Dr. Babasaheb Ambedkar Technological University (Established as University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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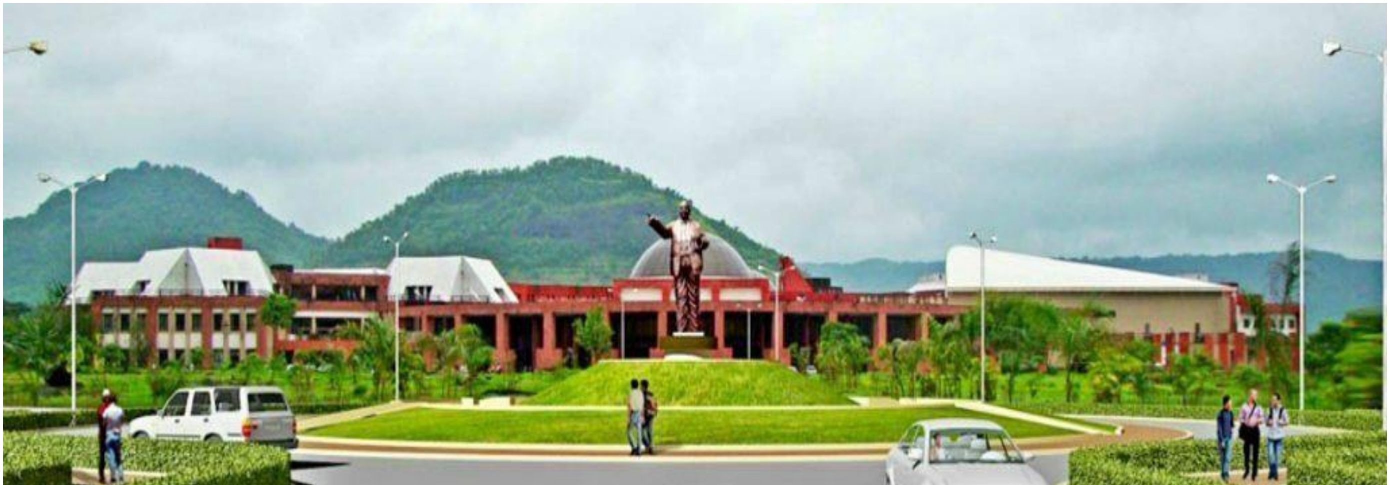
UNDER GRADUATE PROGRAMME

BUCKET OF MULTI-DISCIPLINERY MINOR (MDM) COURSES IN MECHANICAL ENGINEERING AND ALLIED BRANCHES

With effective from the academic year 2025-2026

(For Affiliated Institutes only)



Vision of the Department

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission of the Department

Imparting quality education, looking after holistic development of students and conducting need-based research and extension.

Graduate Attributes

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO2	Graduates should excel in best post-graduate engineering institutes, reaching advanced degrees in engineering and related discipline.
PEO3	Within several years from graduation, alumni should have established a successful career in
	an engineering-related multidisciplinary field, leading or participating effectively in interdisciplinary engineering projects, as well as continuously adapting to changing technologies.
PEO4	Graduates are expected to continue personal development through professional study and self-learning.
PEO5	Graduates are expected to be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes

At the end of the program the student will be able to:

PO1	Apply knowledge of mathematics, science and engineering to analyze, design and evaluate mechanical components and systems using state-of-the-art IT tools.
PO2	Analyze problems of production engineering including manufacturing and industrial systems to formulate design requirements.
PO3	Design, implement and evaluate production systems and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Apply current techniques, skills, knowledge and computer based methods and tools to develop production systems.
PO6	Analyze the local and global impact of modern technologies on individual organizations, society and culture.
PO7	Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and eco-friendly environment.
PO8	Exhibit responsibility in professional, ethical, legal, security and social issues.
PO9	Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Apply management principles to manage projects in multidisciplinary environment.
PO12	Pursue life-long learning as a means to enhance knowledge and skills.

Dr. Babasaheb Ambedkar Technological University, Lonere
Mechanical Engineering and Allied Branches
Course Structure for Multi-Disciplinary Minor (MDM) Bucket in Mechanical Engg. and Allied Branches (UG)
w.e.f. 2024-25 as per NEP 2020
(For Affiliated Institutes Only)

Course Code	Semester	Course Title	Teaching Scheme			Evaluation Scheme				
			L	T	P	CA	MSE	ESE	Total	No. of Credits
	III	Basic Thermodynamics	3	-	-	20	20	60	100	3
	IV	Strength of Materials/ Material Science & Metallurgy	3	-	-	20	20	60	100	3
	V	Theory of Machines	3	-	-	20	20	60	100	3
	VI	Manufacturing Processes/ Fluid Mechanics	3	-	-	20	20	60	100	3
	VII	Machine Design	3	-	-	20	20	60	100	3
Total			**12**	**-**	**-**	**100**	**100**	**300**	**500**	**15**

Semester III

Basic Thermodynamics

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:-- Credits: 03	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

Course Outcomes: At the end of the course, students will be able to:

CO1	Define the terms like system, boundary, properties, equilibrium, work, heat, ideal gas, entropy etc. used in thermodynamics.
CO2	Studied different laws of thermodynamics and apply these to simple thermal systems to study energy balance.
CO3	Studied Entropy, application and disorder.
CO4	Studied various types of processes like isothermal, adiabatic, etc. considering system with ideal gas and represent them on p-v and T-s planes.
CO5	Represent phase diagram of pure substance (steam) on different thermodynamic planes like p-v, T-s, h-s, etc. Show various constant property lines on them.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	1	2	1									
CO3		1	1									
CO4	2											
CO5	1	1										

Course Contents:

Unit 1: Fundamental Concepts and Definitions

Thermodynamic system and its type; Macroscopic vs. Microscopic viewpoint, properties, processes and cycles, point function, path function. Thermodynamic equilibrium, Quasi-static process.

Work and heat Transfer: Work transferred and other types of work, Heat transfer, temperature and its measurement (principle of measurement, various instruments etc. Zeroth law of thermodynamics, specific heat and latent heat,

Unit 2: First Law of Thermodynamics

First law of thermodynamics for a closed system undergoing a cycle and change of state, Energy, different forms of energy, Enthalpy, PMM-I control volume.

Application of first law of steady flow processes (nozzle, turbine, compressor, pump, boiler, throttle valve etc.)

Unit 3: Second Law of Thermodynamics

Limitation of first law of thermodynamics, cycle heat engine, refrigerator and heat pump, Kelvin-Plank and Clausius statements. Reversibility and Irreversibility, Carnot cycle, Carnot theorem.
Entropy: Introduction, Clausius theorem, T-s plot, Clausius inequality, Entropy and Irreversibility, Entropy principle and its application.

Unit 4: Ideal gas

Boyle's law, Charl's law, Avogadro's law, universal gas constant, ideal processes with question.

Unit 5: Properties of Pure Substance

Phase change phenomenon of pure substance, phase diagram of pure substance, critical point parameters, triple point, property table, representationof processes of steam on p-v, T-s, and P-t and h-s diagrams, Dryness fraction and its measurement.

Texts:

1. P. K. Nag,"Engineering Thermodynamics", Tata McGraw Hill, New Delhi, 3rd edition,2005.
2. Y. A. Cengel, M. A. Boles, "Thermodynamics - An Engineering Approach", Tata McGraw Hill, 5th edition, 2006.

References:

1. G. J. Van Wylen, R. E. Sonntag, "Fundamental of Thermodynamics", John Wiley andSons, 5th edition, 1998.
2. J. Moran, H. N. Shapiro, "Fundamentals of Engineering Thermodynamics", John Wileyand Sons, 4th edition, 2004.

Semester IV

Strength of Materials

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:-- Credits: 03	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

CO1	Understand the fundamental concept of stress, strain and mechanical properties of materials.
CO2	Analysis principal stresses, strains and determine principal planes in 2D stress.
CO3	Construct and interpret shear force and bending oment diagrams for various bea configurations.
CO4	Apply torsion theories to design shafts
CO5	Apply Eulers formula to analyze the stability of column under compressive loads and Bending stress thories to design beams.

Course Outcomes

Unit 1: Simple Stresses and Strains

Mechanical properties of materials, analysis of internal forces, simple stresses and strains, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Unit 2: Principal Stresses and Strains

Uni-axial stress, simple shear, general state of stress for 2-D element, ellipse of stress, principal stresses and principal planes, principal strains, shear strains

Unit 3: Shear Force and Bending Moment Diagram

Introduction to different types of beams, different types of supports & loads. Concept and definition of shear force and bending moment in determinant beams due to concentrated loads, UDL, UVL and couple. Relation between SF, BM and intensity of loading, construction of shear force and bending moment diagram for cantilever, simple and compound beams, defining critical and maximum value and position of point of contra flexure. Construction of BMD and **load** diagram from SFD, Construction of load diagram and SFD from BMD.

Unit 4: Torsion

Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation indeterminate solid/homogeneous/composite shafts, torsional strain energy

Unit 5: Columns and Stresses in Beams

Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections-rectangular, solid circular, I-section, other sections design for flexure and shear

Texts:

1. S. Ramamrutham, “Strength of Materials”, Dhanpat Rai and Sons, New Delhi.
2. F. L. Singer, Pytle, “Strength of Materials”, Harper Collins Publishers, 2002.
3. S. Timoshenko, “Strength of Materials: Part-I (Elementary Theory and Problems)”, CBS Publishers, New Delhi.

References:

1. E. P.Popov, “Introduction to Mechanics of Solid”, Prentice Hall, 2nd edition, 2005.
2. S. H. Crandall, N. C. Dahl, T. J. Lardner, “An introduction to the Mechanics of Solids”, Tata McGraw Hill Publications, 1978.
3. S. B. Punmia, “Mechanics of Structure”, Charotar Publishers, Anand

NPTEL

https://onlinecourses.nptel.ac.in/noc23_ce80/preview

https://nptel.ac.in/courses/112107146

Semester IV

Materials Science and Metallurgy

Teaching Scheme:	Examination Scheme:
Lectures: 3 Hrs/week Tutorial: - Credits: 03	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Outcomes: At the end of the course, students will be able to:

CO1	Analyze the crystal structures of materials.
CO2	Illustrate different imperfections in the crystal.
CO3	Understand the mechanism of plastic deformation
CO4	Compare various tests for mechanical properties
CO5	Demonstrate the use of various macroscopic and microscopic techniques

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	1								
CO2	3	2	2	1								
CO3	2	1	1	1								
CO4	3	2	2	1								
CO5	3	1	1	2								

Course Contents:

Unit 1: Crystal Structures

Atomic arrangement: crystalline vs. amorphous materials; unit cell, space lattice, 14 Bravais lattices, lattice parameters, 7 crystal systems; BCC, FCC, and HCP structures: Basic Characteristics: average number of atoms per unit cell, Coordination number, atomic packing factor; Indexing of lattice planes: finding Miller indices of a given plane, drawing a plane with given Miller indices, inter-planar spacing for cubic systems, angle between planes; Indexing of lattice directions, importance, procedure, finding Miller indices of a given direction, drawing a direction with given Miller indices, angle between directions.

Unit 2: Crystal Imperfections

Importance, Classification: Point defects: vacancy, interstitials, impurities, Frenkel, Schottkey defects, Line defects: definition, types, edge, screw, mixed dislocations, characteristics of each type, planar defects: external surfaces, grain boundaries: high and low angle, tilt and twist boundaries; twin boundaries, stacking faults: intrinsic, extrinsic; Volume defects: examples.

Unit 3: Mechanism of Plastic Deformation

Slip: slip direction, slip plane, slip systems for cubic structures, Mechanism of slip: movement of dislocations; Twinning: twin direction and plane; types: deformation and annealing twinning; slip vs twinning; Deformation of single crystal by slip: Schmid’s law, calculation of critical resolved shear stress, sliding and rotation of slip planes; Strain hardening: mechanism, Frank-Read source; Plastic deformation of polycrystalline materials: piling up of dislocations.

Unit 4: Mechanical Properties and their Testing

Tension test, Engineering stress-strain curves, True stress-strain curves, true strain, relationship between engineering and true stress – strain, Evaluation of properties: proportional stress, elastic limit, ultimate tensile strength, breaking or fracture stress, yield stress, proof stress, resilience, toughness, stiffness, ductility, Compression test: Introduction, types of fracture, Poisson's ratio, Formability: Importance, Erichsen test; Hardness testing, different hardness tests: Brinell, Rockwell and Vickers tests; Impact tests: Charpy and Izod.
Non-destructive testing: Introduction, dye penetrant test, magnetic particle inspection, ultrasonic test, and eddy current test.

Unit 5: Metallography

Introduction: Definition, importance; Microscopy: Specimen preparation: Procedure, Metallographic polishing abrasives, Metallographic polishing clothes; Mounting of specimens; Etching: procedure and reagents; Optical metallurgical microscope: Principle of working, construction, and important terms.
Macroscopy: Procedure and methods; Macro tests: Sulphur printing, flow lines observation,
Examination of fractures: fatigue, tensile, fibrous; Spark test.

Textbooks:

1. V. D. Kodgire, S.V. Kodgire, "Material Science and Metallurgy for Engineers", Everest Publishing House, Pune, 24th edition, 2008.
2. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 5th edition, 2001.
3. V. Raghvan, "Material Science Engineering", Prentice Hall of India Ltd., 1992.
4. S. H. Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill, 2nd edition, 1997.
5. R. A. Higgins, "Engineering Metallurgy: Part I", ELBS, 6th edition, 1996.

Reference Books:

1. V. B. John, "Introduction to Engineering Materials", ELBS, 6th edition, 2001.
2. G. F. Carter, D. E. Paul, "Materials Science and Engineering", ASM International, 3rd edition, 2000.
3. T. E. Reed-Hill, R. Abbaschian, "Physical Metallurgy Principles", Thomson, 3rd edition, 2003.

Semester V

Theory of Machines

Teaching Scheme:	Examination Scheme:
Lectures: 2 hrs/week Tutorial: - Credits: 03	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain and analyze kinematic elements, chains, inversions, and common mechanisms.
CO2	Analyze performance parameters of flat belts, V-belts, and chain drives.
CO3	Explain gear terminology, tooth profiles, and analyze gear performance.
CO4	Select and analyze clutches and brakes for torque and braking requirements.
CO5	Apply gyroscopic principles to analyze stability of vehicles, ships, and aircraft.

CO-PO-PSO Mapping Table:

CO \ PO / PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	2	-	-
CO2	3	2	2	-	-	-	-	-	-	2	-	-
CO3	3	2	2	-	-	-	-	-	-	2	-	-
CO4	3	2	3	2	-	-	-	-	-	2	-	-
CO5	3	2	2	2	-	2	-	-	-	2	-	-

Course Contents:

Unit 1: Introduction

Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom. Study of various mechanisms such as straight-line mechanisms, pantograph, Geneva mechanism, steering gear mechanisms.

Unit 2: Belt & Chain Drives

belts: Effect of slip, Creep, crowing of pulley, Length of belt, Centrifugal tension, Initial tension in belts, ratio of belt tensions, power transmitted Belts: Advantages of V-Belts over Flat Belt, ratio of belt tensions, torque transmitted.
Chain, Chain length, Angular Speed ratio, Classification of Chains.

Unit 3: Toothed Gears

Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profiles, Path of contact, Arc of contact, Contact ratio, Interference, Undercutting, Backlash. Introduction to Internal gears.

Helical gear terminology, Normal and transverse module, Virtual number of teeth. Worm Gear & Bevel Gear.

Unit 4: Clutch & Brakes

Friction Clutches: Single plate and multi-plate clutch, Cone clutch, Centrifugal clutch, Torque transmitting capacity, Clutch operating mechanism.

Brakes: Shoe brake, Internal and external shoe brakes, Block brakes, Band brakes, Band and block brakes, Braking torque.

Unit 5: Gyroscope

Gyroscope: Principles of gyroscopic action, Precession and gyroscopic acceleration, gyroscopic couple, Effect of the gyroscopic couple on Aeroplane, Naval ships and four wheelers.

Texts:

1. Ghosh, A. K. Malik, "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
2. S. S. Rattan, "Theory of Machines", Tata McGraw Hill, New Delhi.

Semester VI

Manufacturing Processes

Teaching Scheme:	Examination Scheme:
Lectures: 2 hrs/week Tutorial: - Credits: 03	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Outcomes: At the end of the course, students will be able to:

CO1	Remember the fundamental concepts of manufacturing, metal casting methods and typical casting defects.
CO2	Understand the principles and working of metal forming processes such as rolling, forging, extrusion, and drawing, along with their defects.
CO3	Select appropriate joining technique(s) for a given application
CO4	Identify turning and various hole-making operations.
CO5	Compare milling, broaching, and gear machining processes

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1		1	1				1		1
CO2	2	2	1		1	1				1		1
CO3	2	1	1		1	1				1		1
CO4	1		1		1	1				1		1
CO5	2		1		1	1				1		1

Course Contents:

Unit 1: Introduction and Casting Processes

What is manufacturing? Selection of manufacturing processes, introduction to casting, metal casting process: sand casting; shell molding; investment casting; permanent-mold casting, casting defects.

Unit 2: Metal Forming

Rolling and Forging Processes:
Introduction to rolling, flat-rolling process, defects in rolled plates and sheets, rolling mills, various rolling processes.
Introduction to forging, open-die forging, impression-die and closed-die forging, various forging operations, forging defects.
Extrusion and Drawing:
Introduction to extrusion process, hot extrusion, cold extrusion, extrusion defects.
Introduction to drawing process, drawing practices, drawing defects.

Unit 3: Joining Processes

Gas welding processes: oxy-fuel-gas welding, Arc welding processes: Shielded metal arc welding, submerged arc welding, MIG Welding, TIG Welding; advanced welding methods: electron beam welding, laser beam welding; Other joining processes: brazing; soldering and mechanical fastening.

Unit 4: Machining Processes: Turning and Hole Making

Introduction to turning process, lathes and lathe operations, lathe components, types of lathes. Hole making operations: Boring, drilling, reaming, and tapping.

Unit 5: Machining Processes: Milling, Broaching and Gear Manufacturing

Introduction to milling and milling machines, milling cutters, broaching and broaching machines, gear manufacturing by machining: form cutting, gear generating.

Text Book:

1. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte. India Ltd., 6^{th} edition, 2009.

Reference Books:

1. Milkell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons, New Jersey, 4^{th} edition, 2010.
2. Paul DeGarmo, J.T. Black, Ronald A. Kohser, "Materials and Processes in Manufacturing", Wiley, 10^{th} edition, 2007.

Semester VI

Fluid Mechanics

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week Tutorial: - Credits: 03	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain basic properties of fluid, fluid statics, kinematics and dynamics.
CO2	Identify various types of flow, flow patterns and their significance.
CO3	Explain concepts of flow through pipes dimensionless parameters.
CO4	Derive various equations in fluid mechanics such as Euler's, Bernoulli's, Momentum, Continuity etc.
CO5	Solve the problems related to properties of fluid, fluid kinematics, fluid dynamics, laminar flow, pipe flow, dimensional analysis

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2	2											
CO3	2	2										
CO4	3	2										
CO5	3	2	2									

Course Contents:

Unit 1: Fluid Properties and Fluid Statics:
Fluid Properties: Definition of fluid, Fluid as a continuum, Properties of fluid, Viscosity, Types of fluid, Compressibility, Surface tension, Capillarity and vapor pressure.
Fluid Statics: Pascal's law, Hydrostatic law of pressure, Total Pressure, Centre of Pressure, Buoyancy, Meta center, Condition of Equilibrium of floating and submerged bodies (No Numerical Treatment on fluid Statics)

Unit 2: Fluid Kinematics and Dynamics
Fluid Kinematics: Eulerian and Langragian approach of fluid flow, Types of flow, Definition of steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Compressible, incompressible, rotational, Irrotational flow, 1D flows, Stream line, Streak line, Path line, concept of Velocity, potential & stream function flow net (no numerical treatment), Continuity equation for steady, Uniform, Compressible.
Fluid Dynamics: Euler's equation, Bernoulli's equation, Practical applications of Bernoulli's equation - Pitot tube, Venturi meter, Orifice meter.

Unit 3: Laminar Flow

Laminar Flow: Introduction to flow of viscous fluid through circular pipes, two parallel plates derivation and numerical.

Unit 4: Turbulent Flow: Major and minor losses. Loss of energy due to friction (Darcy's and Chezy's equation). Minor energy losses in transition, expansion and contraction. Concept of HGL and TEL, flow through syphon, flow through pipes in series or compound pipes, equivalent pipe, parallel pipes, branched pipes, Power transmission through pipes. Moody's Diagram.

Unit 5: Dimensional analysis

Introduction to dimensional analysis, dimensional homogeneity, methods of dimensional analysis- Rayleigh's method, Buckingham's π-theorem, dimensionless numbers. (No numerical treatment)

Textbooks:

1. P. N. Modi, S. M. Seth, "Fluid Mechanics and Hydraulic Machinery", Standard Book House, 10th edition, 1991.
2. Fluid mechanics and Hydraulic machines, Dr. R. K. Bansal , Laxmi Publication, Delhi, 2005

References Books:

1. S. K. Som, G.Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2ndedition, 2003

Semester VII

Machine Design

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week Tutorial: - Credits: 03	Internal Assessment: 20 Marks Mid Term Test: 20 Marks End Semester Exam: 60 Marks

Course Outcomes: At the end of the course, students will be able to:

CO1	Understand and apply the phases of mechanical design, material selection, standardization, and ergonomic/aesthetic aspects.
CO2	Analyze machine components under static loading using theories of failure and design of joints.
CO3	Evaluate components under fluctuating loads and perform fatigue design using Goodman and Soderberg criteria.
CO4	Application of theories of failure for the component design
CO5	Design shafts, keys, and couplings based on strength and torsional rigidity criteria using relevant codes.

Mapping of course outcomes with program outcomes

Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	1	1	1					2
CO2	3	3	2	2	2	1						1
CO3	3	3	3	2	2	1	1					2
CO4	3	2	3	2	3	1						1
CO5	3	2	3	2	3	1						1

Course Contents:

Unit 1: Introduction to Mechanical Design

Mechanical Engineering Design: Definition, Meaning, Importance, Phases of Design: Traditional vs. Industrial Design Process, Design Considerations: Aesthetic, Ergonomic, Standardization, Preferred Numbers, Use of Design Data Book and ISO 9000, Selection of Materials, Common Engineering Materials and Their Properties (CI, MS, Brass, Copper),

Unit 2: Design Against Static Loading:

Stresses and Strain: Axial, Bending, and Torsion, Factor of safety, Eccentric Axial loading, Design of Cotter Joint, Knuckle Joint.

Unit 3: Design Against Fluctuating Loads

Types of Loading: Static vs Fluctuating**,** Stress Concentration: Causes, Factors & Reduction**,** Endurance Limit, Fatigue Failure, Notch Sensitivity**,** Design for Finite and Infinite Life, Cumulative Damage Soderberg and Goodman Diagrams.

Unit 4: Theories of Failure

Maximum Normal Stress Theory, Maximum Shear Stress Theory, Maximum Distortion Energy Theory, Comparison of Theories, Combined Loading Applications

Unit 5: Design of Shafts, Keys and Couplings

Types of Shafts: Transmission Shafts, Spindles, Axles, Design for Strength and Rigidity (Torsional & Bending), ASME Code for Shaft Design, Types of Keys: Flat, Square; Design and Fitment, Splined Shafts Overview, Design of Rigid Couplings: Muff, Flange, Design of Flexible Couplings: Bush pin, etc.

Textbook:

1. **V. B. Bhandari** – *Design of Machine Elements*, Tata McGraw Hill Publication, A widely recommended book covering all fundamental concepts and numerical problems aligned with the syllabus.

Reference Books:

1. **Shigley J. E. & Mischke C. R.** – *Mechanical Engineering Design*, Tata McGraw Hill, A classic international text that provides deep insights into the design process and theories of failure.
2. **M. F. Spotts** – *Design of Machine Elements*, Pearson Education Good for understanding design concepts with practical examples.
3. **Robert L. Norton** – *Machine Design: An Integrated Approach*, Pearson Education Suitable for advanced study and application-oriented learning.