Machine spindles. Concept of rigidity and relation with accuracy. Computer aided Inspection: Contact and non-contact sensing technologies, Introduction to machine vision and applications of optical inspection, Coordinate measuring machines and their applications.
Unit V	Manufacturing Automation: Automation strategies, devices, drives and control circuits in automation, performances and analysis of manufacturing system. Fundamentals of Group technology (G.T), Material handling system: conveyors – AGVs, Industrial robots, Basics of FMS and CIM.

TEXTBOOKS:

1. Automation Production System and Integrated Manufacturing, Grover M. P., Prentice Hall of India, New Delhi.
2. CAD/CAM Principle and Application, PN Rao, Tata McGraw Hill Publishing Co. Ltd, New Delhi.

REFERENCE BOOKS:

1. Computer Integrated Design and Manufacturing, David D. Bedworth, McGraw Hill Inc. Singapore.
2. CAD/CAM, Grover M.P, "Prentice Hall of India, New Delhi.

Computer Usage / Software required:
CNC MILLING and CNC TURNING, MASTER CAM Package

COURSE OUTCOMES (COs):

CO1	Will be able to understand and classify various production systems and suggest suitable system for different product.
CO2	Will be able to understand the systems for CNC and DNC.
CO3	Will be able to prepare a process plan for a given product and generate an NC code.
CO4	Will be able to recommend the CAI schemes using optical CMM for given application.
CO5	Will be able to perform CAPP, MRP and understand the working of different material handling systems.

ME-602	Design of Mechanical System	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course focuses on the design and analysis of mechanical power transmission components, including shafts, bearings, and gears. It covers stress analysis, failure mechanisms, fatigue considerations, and design calculations for shafts and couplings. Bearings, including rolling and sliding elements, are explored with emphasis on lubrication, heat transfer, load capacities, and selection criteria. Power transmission systems such as belt and chain drives are examined, including strength, velocity ratio, and material selection. The course also addresses gear design, failure modes, force analysis, and considerations for spur gears, including static and dynamic loads. Additionally, it covers gear drives, gearbox design principles, lubrication, and efficiency.

COURSE OBJECTIVES:

- Reinforce the philosophy that real engineering design problems are open-ended.
- Give practice in longer open-ended problems using design methodology Give practice in longer open-ended problems using design methodology
- Broaden skills in teamwork, critical thinking, communication, planning and scheduling through design project

PREREQUISITES:

- Design of Mechanical Components
- Mechanics of Solids
- Theory of Machines

CONTENT:

Unit I	Shafts: Stresses in shaft, kinds and causes of failure in shafts. Design calculation for strength and deflection. Design of short and line shafts. Fatigue consideration. Types of couplings. Design of muff and flange coupling. Materials for shafts.
Unit II	Bearings: Rolling and sliding elements. Nomenclature of journal bearing. Lubrication in loaded journal. Non-dimensional characteristic numbers and their application in design. Heat generation transfer in journal bearing. Thrust bearings. Ball and roller bearings. Types of roller bearing types of ball bearing. Friction in following contact bearings. Equivalent static Load, basic static and dynamic load capacities. Life and selection of roller bearing
Unit III	Power Transmission Systems: Types of drives. Comparison. Mechanical drives and their characteristics. Belt drives and types. Design of belts for strength. Theory and design of belt drives. Velocity ratio. Flat belts. V-belts. Selection of belts and belt materials. Surface strength and against bending. Design o chain drives.
Unit IV	Gear: Types of gears. Modes of gear failures. Force analysis for gears. Design of spur gear based upon contact stress. Beam strength of gear teeth. Lewis form factor and other factors affecting design of gear. Dynamic and static tooth load considerations. Design of spur gears based upon wear. Gear materials.
Unit V	Design of Gear Drives: Introduction to Gear box, Structural Diagram, Sliding-Mesh Gearing. Design calculation for spur gear (Straight tooth and inclined tooth) reducers. Materials for gears standards for spur gears. Lubrication & efficiency of a gear drive.

TEXTBOOKS:

1. Mechanical Engineering. Design by J.E. Shigley, C.R. Mischke, McGraw HI Book Co.
2. Fundamentals of Machine Component Design by R.C. Juvinall, John Wiley &Sons.

REFERENCE BOOKS:

1. Design of Machines Elements by M.F. Spotts, Prentice Hall of India.
2. Machine Elements by V. Dobrovolsky, MIR Publishers,
3. Machine Design by Black and Adams, McGraw-Hill Book co.
4. Machine Component Design by William Orthwein, Jaico Publishing House.
5. Machine Design by A. Mubeen, Khanna Publication

Computer Usage / Software required:
Pro/E, CATIA, ANSYS

Other details regarding this course:
Mini projects as assignments for improving the practice of design of mechanical system should be done.

COURSE OUTCOMES (COs):

CO1	Will be able to design shafts and mechanical couplings.
CO2	Wil be able to select and design rolling contact bearings and sliding contact bearings.
CO3	Will be able to design power transmission systems like belt and chain drives.
CO4	Will be able to design spur gears for transmitting power.
CO5	Will be able to design gear trains using spur and helical gears.

ME-603	Operations Research	HSMC (OEC-I)	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course covers the fundamentals of Operations Research, including linear optimization, queuing theory, transportation and assignment problems, simulation techniques, and decision theory. It explores network models like CPM and PERT for project management, along with optimization software tools and industrial applications.

COURSE OBJECTIVES:

1. Introduction to operational research and its general methodology. Problem formulation and solution with graphical methods.
2. Understanding the simplex algorithm and its application in simple situations
3. Understanding the queuing system and concepts with basic numerical. Transportation and assignment model solutions
4. Introduction to simulation and its applications Decision making under uncertainty
5. Learning the basic knowledge of network development and project management with Project time management using CPM & PERT

PREREQUISITES:

- Mathematics I, II, and III

CONTENT:

Unit I	Introduction: Nature and development of operations research, general methodology of OR; applications of OR to industrial problems. Formulation of linear programming; deterministic models Linear Optimization Models: Graphical solutions. Introduction to LINDO, LINGO and related software for solving optimisation problems.
Unit II	Simplex algorithm, computational procedure in simplex, duality and its concept. Application of elementary sensitivity analysis Application of Linear Programming. Applications of simplex technique
Unit III	Queuing Problems: Queuing systems and concepts; classification of queuing situations; Kendall's notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time; applications to industrial problems. Transportation problems; methods for obtaining the solution, degeneracy in transportation problems. Stepping stone method. Trans-shipment problems. Assignment problems.
Unit IV	Simulation: Introduction, reasons for using simulation, limitations of simulation. Steps in simulation process. Application of simulation. Computer simulation. Monte Carlo simulation. Sequencing, n jobs two stations, two jobs n stations and graphical method. Decision theory.
Unit V	Network development, Gantt chart. Project Critical path scheduling, construction of a CPM network, the critical path. Float calculations. Project Evaluation and Review Technique and its calculations, Network applications in operations management. Project crashing and resource allocation. Newer Network methods. Mathematics I, II and III

TEXTBOOKS:

1. Operations Research – Introduction, Taha, H.A., Pearson Education, India.

REFERENCE BOOKS:

1. Quantitative Techniques for Decision Making, Gupta M P, Prentice Hall of India.
2. Introduction to Operations Research by Hillier and Lieberman, Tata McGraw Hill, India.

Computer Usage / Software required:

MS Project 2000 (and Prima Vera), Operation research software like LINDO, LINGO, SOLVER SUIT, EXCEL etc.

COURSE OUTCOMES (COs):

CO1	Will be able to identify and develop operational research models from the verbal description of the real system.
CO2	Will be able to understand the mathematical tools that are needed to solve Linear programming problem, transportation problem, and assignment problems.
CO3	Will be able to understand the basic concepts of goal programming and queuing theory for different applications.
CO4	Will be able to use mathematical tools/software to solve the simulation models.
CO5	Will be able to understand network development and project management technique.

ME-604	Refrigeration and Air Conditioning	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers refrigeration and air-conditioning principles, including the second law interpretation, vapor compression cycles, and compound compression systems. It explores refrigerants, absorption refrigeration, and cascade systems. Key refrigeration equipment such as evaporators, condensers, compressors, and expansion devices are studied, along with cooling towers and water treatment. Air-conditioning topics include psychrometry, comfort conditions, cooling load calculations, system design, and ductwork.

COURSE OBJECTIVES:

- Clear all concepts of Refrigeration Cycles
- Clear all concepts of Heating, Ventilation and Air-conditioning systems and cycles
- Introduce to Green, Intelligent Buildings
- Train students to work as an HVAC Engineer

PREREQUISITES:

- Thermodynamics
- Heat Transfer
- Fluid Mechanics

CONTENT:

Unit I	The second law interpretation, Vapour compression cycle. Actual vapor compression cycle. Effect of Super Heating, the suction vapour, super-heating with useful cooling and super-heating, Liquid-Suction heat exchanger, removal Flash gas, Inter-cooling, Compound Compression with water inter-cooling, Compound Compression with liquid flash cooler. Combination of multiple components in compound compression systems, Cascade systems.
Unit II	Refrigerants: classification of refrigerants, Designation of refrigerants, Selection of refrigerant, required properties of an ideal refrigerant, Secondary refrigerants, Brine. Absorption Refrigeration System: Simple vapour absorption system, Co-efficient of Performance of absorption systems. Lithium -Bromide- Absorption refrigeration system, Brief Study of Domestic Refrigerators, Solar Refrigeration, Reversed Brayton cycle. Spray Ponds and cooling towers, and water treatment plant.
Unit III	Refrigeration Equipment: Evaporators: flooded evaporators, liquid chiller, direct expansion coil, Heat transfer during boiling. Fluid side heat transfer, Overall performance. Condenser: Air cooled condensers, water cooled condensers, heat transfer in condensers, Fouling Factor, water side co-efficient, superheating, Finned tubes air cooled and evaporative condenser. Expansion Devices: Automatic or constant pressure expansion valve, thermostatic Expansion valves. Capillary tube and its sizing. Types of Compressors, Selection of Compressors for Refrigeration systems.

Unit IV	Air-conditioning: Psychrometry, Definition of Psychometric properties, Psychrometric relations, Psychrometric chart, Psychrometric processes, Thermodynamic wet bulb temperature, Calculation of air properties, Summer air-conditioning system for hot and dry outdoor conditions and for hot and humid air conditions, winter air-conditioning system, Year round air-conditioning system.
Unit V	Requirement of comfort air Air-conditioning: Effective temperature economic consideration for selecting the comfort point, Cooling load calculation; sum load, Load from occupants, equipment load, Infiltration air load, fan load, fresh air Load. Design of air-conditioning systems, Cooling load and air quantities, Central air-conditioning system, and unitary air-conditioning system, Comfort indices, Control, Duct design

TEXTBOOKS:

1. Refrigeration and Air-conditioning by C.P. Arora, McGraw-Hill.

REFERENCE BOOKS:

1. Fundamental of Refrigeration by Dossat – McGraw Hill
2. Refrigeration and Air-conditioning by P.L. Ballaney, Khanna. Publication

Computer Usage / Software required:

Students can be introduced to basic simulation software such as Fluent; HEVACOMP, Primavera, and other CFD modelling techniques.

Other details regarding this course (if any):

HVAC is a big industry & student has prospects of becoming Design Engineer; Site Engineer; Procurement Engineer; Project Engineer etc.

COURSE OUTCOMES (COs):

CO1	Will be able to understand the working of different refrigerating machine and multi pressure systems.
CO2	Will be able to select suitable refrigerant for different refrigerating systems.
CO3	Will be able to analyze various refrigeration equipment like condenser, compressor etc.
CO4	Will be able to carry out the determination of air properties for different seasonal requirements.
CO5	Will be able to determine the performance parameter for achieving comfort air conditioning.

ME-605	Turbo Machines	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers the principles and analysis of turbomachinery, including hydraulic turbines, pumps, compressors, fans, blowers, and gas turbines. It explores velocity triangles, efficiency, performance characteristics, losses, cavitation, and propulsion systems. The course also introduces unconventional turbomachines like wind and solar turbines.

COURSE OBJECTIVES:

To provide basic understanding of working and associated principles of Turbo Machines. This includes turbines, compressors, pumps, blowers, fans and other associated devices.

PREREQUISITES:

- Fluid Mechanics –I and II,
- Applied Thermodynamics

CONTENT:

Unit I	**Fundamentals of Turbomachines:** Introduction, fluid machines, turbomachines, classification of turbomachines, basic laws and equations, Euler's equation for a turbomachine, velocity triangles, slip, steady flow energy equation, degree of reaction, impact of jets, aerodynamics of turbomachinery blading, losses in turbomachines. Dimensional Analysis and Model Testing: Buckingham's π theorem, significant dimensionless groups in turbomachinery, incompressible and compressible flow turbomachines, flow similarity and model studies, specific speed, unit quantities, thermodynamics of fluid flow; stagnation and static properties, problems.
Unit II	**Hydraulic Turbines:** Introduction, schematic layout of a hydro-electric power plant, Euler's equation for hydro-turbines, efficiencies of hydraulic turbine, classification of hydraulic turbines; impulse and reaction turbines, working and analysis of Pelton, Francis, Kaplan and Propeller turbines, draft tube, specific speed, cavitation in turbines, performance characteristics of turbines, governing of turbines, comparison of turbines, selection of hydraulic turbines, problems.
Unit III	**Hydraulic Pumps:** Introduction, classification, centrifugal pump; working, priming, head developed, losses and efficiencies, theoretical head vs. discharge curve, velocity triangles, slip, effect of blade outlet angle on head vs. discharge characteristics, specific speed, performance characteristics, net positive suction head (NPSH) and cavitation, pumps in series and parallel, problems, axial flow pump; working principle, performance characteristics, centrifugal vs. axial flow pumps.
Unit IV	**Compressors, Fans and Blowers:** Introduction, classification, centrifugal compressor; working principle, velocity triangles, slip factor, power input factor, specific work and pressure rise, losses and efficiencies, T-s diagram, non-dimensional quantities, performance characteristics, surging, choking and rotating stall, problems. axial flow compressor; description and principle of operation, stage velocity triangles, losses and efficiencies, T-s/h-s diagram, pressure ratio per stage, work done factor, flow coefficient, degree of reaction, performance characteristics, centrifugal vs. axial flow compressors, problems. Fans and Blowers; terminology, difference between a fan, blower and a compressor, classification, velocity triangles, losses, performance characteristics.

Unit V	**Gas Turbines:** Introduction, Joule-Brayton cycle, classification; axial and radial flow turbines, velocity triangles and T-s diagram, performance characteristics, propulsive devices; turbojet, turboprop, bypass turbojet engines, thrust augmentation, problems. Unconventional Turbomachines: wind turbines, solar turbines etc.

TEXTBOOKS:

1. Shepherd, D. G., Principles of Turbomachinery, Macmillan.

REFERENCE BOOKS:

1. Cherkassky, V. M., Pumps, Fans and Compressors, Mir Publishers,
2. Yahya, S. M., Turbines, Fans and Compressors,
3. Douglas, J.F., Gasiorek, J.M., Swaffield, J.A., and Jack, L.B., Fluid Mechanics, Pearson Education, Ltd.
4. Sayers, A.T., Hydraulic and Compressible Flow Turbo machines, McGraw Hill, 1990.
5. Saravanamuttoo, HIH. Cohen, H., Rogers, GFC. Gas Turbine Theory, Pearson Education, Ltd.
6. Wright, T., Fluid Machinery: Performance, Analysis and Design, CRC Press,
7. Lefevre, A. H., Gas Turbine Combustion, Taylors & Francis

Computer Usage / Software required: MATLAB, EXCEL, EES, Fluent, STAR-CD etc.

COURSE OUTCOMES (COs):

CO1	Will be able to carry out dimensional analysis and model testing for different turbo machines.
CO2	Will be able to analysis the performance of various hydraulic machines and will be able to carry out selection of hydraulic turbines for specific applications.
CO3	Will be able to analyze the performance characteristics of hydraulic pumps.
CO4	Will be able to analyze the performance characteristics of compressors, fans and blowers.
CO5	Will be able to conduct performance analysis of gas turbine and other propulsive devices.

ME-631	Computer Aided Manufacturing Lab	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in computer-integrated manufacturing, focusing on CNC machining, PLCs, industrial robotics, and automated material handling. Students will study the layout and components of CIM, understand the operations of CNC lathe, milling, and wire-cut EDM machines, and develop CNC programs. The course also covers industrial automation, including PLC-controlled systems, robotic applications, and material handling technologies such as AGVs and automated storage and retrieval systems.

COURSE OBJECTIVES:

- Understand the components, layout, and functions of CIM systems, CNC machines, and PLCs.
- Develop and simulate CNC programs for various machining operations.
- Explore industrial automation technologies including robots, AGVs, conveyors, and AS/RS.

LIST OF EXPERIMENTS:

1. To study the layout and components of CIM.
2. To study specifications, components and operations of a CNC Lathe machine.
3. To study specifications, components and operations of a CNC Milling machine.
4. To study specifications, components and operations of a CNC Wire-Cut EDM machine.
5. To study specifications, components and operations of a PLC.
6. To study Point-To-Point control system by drilling a set of holes in given metal plate using CNC Milling Machine.
7. To study Straight cut control system by pocket milling in given workpiece using CNC Milling Machine.
8. To study Contouring control system by cutting a slot of given contour in given metal plate using CNC Milling Machine.
9. To make a component on a CNC Lathe machine.
10. To make and simulate CNC program.
11. To study specifications, configuration and operation of an Industrial Robots.
12. To study various types of material handling equipment such as conveyors, AGV etc.
13. To study Automated Storage and Retrieval System.

REFERENCE BOOKS:

1. Heat and Mass Transfer by P.K. Nag (McGraw Hill Education).
2. Fundamentals of Heat and Mass Transfer by Frank P. Incropera and David P. DeWitt (Wiley).

COURSE OUTCOMES (COs):

CO1	Will be able to apply computer-aided technologies such as CAD, CAM, CNC, PLC, Robots, AS/RS for efficient and accurate manufacturing processes.
CO2	Will be able to develop and simulate machining programs for various CNC.
CO3	Machines using CAM software package.

CO4	Will be able to execute machining programs for various CNC machines using software package and verify the accuracy and quality of the machined parts.
CO5	Will be able to verify the accuracy and quality of the machined parts made on various CNC machines.

ME-632	Refrigeration and Air Conditioning Lab	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in refrigeration and air-conditioning systems, covering fundamental concepts, components, and performance analysis. Students will conduct experiments on vapor compression cycles, heat pumps, cooling towers, air coolers, and dehumidifiers. The course includes practical exercises such as copper piping techniques, psychrometric analysis, and energy recovery ventilation to enhance understanding of system efficiency and performance evaluation.

COURSE OBJECTIVES:

- To understand the working principles, components, and performance parameters of refrigeration and air-conditioning systems.
- To analyze the effects of load variation, energy balance, and efficiency in refrigeration and heat pump systems.
- To perform fundamental processes in refrigeration systems, including copper piping, flaring, soldering, bending, and pressure testing.
- To study different types of valves used in refrigeration and air-conditioning applications.
- To examine the operation and performance of cooling towers, air coolers, and dehumidifiers under varying conditions.
- To conduct psychrometric analysis of air-conditioning processes, including air mixing, heating, humidification, and energy recovery ventilation.
- To evaluate energy consumption, efficiency improvements, and sustainability aspects of refrigeration and air-conditioning systems.

LIST OF EXPERIMENTS:

1. To understand the working of Vapor Compression unit, its components, find the effect of load variation on evaporator, condenser pressure, work of compression condenser water circulation rate and make Energy balance analysis.
2. To conduct experiment for the analysis if Heat Pump and energy consumption.
3. To perform simple processes used in Copper piping like flaring, cutting, soldering, bending at different angles and pressure testing applied in refrigeration systems.
4. To study various type of valve used in air-conditioning and refrigeration industries distinguish in it application.
5. To understand a Cooling Tower Set up, working and perform tests to analyze the effect of inlet water temperature air circulation and variation in its performance.
6. To Conduct experiment on Air Coolers and understand humidifying efficiency, Adiabatic Humidification process. Find the effect of water Circulation.
7. To understand DBT, WBT, DPT and conduct experiment on mixing of air, Sensible heating, Humidification in air conditioning Tet rig and do its Psychrometric analysis.
8. To work on the Energy Recovery Ventilation system (ERV) and understand the use of power saving in 100% Fresh Air- Circulation. Also Calculate the Pay Back Period for application where it is utilized.
9. To Study the components and understand the Ejector Refrigeration System.
10. To study a Dehumidifier and its use.

REFERENCE BOOKS:

1. Refrigeration and Air-conditioning by C.P. Arora, McGraw-Hill.
2. Fundamental of Refrigeration by Dossat – McGraw Hill
3. Refrigeration and Air-conditioning by P.L. Ballaney, Khanna. Publication

COURSE OUTCOMES (COs):

CO1	Will be able to analyze Vapor Compression System and Heat Pump.
CO2	Will be able identify the application of various valves in Refrigeration systems.
CO3	Will be able to carry out the analysis of Air Cooler and Cooling Tower.
CO4	Perform and analyze Comfort Air-Conditioning, Energy saving in systems.
CO5	Will be able to understand the applications of new technologies like Ejector refrigeration and Dehumidifier.

ME-633	Design of Mechanical Systems Practice Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course focuses on the design and analysis of machine components using strength criteria, ASME codes, and industry standards. Students will design shafts, couplings, bearings, belt and chain drives, and spur gears while applying analytical and simulation techniques. The course also includes gear train design, load-life calculations, and case studies on real-world mechanical systems using simulation software.

COURSE OBJECTIVES:

- To design shafts, couplings, and bearings based on strength criteria and industry standards.
- To analyze and select suitable belt, chain, and gear drives for mechanical power transmission.
- To apply AGMA standards and Buckingham's equation for spur gear design and evaluate performance.
- To develop and simulate gearboxes, mechanical systems, and machine components using software tools.
- To conduct case studies on real-world mechanical systems such as transmissions, conveyor systems, and suspensions using simulation techniques.

LIST OF EXPERIMENTS:

1. Design of shaft using strength criteria and ASME CODE.
2. Design of Rigid and Flexible Couples for Transmission Shaft
3. Load and Life calculations for Ball and Roller Bearing, Selection of RCB
4. Design of Sliding Contact Bearings
5. Design Problems on:
    i) Flat Belt Drives
    ii) V Beld Drives
    iii) Chain Drives
6. Design of Spur Gear using Bending strength and surface strength Criteria. AGMA design of Spur Gears
7. Design of Spur gears using Buckingham equation.
8. Design of Sliding Mesh Gear Box using simulation software
9. Anatomy of Mechanical System using Simulation software, e.g. Fusion 360
10. Group Case studies on Mechanical Systems, e.g., automobile suspensions, automatic transmissions, material conveyor systems, construction machinery, etc, using simulation.

REFERENCE BOOKS:

1. Mechanical Engineering. Design by J.E. Shigley, C.R. Mischke, McGraw HI Book Co.
2. Fundamentals of Machine Component Design by R.C. Juvinall, John Wiley &Sons.

COURSE OUTCOMES (COs):

CO1	Will be able to carry out the design of shaft and flexible couplings.
CO2	Will be able to design Rolling and Sliding Contact bearings.
CO3	Will be able to design and belt and chain under different applications.
CO4	Will be able to design and analyse Spur gears.

CO5	Will be able to Gear Drives and analyze the anatomy of machines and case studies of mechanical systems.

ME-634	Turbo Machines Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:
This laboratory course provides hands-on experience in analyzing fluid flow behavior and studying hydraulic machines. Students will investigate flow characteristics, pressure distribution, and drag forces in air and water, as well as perform experiments on turbines and pumps to evaluate their performance. The course emphasizes practical applications of fluid mechanics principles, including continuity, momentum, and energy equations.

COURSE OBJECTIVES:

- To understand the application of basic fluid flows in various fluid machines.
- To apply the principle of instrumentation and measurement in various fluid machines.
- To conduct the performance measurement of fluid machines, e.g. turbines, pumps, compressor, etc.

LIST OF EXPERIMENTS:

1. To study the mean flow characteristics of a free air jet and to study the application of the integral form of the continuity, momentum and energy equations.
2. To determine the drag force on a circular cylinder placed in a uniform stream of air.
3. To draw pressure distribution around a circular cylinder for laminar and turbulent flows and identify the point of flow separation and recirculation zone.
4. To study the Pelton turbine and perform experiment to draw its operating characteristics curve.
5. To study the Kaplan turbine and perform experiment to draw its operating characteristics curve.
6. To study the Centrifugal pump and perform experiment to draw its operating characteristics curve.

REFERENCE BOOKS:

1. Shepherd, D. G., Principles of Turbomachinery, Macmillan.
2. REFERENCE BOOKS:
3. Cherkassky, V. M., Pumps, Fans and Compressors, Mir Publishers,
4. Yahya, S. M., Turbines, Fans and Compressors,
5. Douglas, J.F., Gasiorek, J.M., Swaffield, J.A., and Jack, L.B., Fluid Mechanics, Pearson Education, Ltd.

COURSE OUTCOMES (COs):

CO1	Will be able to determine the mean flow characteristics of a free air jet and will be able to interpret the integral form of the continuity, momentum and energy equations.
CO2	Will be able to determine the drag force on a circular cylinder placed in a uniform stream of air.
CO3	Will be able to draw pressure distribution around a circular cylinder for laminar and turbulent flows and identify the point of flow separation and recirculation zone.
CO4	Will be able to experimentally determine the operating characteristics of Pelton and Kaplan turbine.

CO5	Will be able to experimentally determine the operating characteristics Centrifugal pump.

SEVENTH SEMESTER

Course Details:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
VII SEMESTER	1	ME-701	Mechanical Vibrations	PC	3	2	1	0	3
	2	ME-702	Industrial Engineering	PC	3	2	1	0	3
	3	ME-703	Automobile Engineering	PC	3	2	1	0	3
	4	ME-715	Program Elective I (Thermal & Fluid) (Separate list of elective courses attached)	PE	3	2	1	0	3
	i	ME-731	Automobile Engineering and IC Engine Laboratory	PC Lab	1	0	0	2	2
	ii	ME-732	Industrial Engineering Laboratory	PC Lab	1	0	0	2	2
	iii	ME-733	Mechanical Vibrations Laboratory	PC Lab	1	0	0	2	2
	iv	ME-734	Solar Energy Laboratory	PC Lab	1	0	0	2	2
	v	ME-735	Project-I	Project Work	5	0	0	10	10
				Total	**21**	**8**	**4**	**18**	**30**

ME-701	Mechanical Vibrations	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers the fundamentals of vibrations in mechanical systems, including free and forced vibrations of single, two, and multi-degree-of-freedom systems. It explores damping effects, response under harmonic forces, vibration absorbers, and modal analysis. The course also introduces approximate methods for natural frequency determination and studies vibrations in continuous systems, including beams, shafts, and strings.

COURSE OBJECTIVES:

- Understand undamped SDOF systems and its relation to a vibrating system
- Understand Damped SDOF systems-viscous (underdamped, critically damped and overdamped) and coulomb friction, their differences and relation to real world
- Understand Forced Motion due to harmonic loading and rotating unbalance
- Understand the concept of lumped parameter analysis to represent a system as a set of masses, springs and dampers to evaluate the vibration characteristics of the system.

PREREQUISITES:

- Theory of Machines
- Machine Dynamics
- Engineering Mathematics

CONTENT:

Unit I	**Free vibrations of single degree of freedom systems**: Importance of the study of vibration, basic concepts of vibration, classification of vibration, vibration analysis procedure, free vibrations of undamped and damped, translational & torsional, single degree of freedom systems, derivation and solution of equations of motion using different methods. free vibration with viscous damping, coulomb damping and hysteretic damping.
Unit II	**Forced vibrations of single degree of freedom systems**: response of an undamped system under harmonic force, response of a damped system under harmonic force, response of a system under the harmonic motion of the base, response of a damped system under rotating unbalance, transfer-function approach, solutions using Laplace Transforms.
Unit III	**Free and forced vibrations of two degree of freedom systems**: Derivation and solution of equations of motion using different methods, Free& forced Vibration Analysis of damped and undamped System, Coordinate Coupling and Principal Coordinates, Semi-definite Systems, vibration absorbers.
Unit IV	**Free and forced vibrations of multi degree of freedom systems**: Modeling of continuous systems as multi-degree of freedom systems, derivation of equations of motion using influence coefficients, Lagrange’s equations, generalized coordinates and generalized forces, Eigenvalue problem, solution of the eigenvalue problem, free vibration of undamped systems, forced vibration of undamped systems using modal analysis.

Unit V	**Approximate methods for determination of natural frequency of multi degree of freedom systems**: Dunkerley's Method, Rayleigh's Method, Holzer's Method, Matrix Iteration Method, Jacobi's Method, Standard Eigenvalue Problem. Simple cases of continuous systems: Transverse vibration of string, longitudinal vibration of bar, torsional vibration of shaft or rod, lateral vibration of beams. Whirling of shafts.

TEXTBOOKS:

1. Mechanical Vibrations (Sixth Edition in SI Units) by Singiresu S. Rao, Pearson Education, 2018.
2. Mechanical Vibrations by G.K. Grover, Nem Chand Bros. Roorkee.
3. Theory of Mechanisms & Machines by A. Ghosh & A. K. Mallik, EWP.

REFERENCE BOOKS:

1. Mechanical Vibrations, Theory and Applications by S. Graham Kelly, Cengage Learning.
2. Schaum's Outline of Theory and Problems of Mechanical Vibrations by S. Graham Kelly, McGraw Hill.
3. An Introductory course on Theory & Practice of Mechanical Vibrations by J.S. Rao & K. Gupta, Wiley Eastern Ltd.
4. Elements of Mechanical Vibrations by William P. Thomson Prentice Hall, India.

COURSE OUTCOMES (COs):

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

CO1	Formulate and solve equations of motion for free vibration of single degree of freedom systems, with and without damping.
CO2	Analyze the vibration response of a single degree of freedom system under different kinds of external excitation.
CO3	Formulate and solve equation of motion for two-degree of freedom system.
CO4	Model and solve equations of motion for multi-degree of freedom and simple continuous systems.
CO5	Design/select appropriate vibration sensors and control systems for specific engineering applications.

ME-702	Industrial Engineering	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course explores the contributions of industrial engineering to everyday life, covering production systems, innovation, problem-solving approaches, and productivity enhancement. It includes motion and time study techniques, process analysis, and work measurement methods. Inventory management, material handling, and supply chain concepts are introduced alongside quality control, acceptance sampling, and total quality management. The course emphasizes efficiency, cost reduction, and system optimization in manufacturing and service industries.

COURSE OBJECTIVES:

Industrial Engineering has evolved and established itself as a branch of engineering. A basic overview of different areas covered in this branch of engineering is provided.

PREREQUISITES:

- Operation Research
- Engineering Economy and Management.

CONTENT:

Unit I	Contribution of Industrial engineering in everyday life, Definition and scope of Industrial engineering, some historical developments. Production and production systems. Role of Innovation and disruptive innovation in development of industrial engineering. The general problem solving approach. Systems approach in problem identification and solving, brief of some other methods. Productivity, Manufacturing process technology and its relevance, site location and factors affecting site location. Plant location and capacity planning design and assembly line balancing.
Unit II	Motion and Time Study, definition, importance, limitations & historical background, Process Analysis through charts: Process chart, activity charts, man & machine charts and operation process charts. Motion study: Motion analysis, camera study, micro motion study, cyclograph and chronocyclograph. Fundamental hand motions. Principles of motion economy and human body, arrangement of workplace in respect of tools and equipment. Micro motion Study, SIMO Charts. Time Study: Stopwatch time study: Information recording, data recording by continuous, repetitive and cumulative timing, determining number of observations, the rating factor, performance rating, allowances determination, normal and standard time. Work sampling: theory, procedures, and applications. Synthetic time and introduction to predetermined times.
Unit III	Inventory: reasons of holding inventory, Inventory concepts, inventory costs and Inventory models assuming certainty. Inventory management. ABC and related analysis Inventory models with safety stock Material Requirement Planning (MRP) Introduction to Enterprise Resource Planning. Just in Time Systems Supply Chain Management and critical chain Material Handling & Reliability.
Unit IV	Quality: evolution of Quality concepts in industry, historical perspective, definition. Importance to services and manufacturing. Basic quality related concepts. Quality dimensions. Economics of quality, quality is free. Acceptance sampling plans by attributes, Operating Characteristic Curve, producing and consuming risks. Single, double and sequential sampling plans. Acceptance sampling by variables. Average outgoing quality. Limitations and importance of Sampling plans.

Unit V	Quality Management, Quality Circle. Quality Systems. Seven Quality control tools. Control charts for variables. Control chart for attributes. Total Quality Management I. Business Process Redesign and Breakthrough improvements.

TEXTBOOKS:

1. Motion and Time Study Design and Measurement of Work, Ralph M. Barnes, John Wiley & Sons. New York.
2. Introduction to Statistical Quality Control, Douglas C. Montgomery, John Wiley & Sons. New York.

REFERENCE BOOKS:

1. Martinich, Joseph S, "Production and Operations Management: An Applied Modern Approach," John Wiley, Re. Ed.

Computer Usage / Software required:
MS EXCEL and other Industrial Engineering Software.

Other details regarding this course
This course is predominantly important in industry and needs lots of industrial visits and awareness of what best practices are being followed.

COURSE OUTCOMES (COs):

CO1	Understand the fundamentals of Industrial Engineering, including its history, scope, production systems, and the role of innovation in enhancing productivity and problem-solving.
CO2	Apply motion and time study techniques to analyze and improve workflows, aiming for greater efficiency in production processes.
CO3	Implement inventory control and management strategies, including MRP, JIT, and supply chain management, to ensure effective resource planning and material handling.
CO4	Evaluate quality control and management practices, including sampling plans, quality tools, and cost-benefit analysis in manufacturing and services.
CO5	Apply advanced quality management concepts like TQM, Quality Circles, and process improvement methodologies to foster continuous improvement in industrial settings.

ME-703	Automobile Engineering	PCC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers the fundamental components of automobiles, including their composition, power unit, and general vehicle layout. It explores engine performance, turbocharging, supercharging, and multi-cylinder engine configurations. Topics include power requirements, tractive effort, vehicle performance, and gearbox types. Power transmission systems such as clutches, propeller shafts, differentials, and axles are examined. The course also delves into steering mechanisms, tyre specifications, suspension systems, and braking technologies, including disc, drum, and hydraulic brakes.

COURSE OBJECTIVES:

- To develop an understanding of basics of an automobile function.
- To make students competent enough to be absorbed in automobile industries.

PREREQUISITES:

- Thermodynamics
- Fluid Mechanics
- Heat and Mass Transfer

CONTENT:

Unit I	Components of Automobile and their compositions, Power unit, General layout of automotive vehicle, Engine performance characteristics, Turbo charging and supercharging, Multi cylinder engines and their arrangements, Firing order.
Unit II	Rolling, air or wind and gradient resistance, Power requirement, Matching of engine power with demand power, Tractive effort, Vehicle performance, Gear Box and types of Gear box, Relationship for two and four-wheel vehicles.
Unit III	Power transmission, Clutch and its types, Gear boxes—Sliding mesh, constant mesh, synchromesh and epicyclic arrangements, Propeller shaft, universal joint, Differential, Live axle, Floating and full floating axle system.
Unit IV	Steering system, steering geometry, Types of steering mechanisms: Ackerman steering mechanism, Davis steering mechanism, steering linkages, power steering. Tyres and its types, specifications and construction, tyres ground contact area, material and disposal of tyres.
Unit V	Suspension system, types of suspension system—Rigid axle suspension system, torsion bar, Independent suspension system, shock absorbers. Braking system, mechanical braking system, disc and drum brakes, hydraulic brakes, master cylinder, Brake fluid and its properties, Weight transfer during braking and stopping distances.

TEXTBOOKS:

1. The motor vehicle by K. Newton, W. Steeds and T. K. Garret, ESBS Publications.

REFERENCE BOOKS:

1. Automobile Engineering by G. B. S. Narang
2. Automotive Mechanics—Principles and practices by Heitner Joseph, East-West Press
3. Automobile Engineering, Kirpal Singh, Standard Publishers

4. Automotive Chassis, by P.L. Kohli, Papyrus publications
5. Auto mechanics, by Michell, McGraw Hill Publications.
6. Automobile Engineering by S K Gupta, S Chand publisher
7. Automobile Engineering by D S Kumar, S K Kataria and Sons.
8. Automotive Technology, Heinz and Hizler, ELBS Edition.

Computer Usage / Software required:
Relevant Industry software

Other details regarding this course
This course is of predominant importance in automobile engineering and its Indian perspective for Mechanical Engineering.

COURSE OUTCOMES (COs):

CO1	Get ability to apply knowledge of IC engine and automobile engine.
CO2	Conduct experiment analysis and interpret data from various experiment.
CO3	Enable the student to learn different type of fuel supply system, SI and CI engine with physical.
CO4	Bring them on theory of concept of torque convertors and automatic transmission.
CO5	Impart knowledge about mechanics of motors which creates power of propulsion.

ME-715	Non-Conventional energy Sources	PEC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course provides an overview of conventional and renewable energy sources, energy consumption trends, and the need for alternative energy. It covers the economics of energy, load curves, and electricity generation costs. Topics include steam power plants, hydroelectric power plants, and nuclear power generation, detailing their components, working principles, and environmental considerations. Renewable energy sources such as solar, wind, tidal, geothermal, ocean, and biomass energy are examined, including their technologies, site selection, and limitations. The course also explores energy conversion methods and waste-to-energy solutions.

COURSE OBJECTIVES:

- Understand and analyze various conventional and renewable energy systems and their technologies.
- Explore the economic and environmental implications of energy production and consumption.
- Assess the feasibility, design, and performance of energy conversion systems and technologies.

PREREQUISITES:

- Fluid Mechanics I & II, Applied Thermodynamics, A.T.H.T

CONTENT:

Unit I	Introduction: Sources of conventional and renewable energy, Trends of energy consumption, Fossil fuel availability and limitations, Need to develop new energy sources. Energy Economy. Various Terms and definitions, load curves, cost of electricity generation, performance and operating characteristics.
Unit II	Steam Power Plant: General layout of steam power plant, site selection, coal burning methods, disposal of ash and dust, combined cycle power plants, integrated coal gasification, major plant components: Super heaters, Re-heaters, Economizers, Air Pre-heaters condensers, cooling towers.
Unit III	Hydro-electric Power Plant: Classification, layout, components and auxiliaries of hydro power plant, Selection of turbines, micro hydro plants, pumped storage. Solar Energy: Solar radiation, characteristics and estimation, Solar Collectors, Flat Plate concentrating types; Their comparative study, Direct Conversion of Solar energy to electricity.
Unit IV	Principles of release of nuclear energy Fusion and fission reactions. Nuclear fuels used in the reactors. Nuclear Power Plants: Location, component of nuclear plants, Elements of the Nuclear reactor; Moderator, control rod, fuel rods, coolants. Description of reactors of the following types - Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards and Radioactive waste disposal.
Unit V	Wind Energy: Wind turbines and their characteristics; Types of rotors, horizontal axis and vertical axis systems, system design, site selection and Performance analysis. Tidal

	Energy: Sites, potentiality and possibility of harnessing from site, limitations. Geo-thermal Energy: Sites, potentiality and limitation, study of different conversion systems. Ocean Energy: Principle of utilization and its limitations, description of various systems. Biomass Systems: Biomass conversion – Combustion, gasification, Energy from waste and other sources.

TEXTBOOKS:

1. G.N. Tiwari & S. Suneja: Solar Thermal Energy Systems, Narosa Publishing House

REFERENCE BOOKS:

1. S.P. Sukhatme: Solar Energy – Principles of Thermal Collection & Storage, Tata McGraw Hill.
2. H.P. Garg: Advances in Solar Energy Technology, D. Reid Publishing House
3. A.N. Mathur and N.S. Rathore: Biogas Production, Management and Utilization, Himansu Publications.
4. K.C. Khandelwal& S.S. Mandi: Practical Hand Book of Biogas Technology

COURSE OUTCOMES (COs):

CO1	Will be able to conduct solar energy measurement and estimation of solar insulation availability.
CO2	Students will be able to analyze the different solar based thermal systems and their applications.
CO3	Will be able to conduct performance analysis and testing of biomass and wind energy system.
CO4	Will be able to analyze tidal, Geothermal and Ocean energy.
CO5	Will be able to determine the characteristics and potential of LFG plant and nuclear power plant.

ME-731	Automobile and IC Engines Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:
This laboratory course provides practical exposure to internal combustion (IC) engines and energy systems. Students will study engine components, fuel injection systems, and carburetors, along with performance evaluation through efficiency tests and energy balance analysis. The course also includes experiments on reciprocating air compressors and solar energy systems, emphasizing their operational characteristics and energy efficiency.

COURSE OBJECTIVES:

- To study the construction and working of internal combustion engine components, including valve timing diagrams.
- To analyze fuel injection systems and carburetors in SI and CI engines.
- To determine the mechanical efficiency and performance characteristics of diesel and petrol engines.
- To evaluate the performance of a two-stage reciprocating air compressor.
- To investigate the effect of tilt angle and radiation on solar cell power output and compare different solar cell technologies.

LIST OF EXPERIMENTS:

1. To study the various components of an I.C. Engine and to draw the valve timing diagram for 2-stroke engines.
2. To study the fuel pump and injector of a Diesel Engines.
3. To study the carburetor of an SI Engine.
4. To determine the mechanical efficiency of a Ruston Diesel engine by drawing Williams line and to plot the various curves
5. To determine the mechanical efficiency of a four stroke, 4- cylinder petrol engines by performance
6. Performance test on a kirlosker diesel engine
7. To draw the energy balance sheet for kirlosker diesel engine
8. Performance test on two stage reciprocating air compressor.
9. To study the effect of the tilt angle and radiation on the power output of solar cell
10. To compare polycrystalline and thin film solar cells

REFERENCE BOOKS:

1. The motor vehicle by K. Newton, W. Steeds and T. K. Garret, ESBS Publications.

2. Internal Combustion Engine by V. Ganesan; Tata McGraw Hill Publication

COURSE OUTCOMES (COs):

CO1	Will be able to identify the various components of an I.C. Engine and will be able to draw the valve timing diagram for 2- stroke engines.
CO2	Will be able to understand the fuel injection in diesel and petrol engines.
CO3	Will be able to determine the performance characteristics and energy balance of diesel and petrol engines and air compressors.

CO4	Will be able to understand the effect of the tilt angle and radiation on the power output of solar cell.
CO5	Will be able to experimentally compare poly crystalline and thin film solar cells.

ME-732	Industrial Engineering Laboratory	OEC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This course covers industrial process optimization through layout design, workflow analysis, and statistical process control. Students will develop flow process charts, SIMO charts, and control charts while conducting process capability and time studies. The course also includes inventory management using ABC analysis and discrete event simulation for process improvement. Emphasis is placed on software-based simulations and data-driven decision-making in manufacturing and industrial settings.

COURSE OBJECTIVES:

- To study Layout of Factory/ Office/ workshop
- To perform motion and time study
- To draw a Control chart for variables, Control chart for defects and Determine the Process Capability of a machine tool
- To undertake ABC analysis of given inventory datasets
- To undertake an exercise on discrete event simulation

LIST OF EXPERIMENTS:

1. Draw Layout of Factory/ Office/ workshop /etc. and suggest possible improvements. (Using REL chart method / some relevant plant layout software to experiment). Give focus on your simulations and improvement. Provide all reasonable assumptions, methodology figures and appropriate analysis.
2. Draw a Flow Process Chart for a process of your choice. Also, draw its improved version. Give figures, assumptions and suggested improvements.
3. Draw a Left hand and Right-hand chart of any process of your choice. Suggest possible improvements. (Use standard formats to provide all possible assumptions, figures and appropriate improvements).
4. Draw a SIMO chart for the process of your own choice. Give figures, relevance and assumptions and suggest possible improvements.
5. Draw a Control chart for variables for a given sample of rivets coming from a continuous stream of lots. Draw Mean and Range charts with appropriate data. Give assumptions and limitations also. Use software to support your results.
6. Determine the Process Capability of a machine tool, manufacturing rivets and specify the tolerances for this job based on the process capability study.
7. Time study the process of your choice with the help of your stopwatch. Provide relevant materials. List all assumptions. Suggest limitations and improvements.
8. Draw a Control chart for defects with the help of proper software to plot this Chart and suggest improvements. Alternatively, draw a Control chart for per cent defective with the help of proper software and suggest improvements.
9. Undertake ABC analysis of given inventory datasets. Use Ms excel to analyse. Further classification can also be made.
10. To undertake an exercise on discrete event simulation with the help of a selected data set/problem of your choice and software of choice.

REFERENCE BOOKS:

1. Motion and Time Study: Design and Measurement of Work by Ralph M. Barnes, Wiley; 7th edition (1 October 1980), ISBN-13 : 978-0471059059.
2. Statistical Quality Control by Douglas C. Montgomery, John Wiley & Sons; 7th Edition (21 June 2012), ISBN-13: 978-1118146811.

COURSE OUTCOMES (COs):

On completion of this course, student will be able to:

CO1	Analyze and design optimal layouts for production and service facilities using systematic tools like REL charts or relevant software to improve efficiency.
CO2	Construct and optimize process flow and motion charts to identify bottlenecks and suggest practical enhancements in industrial operations.
CO3	Develop statistical control charts and conduct process capability studies for quality monitoring and improvement in manufacturing systems.
CO4	Conduct time and motion studies to evaluate operational efficiency and recommend productivity improvements.
CO5	Implement simulation and inventory management techniques, including ABC analysis, to optimize resource utilization in industrial setups.

ME-733	Mechanical Vibrations Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:
This laboratory course provides practical experience in vibration analysis through a series of experiments designed to reinforce key concepts in mechanical vibrations. Students will study both undamped and damped systems, including pendulums, spring-mass systems, shaft- rotor and beams vibrations, with a focus on real-world applications. The course also develops skills in vibration measurement through sensors, data interpretation, and analysis.

COURSE OBJECTIVES:

- Gain the fundamental knowledge of vibration by observing motions of simple pendulums, spring-mass systems, and torsional vibrations.
- Analyze the effects of damping on mechanical systems and determine the damping constants for linear and torsional vibrations.
- Explore interesting vibration behaviors such as whirling shafts, rigid body modes, and high frequency vibrations in continuous systems, focusing on real-world applications.
- Develop calibre for vibration measurement and interpretation through experimental techniques and data analysis.

LIST OF EXPERIMENTS:

1. Study of oscillations of simple pendulum (CO1)
2. Study of the undamped longitudinal vibrations of helical spring-mass system (CO1)
3. Study of the undamped torsional vibrations of single disc-shaft system (CO2)
4. Study of the undamped torsional vibrations of two disc-shaft system (CO2)
5. Determination of damping constant of a given viscous damper (CO3)
6. Study of the damped torsional vibrations of single disc-rotor shaft system (CO3)
7. Study of the whirling of shafts (CO4)
8. Modal Analysis of a Free-Free beam (CO5)

REFERENCE BOOKS:
Mechanical Vibrations (Sixth Edition in SI Units) by Singiresu S. Rao, Pearson Education, 2018.

COURSE OUTCOMES (COs):
After the completion of this laboratory course, the students will be able to:

CO1	Experimentally determine the natural frequency of undamped, single degree of freedom systems.
CO2	Experimentally determine the natural frequency of torsional vibrations of shaft with single and double rotors.
CO3	Experimentally determine the linear and torsional viscous damping of a dashpot system.
CO4	Experimentally determine the critical speeds of shaft under different types of supports.
CO5	Perform vibration measurement using instruments like accelerometers, impact hammers, and data acquisition cards, and interpret the collected signals.

ME-734	Solar Energy Laboratory	PCC	L	T	P	C
		2Hrs	0	0	2	1

COURSE DESCRIPTION:

This laboratory course provides hands-on experience in characterizing the electrical performance of photovoltaic solar cells and modules. Students will investigate the impact of various environmental factors, such as spectrum, radiation, temperature, and shading, on the I-V and P-V characteristics of PV devices. The course also explores the behavior of PV modules in series and parallel configurations and the effect of tilt angle on power output.

COURSE OBJECTIVES:

- To familiarize students with the fundamental concepts of solar energy, including solar radiation, solar thermal systems, and photovoltaic technologies.
- To provide hands-on experience in setting up and operating solar energy systems and equipment.
- To teach students experimental methods for measuring solar radiation, thermal efficiency, and electrical output of solar energy systems.

LIST OF EXPERIMENTS:

1. To demonstrate the I-V and P-V characteristics of different types of solar cells with varying spectrum, radiation and temperature level.
2. To demonstrate the impact of partial shading on solar cell performance.
3. To draw I-V characteristics of rheostat with I-V characteristics of solar cells.
4. To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.
5. To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules
6. To show the effect of variation in tilt angle on PV module power.

REFERENCE BOOKS:

1. Sukhatme. S. P, Nayak. J. K, “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
2. Chetan Singh Solanki., Solar Photovoltaic: “Fundamentals, Technologies and Application”, PHI Learning Pvt., Ltd., 2009.

COURSE OUTCOMES (COs):

CO1	Will be able to understand conventional & renewable energy sources & develop new energy sources.
CO2	Will understand solar energy characteristic and their application.
CO3	Will be able to understand mass systems thermal application and power generation.
CO4	Will be able to understand wind energy, their characteristic site selection and performance analysis.
CO5	Will be able to understand about geothermal energy, potentiality and conversion system.

EIGTH SEMESTER

Course Details:

	S. No.	COURSE NUMBER	COURSE NAME	COURSE TYPE	Credits	L	T	P	Hrs
VIII SEMESTER	1	ME-801	Program Elective II (Machine Design) (Separate list of elective courses attached)	PE	3	2	1	0	3
	2	ME-830	Program Elective III (Production & Industrial) (Separate list of elective courses attached)	PE	3	2	1	0	3
	3	ME-850	Special Topics (Optional Audit Course)	Optional Audit Course	0	3	0	0	3
	4	ME-814	Product Design	PE (CBCS)	4	3	1	0	4
	i	ME-851	Seminar on Industrial Training (Compulsory Audit Course)	Seminar	0	0	0	2	2
	ii	ME-852	Project-II	Project Work	10	0	0	20	20
				Total	**20**	**10**	**3**	**22**	**35**

ME-801	ROBOTICS Elective (PRODUCTION & INDUSTRIAL) *	PEC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:

This course covers the fundamentals of robotics, including automation, robot anatomy, classification, and movement precision. It explores robot arm kinematics, homogeneous transformations, and Denavit-Hartenberg notation for kinematic analysis. Various robot grippers, their classifications, and design considerations are examined. The course also delves into robot drive systems (hydraulic, pneumatic, and electric), sensors, actuators, and control concepts. Robot programming methods, languages, and industrial applications such as material transfer, assembly, and inspection are also discussed, along with future trends in robotics.

COURSE OBJECTIVES:

To provide an introduction to Robotics including robot classification, design and selection, analysis, sensing and control, and applications in industry.

PREREQUISITES:

- Kinematics & Dynamics of Machines
- Instrumentation & Control Engineering

CONTENT:

Unit I	**Fundamentals of Robotics:** Introduction, Automation and Robotics, A Brief History of Robotics, Human system & Robotics, Laws & Definition of Robot, Industrial Robot Anatomy, Classification & Structure, Work Volume, Specifications of Robot, Precision of Movement. The Robotics Market, Social Issues and the Future Prospects.
Unit II	**Robot Arm Kinematics:** Introduction to Robot Arm Kinematics, Homogeneous Coordinate transformations, Composite Homogeneous transformation matrix. Link, joint and parameters. Denavit Harten Berg Notation, D-H Matrix, Kinematic equations. Direct & Inverse Kinematics, Exercises on Direct & Inverse Kinematics up to six degree of freedom Robots.
Unit III	**Robot Grippers:** Classification of End Effectors, Mechanical Grippers, Magnetic gripper, Vacuum gripper, Adhesive gripper, Multi fingered gripper - Utah, Okada, Stanford, DGIT Hands. Considerations in Gripper Selection - Force Analysis and Design.
Unit IV	**Robot Drives, Sensors, Actuators and Control:** Robot drive systems-Hydraulic, Pneumatic & Electric. Robot Sensors - Contact & non-contact type sensors, Force & torque Sensor. Robotic vision system. Basic Control Systems Concepts and Models, Controllers, Control System Analysis.
Unit V	**Robot Programming-Languages & Applications in Manufacturing:** Methods of Robot Programming, Lead through Programming Methods. Robot Languages & classification. Programming Exercise on ACL/ATS for Robots Eshed Robots. Robot Application areas- Material Transfer and Machine Loading/ Unloading, Processing Operations, Assembly and Inspection, Future Manufacturing Applications Robots.

TEXTBOOKS:

1. Introduction to Robotics by S. K. Saha, Tata McGraw-Hill Pvt. Ltd.
2. Industrial Robotics" by M.P Groover, McGraw-Hill International Editions

REFERENCE BOOKS:

1. Introduction to Robotics by J.J Craig., Addison Wesley N Delhi.
2. Robotics: Control, sensing & Vision by K. S. Fu., McGraw-Hill International Editions.

Computer Usage / Software required:

MATLAB, ACL & ATS

COURSE OUTCOMES (COs):

CO1	Will be able to understand the fundamentals of robotics and automation.
CO2	Will be able to conduct robot arm kinematics of a given robot.
CO3	Will be able to recommend gripper for different industrial applications.
CO4	Will be able to understand the application robotic sensors, actuators, and control mechanisms.
CO5	Will be able to program a given robot for a particular process/ activity using different programming language.

ME-830	ERGONOMICS Elective (PRODUCTION& INDUSTRIAL) *	PEC	L	T	P	C
		3Hrs	2	1	0	3

COURSE DESCRIPTION:
This course covers the fundamentals of ergonomics, emphasizing its importance in work-system design and human-machine interaction. Topics include muscular work, physiological principles, nervous system dynamics, and anthropometry in system design. It also explores workstation ergonomics, tool evaluation, displays and controls, work-related musculoskeletal disorders (WMSDs), human vibration effects, and noise and illumination studies in the workplace.

COURSE OBJECTIVES:
- Provide students with the basis of occupational ergonomics.
- Ergonomic considerations in design, ergonomic consideration in re-design and research basis of ergonomics.

PREREQUISITES:
- Industrial Engineering

CONTENT:

Unit I	Introduction to ergonomics, scope of ergonomics, cost of ignoring ergonomics, result of application of ergonomics, Ergonomics and its areas of application in the work-system, Description of Human-Machine system. Standard format for describing human-machine system.
Unit II	Muscular Work: Physiological Principles, Sources of Energy, Nervous control of movements and structure of nervous system: Types of nervous system, Neurons, Action potential, Sodium potassium pump, innervations of muscles, Reflex-arc. Dynamics and static muscular work. Field method for assessing physical overload.
Unit III	Introduction to Anthropometry, Its application in design of system, Design aspect in ergonomics: Manufacturing work-station design; Determining work-station design parameters, Systematic approach for determining work-station design, determining work-station dimension. Tool evaluation and design: Principles of tool design (General principles, Anatomical concern, and Single handle); Attributes of common industrial hand tools, Attributes of common industrial power tools, Tool evaluation check list. Displays and controls.
Unit IV	Cumulative Trauma Disorder: Work-related Musculoskeletal Disorder: Definition of work-related Musculoskeletal Disorder, Types of WMSDs, Factors affecting WMSDs. Occupational Human Vibration: Characteristics of vibration, Whole-body and hand-arm vibration, Effect of vibration on comfort, health and performance.
Unit V	Sound and related studies: Definition, evaluation of noise, combining decibels. Levels and Spectra: Sound power level, sound intensity level, numerical problems on sound its measurement, Illumination and its measurement.

TEXTBOOKS:
1. Introduction to Ergonomics-R.S. Bridger, McGraw-Hill International Edition.

REFERENCE BOOKS:
1. Industrial Noise Control-Lewis H-Bell and Douglas H-Bell, Marcel Dekker, INC.

2. Fitting Tasks to Human, Kroemer, K.H.E. and Grandjean, E. (1997). Philadelphia: Taylor and Francis
3. The Ergonomic Edge-MacLeod, D. (1995). New-York: Van Nostrand Reinhold.

Computer Usage / Software required:

- Adobe Acrobat Reader, Power Point or PP viewer, Video Player.

COURSE OUTCOMES (COs):

CO1	Will be able to understand the Human Machine system and importance of ergonomics.
CO2	Will be able to assess the physical workload on human operators.
CO3	Will be able to understand the principle of anthropometry and its applications in workstation design.
CO4	Will be able to understand the cumulative trauma disorder in machine operators and carry out the whole body and hand arm vibration estimation.
CO5	Will be able to conduct sound mapping and illumination study.

ME-814	PRODUCT DESIGN Elective (PRODUCTION& INDUSTRIAL) *	PEC	L	T	P	C
		4Hrs	3	1	0	4

COURSE DESCRIPTION:

This course covers product design and development, emphasizing innovation, concept generation, selection, and testing. It explores product architecture, CAD tools, value engineering, and 3D scanning technologies. Additive manufacturing methods like SLA, SLS, and FDM are discussed, along with their applications. Practical projects and hands-on exercises enhance learning.

COURSE OBJECTIVES:

This is an interdisciplinary subject area. This course tries to build fundamentals and working knowledge of product design.

PREREQUISITES:

- Industrial Engineering
- Production Engineering
- Computer-Aided Design
- Basics of Machine Design

CONTENT:

Unit I	Significance of product design, product design and development process, sequential engineering design method, the challenges of product development. Introduction to AM Theory of inventive problem solving (TRIZ): Fundamentals, problem Solution, methods and techniques, General Theory of Innovation and TRIZ, Identifying Customer needs: Gather raw data from customers, interpret raw data in terms of customer needs, organise the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.
Unit II	Concept Generation: The activity of concept generation clarifies the problem, search externally, search internally, explore systematically, and reflect on the results and the process. Concept Selection: Overview of methodology, concept screening, and concept scoring. Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, and reflect on the results and the process.
Unit III	Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Design of Modular System – abstract design. The process of conception and its documentation.
Unit IV	Computer-aided design (CAD), need for CAD, components of CAD systems, advantages. Various design tools in product development, product development process stages, QFD, concurrent engineering. Value engineering Applications in Product development and design, Model-based technology for generating innovative ideas. 3D scanner: its types with scanning principle, applications. Overview of Steinbichler blue light 3D scanner, different components function and working principle. Rhinoceros 3D software.

Unit V	Differentiate Additive manufacturing from subtractive manufacturing. Step used to create a 3D model. Different technologies used in additive manufacturing technologies like Stereolithography (SLA), Selective laser sintering (SLS), Fused deposit modeling (FDM), Selective Laser Melting (SLM), Laminated Object Manufacturing (LOM), Direct Metal Laser Sintering (DMLS), Inkjet Printing (IJP), Polyjet 3D printing, binding jet 3D printing, Built mechanism of each technology, applications. Overview of Colour-Jet 3D Printing (CJP), working principle, the material used, post processing in CJP. Project, seminar and exercises related to the above topics.

TEXTBOOKS:

1. Product Design and Development, Karl. T. Ulrich, Steven D Eppinger, Irwin Mc Graw Hill

REFERENCE BOOKS:

1. Product Design, Pearson Engineering of creativity: an introduction to TRIZ Methodology of Inventive Problem Solving, By Semyon D. Savransky, CRC Press.
2. Inventive thinking through TRIZ: A practical guide; By Michael A. Orloff, Springer.
3. Systematic innovation: An introduction to TRIZ (theory of inventive Problem.
4. Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, “
5. Product Design: Fundamentals and Methods, Roozenburg and Eekels, Publisher: McGraw-Hill
6. Design Secrets: Products: 50 Real-Life Projects Uncovered - Industrial Designers, Goodrich, Kristina; Society of America, Publisher: Rockport Publishers
7. Creating Breakthrough Products: Innovation from Product Planning to Program Approval, Cagan, Jonathan; Vogel, Craig M, Publisher: Financial Times Prentice Hall.

Computer Usage / Software required:

- Relevant software on scanning, inspection, reverse engineering, FEA and multi-body analysis needs to be practised.

Other details regarding this course:

- Product design is being taught through the foundation of theory and also engaging students in loosely supervised practice and industry exposure.

COURSE OUTCOMES (COs):

On completion of this course, Student will be able to:

CO1	Understand the principles and challenges of product design and development, including customer need analysis and specification setting.
CO2	Apply concept generation, selection, and testing methodologies to develop product concepts that meet customer requirements.
CO3	Analyze product architecture and design modular systems, considering supply chain implications and platform planning.
CO4	Utilize computer-aided design (CAD) tools, value engineering, and model-based techniques to enhance the product development process.
CO5	Differentiate and apply various additive manufacturing technologies and processes, including their applications and post-processing methods.