COURSE STRUCTURE
&
SYLLABUS

For

B. Tech in Mechanical Engineering

(III & IV SEMESTER)

For Academic Session 2023-24

Indian Institute of Petroleum and Energy

Visakhapatnam, Andhra Pradesh - 530 003

Semester-III				
S.No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credits**
1	IC2101	Numerical Methods and Transform Calculus	4-0-0	4
2	IC2102	Fluid Mechanics & Multiphase Flow	3-1-0	4
3	IC2103	Object Oriented Programming	3-1-0	4
4	ME2101	Kinematics of Machine	3-1-0	4
5	ME2102	Thermodynamics	3-1-0	4
6	ME2103	Fluid Flow Lab	0-0-3	2
7	ME2104	Strength of material lab	0-0-3	2
Total			16-4-6	24
Semester-IV				
S.No.	**Subject Code**	**Subject Name**	**L-T-P**	**Credits**
1	ME2201	Heat Transfer	3-1-0	4
2	ME2202	Manufacturing Processes	4-0-0	4
3	ME2203	Mechanical Measurements	3-0-0	4
4	ME2204	Dynamics of Machines	3-1-0	4
5	ME2205	Turbomachinery	3-1-0	4
6	ME2206	Fluid system Lab	0-0-3	2
7	ME2207	Heat Transfer Lab	0-0-3	2
Total			**16-3-6**	**24**

Semester-III

Course Type	Course Code	Name of Course	L	T	P	Credit
Core	**IC2101**	**Numerical Methods & Transform Calculus**	4	0	0	4

Course Objective

- This course is to introduce the basic concepts of numerical methods for a variety of problems such as algebraic equations, linear systems of equations, approximation, ordinary differential equations.
- To make the students understand the basic concepts of Laplace and Fourier transforms, Fourier series and the applications of these transform techniques in solving initial and boundary value problems.

Learning Outcomes

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

- Understand the numerical error and applicability of a particular method.
- Find roots of a nonlinear equation, and interpolate a function and analyze the variety of direct and iterative methods for solving systems of linear equations.
- Identify different methods to find the approximate integration by quadrature rules.
- Solve ordinary and partial differential equations by finite difference methods.
- Solve initial and boundary value problems by using Laplace and Fourier transform techniques.
- Understand the approximation of a function in terms of Sine and Cosine functions.

Unit No.	Topics to be Covered	Learning Outcome
1.	**Numerical Methods:** A. Finding roots of equations: Bisection, Regula-falsi, Newton-Raphson, secant and fixed-point iteration techniques. Lagrange and Newton divided differences methods. Numerical differentiation. Numerical integration: Rectangle, Trapezoidal and Simpson's rules, Composite rules. B. System of Linear Equations: Gaussian elimination, Gauss-Jordan method, LU decomposition, Iterative methods: Gauss-Seidel and Gauss-Jacobi, Eigenvalue problems: power method. Numerical Solution of ODE: Taylor's, Euler's, Modified-Euler, Runge-Kutta methods.	The student will be able to understand numerical error and applicability of a particular method to find roots of a nonlinear equations, system of linear equations, interpolation of a function, numerical integration, and ODEs.
2.	**Transform Calculus:** **A. Laplace Transforms:** Definition, linearity property, conditions for existence, shifting properties, Laplace transform of derivatives and integrals, unit step function, Dirac-delta and error function, differentiation and integration of transforms, convolution theorem, inversion, periodic functions, evaluation of integrals by Laplace transforms, solution of initial and boundary value problems. **B. Fourier Series and Fourier Transforms:** Fourier series representation of a function and its convergent properties, half range series, sine and cosine series, Fourier integral representation of a function, Parseval's identity. Fourier transform, Fourier sine and cosine transforms, linearity, scaling, shifting properties, convolution theorem, Applications to initial and boundary value problems. **C. Introduction to Machine Learning:** Data, models and learning, empirical risk minimization, parameter estimation.	The student will be able to solve initial and boundary value problems by using Laplace and Fourier transform techniques. In addition, the student will be able to approximate a function in terms of Sine and Cosine functions The student will be able to know basic knowledge of machine learning.

Numerical Methods:
Text Books:
S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980.
K. Atkinson, An Introduction to Numerical Analysis (2nd Edition), John-Wiley & Sons, 1989.
E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999).
References :
S.S. Sastry, Introductory Methods of Numerical Analysis - Prentice Hall of India

Transform Calculus:
Text Books:
R. K.Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa publisher
Erwin Kreyszig, Advanced Engineering Mathematics, Wiley publisher.
References :
W. Feller, An introduction to Probability theory and its applications
Peter V, O'Neil, Advanced Engineering Mathematics, 6th edition.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE	**IC 2101**	**Fluid Mechanics &Multiphase Flow**	3	1	0	4

Course Objective
• To understand the kinematics and dynamics of fluid motions. • To understand the governing equations dictating various types of flow problems. • To develop an idea on the effects of pressure (and its gradient), viscosity, fluid stress, strain rate and their mutual relationship.
Learning Outcomes
Upon successful completion of this course, students will: • Understand the kinematics and dynamics of fluid motions as opposed to deformable solids. • Develop a first-hand understanding of various types of flow problems: potential, irrotational, inviscid, viscous, incompressible and compressible. • Understand the logic behind the derivations of Bernoulli's, Euler's and Navier-Stokes Equations governing specific fluid flows. • Develop a clear understanding of the constitutive relationship between stress and strain rate for fluid motions. • Develop a clear understanding of Boundary Layer Approximations and Boundary Layer Theory. • Develop the understanding on the importance and application of Dimensional and similarity Analysis. • Develop an understanding on the laminar and turbulent flows.

Unit No	Topics	Learning Outcome
1.	Fluid and their properties: Concept of fluid, difference between solids, liquids and gases; ideal and real fluids; properties of fluid, Newtonian and non-Newtonian fluids.	Understanding of characteristics of various types of fluids: Their mutual similarities and differences.
2.	Fluid Statics: Pressure and its measurement, Pascal's law and its engineering applications, Hydrostatic force on a plane and curved submerged surfaces, resultant force and center of pressure, Buoyancy and flotation, stability of floating and submerged bodies, metacentric height and its determination, pressure distribution in a liquid subjected to constant horizontal/ vertical acceleration, rotation of liquid in a cylindrical container.	Develop the ideas of pressure and hydrostatic force.
3.	Fluid Kinematics: Classification of fluid flows, velocity and acceleration of fluid particle, local and convective acceleration, normal and tangential acceleration, streamline, path line and streak line, continuity equation; Rotational flows, rotation velocity and circulation, stream and velocity potential functions, flow net.	• Understand difference between streamlines/ path lines and streak lines. • Develop understanding of the kinematics of the vorticity and potential flows.
4.	Fluid Dynamics: Reynolds Transport Theorem, Euler's equation, Bernoulli's equation and steady flow energy equation; applications of Bernoulli's equation, Siphon, Venturi meter, Orifice meter, impulse momentum equation, flow along a curved streamline, free and forced vortex motions	Understand the application of Bernoulli's Equation to specific flow problems. • Understand the Impulse Momentum equation for flows around curved boundaries
5.	Boundary Layer Flow: Navier-Stokes equation, Boundary layer concept, displacement, momentum and energy thickness, Von-Karman momentum integral equation, laminar and turbulent boundary layer flows, drag on a flat plate	Develop an understanding of Boundary Layer approximation and various aspects of boundary layer flows.
6.	Viscous Flow: Relationship between shear stress and pressure gradient, flow through pipes, flow between two parallel plates; Kinetic energy and momentum correction factor	Develop an understanding on the effects of flow viscosity, fluid stress and the constitutive relationship between stress and strain rate.
7.	Dimensional Analysis and Similitude: Fundamental and derived units and dimensions, dimensional homogeneity; Rayleigh's and Buckingham's Pi method for dimensional analysis; Dimensionless numbers and their significance; model studies	Develop an understanding on the Dimensional Analysis and Similitude and their applications in solving various fluid-flow problems.
8.	Flow Through Pipes: Major and minor losses in pipes, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes.	Develop an understanding on the laminar and turbulent flows through pipes and various kinds of subsequent losses due to friction.

Text Book:

1. Introduction to Fluid Mechanics by Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, Wiley, 2009

Reference books:

1. F.M. White, Fluid Mechanics, McGraw-Hill (India) Ltd., 8th edition
2. Fluid Mechanics, Kundu and Cohen, Academic Press.
3. Foundations of Fluid Mechanics by Shao Wen Yuan, Prentice-Hall Publications.
4. S.K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, Tata McGrawHill, 3rd edition.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**Kinematics of Machines**	3	1	0	4

Course Objective
1. To learn how to analyze the motions of mechanisms, design mechanisms to have given motions, and analyze forces in machines. 2. To understand the operating principles of different parts of mechanical system gears, gear trains, cams and linkages. 3. To provide a foundation for the study of machine design and for interpretation of computer-aided design and analysis data.
Learning Outcomes
At the end of the course, the student will be able to: 1. have a broad understanding of different mechanism, motion of machines. 2. have an understanding about degree of freedom of a mechanical system. 3. be able to find velocity and acceleration of kinematic pair if input is known to a mechanical system. 4. have a broad understanding about designing part of different mechanical system like gear, cam, break, clutch etc.

Unit No	Topics	Learning Outcome
1.	Kinematic pairs, inversion, mobility and range of movements, degree of freedom, equivalent mechanism.	Understanding of kinematics of motion, degree of freedom of a mechanism.
2.	Displacement, velocity analysis, I-Centre method: angular velocity ratio theorem	Understanding of linear velocity and numerical to solve velocity of different kinematic pair in a mechanism.
3.	Acceleration analysis of planar linkages, Coriolis acceleration component	Understanding of acceleration and numerical to solve acceleration of different kinematic pair in a mechanism.
4.	Lower pairs: Simple Mechanism: Pantograph, Straight-line mechanisms, Engine Indicators, Automobile steering gears: Devis and Ackermann steering mechanisms, Hooke joint. Mechanical Couplings	Understanding of Understanding of different lower pair mechanism, their dimensional synthesis for motion.
5.	Higher Pairs: Types of Cam, Types of follower, Follower motion: Velocity and Acceleration, Layout of Cam profiles.	Understanding of different types of cam and follower movement and their applications. Design of a cam for a certain motion outcome.
6.	Higher Pairs: Types of gears, Gear terminology, Law of Gearing, motion and synthesis of simple gear, Gear Train: Simple, compound, reverted and planetary gear trains	Understanding of different types of gear and gear train mechanism and their applications.
7.	Brakes: Types, Analysis, Dynamometers	Understanding of different types of break and dynamometer and their applications.
8.	Clutches: Types, Analysis.	Understanding of different types of clutch and their applications.

Text Books:

Theory of Machines-S.S.Rattan

Reference Books:

1. Theory of Machines and Mechanisms-John Uicker, Gordon Pennock, Joseph Shigley
2. Theory of Machines-Khurmi and Gupta

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**THERMODYNAMICS**	3	1	0	4

Course Objective

- To describe various thermodynamic processes, laws of thermodynamics and describe their significance
- To understand the limitations of different energy conversion processes
- To introduce concepts of irreversibly, entropy and maximum work
- To establish the relation between commonly measurable properties and properties that cannot be measured directly

Learning Outcomes

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

- Understand the concept of temperature, system, surrounding, universe, state and relation between heat and work transfer
- Ability to conduct energy analysis on open and closed thermodynamic systems
- Ability to evaluate feasibility of a process and estimate irreversibility associated with the process
- Ability to conduct exergy analysis on open and closed thermodynamic systems
- Ability to estimate various non-measurable properties from measurable properties

Unit No	Topics	Learning Outcome
1.	Introduction: Fundamental Concepts: definitions of system and surrounding, concept of control volume, thermodynamic state, concepts of simple compressible substances, pure substance and phase, thermodynamic processes and thermodynamic equilibrium; Temperature and Zeroth law; Thermodynamic properties and use of tables of thermodynamic properties; Idea of a generalized chart and the law of corresponding states; Concept of ideal gases and their equations of state; Thermodynamic concept of energy; Modes of work and heat transfer.	Understand the concept of temperature, system, surrounding, universe, state and relation between heat and work transfer
2.	First Law of Thermodynamics: The first law referred to cyclic and non-cyclic processes, concept of internal energy of a system, conservation of energy for simple compressible closed systems; Definitions of enthalpy and specific heats; Conservation of energy for an open system or control volume, steady & transient Processes.	Ability to conduct energy analysis on open and closed thermodynamic systems
3.	Second Law of Thermodynamics: The directional constraints on natural processes; Formal statements; Concept of reversibility; Carnot principle; Absolute thermodynamic temperature scale; Clausius Inequality, entropy, change in various thermodynamic processes, Tds relations, entropy balance for closed and open systems, Principle of increase-in-Entropy, entropy generation.	Ability to evaluate feasibility of a process and estimate irreversibility associated with the process
4.	Exergy: Concept of reversible work & irreversibility; Second law efficiency; Exergy change of a system: closed & open systems, exergy transfer by heat, work and mass, exergy destruction, exergy balance in closed & open systems.	Ability to conduct exergy analysis on open and closed thermodynamic systems
5.	Thermodynamic Property Relations: Maxwell relations; Clausius-Clapeyron equation; Difference in heat capacities; Ratio of heat capacities; Joule-Thompson coefficient.	• Ability to conduct exergy analysis on open and closed thermodynamic systems.

Text Books:

1. Y. Cengel and MBoles, Thermodynamics - An Engineering Approach, Tata McGraw-Hilll, 7th Edition, 2010.

References:

1. Nag.P.K., "Engineering Thermodynamics", 4th Edition, Tata McGraw-Hill, New Delhi, 2008.
2. Sonntag R E, Borgnakke C and Van wylen G J, Fundamentals of Thermodynamics, 7th Edition, Wiley, 2009.
3. Moran M J and Shapiro H N, Fundamental of Engineering Thermodynamics, 7th Edition, John Wiley, 2010.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**Fluid Flow Lab**	0	0	3	2

Course Objective
• To verify various theorem of fluid mechanics. • To measure flow velocity, discharge, coefficient of discharge etc. • To understand the losses in pipes.
Learning Outcomes
Upon successful completion of this course student will: • Have a broad understanding of various measuring equipment such as venturimeter, orificemeter, rotameter, PIV, pitot static tube.

S.No.	Experiment
1.	Experiment to proof the Bernoulli s theorem
2.	Flow through square and circular pipes; horizontal nozzles; pipe fittings; V-notch
3.	Experiment to determine the value of discharge coefficient in Venturi meter, orifice meter.
4	Experiment to determine flow velocity in a pipe
5	Experiment to determine mass flow rate using rotameter. Calibration of Rotameter
6	To visualize two phase flow

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**Strength of material lab.**	0	0	2	2

Experiment No	Title of the Experiment
1.	Tension testing of ductile material
2.	Compression testing of brittle material
3.	Bending test on simply supported beam
4.	Bending test on cantilever beam
5.	Buckling of struts
6.	Torsion testing of shafts
7.	Impact testing
8.	Poisson ratio estimation
9.	Spring stiffness test (open and close coiled springs)
10.	Hardness testing of materials

Semester-IV

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**HEAT TRANSFER**	3	1	0	4

Course Objective
1. To develop the fundamental principles and laws of heat transfer and to explore the implications of these principles for system behavior. 2. To formulate the models necessary to study, analyze and design heat transfer systems through the application of these principles. 3. To develop the problem-solving skills essential to good engineering practice of heat transfer in real-world applications. 4. To understand basics of mass transfer process.
Learning Outcomes
At the end of the course, the student will be able to: 1. Ability to apply heat conduction law to estimate temperature distribution under steady and unsteady state conditions 2. Understand the concept of thermal boundary layers. 3. Identification and use of various forced convection non-dimensional number correlations under various conditions to estimate heat transfer 4. Identification and use of various free convection non-dimensional number correlations under various conditions to estimate heat transfer 5. Ability to estimate heat transfer during various boiling and condensing processes 6. Ability to select and design heat exchangers for any application 7. Understand basics of electromagnetic waves and basic laws of thermal radiation 8. Ability to estimate view factors and radiation heat transfer under different conditions 9. Ability to estimate mass transfer in various phenomenon.

Unit No	Topics	Learning Outcome
1.	Introduction, Modes of heat transfer, thermal conductivity, combined modes of heat transfer, concept of thermal contact resistance. Derivation of heat conduction equation, steady state one-dimensional heat conduction with and without generation of heat in simple geometries: plane wall, cylindrical and spherical walls, critical thickness of insulation, heat transfer from extended surfaces, 2D steady state heat conduction	LO1
2.	Forced convection: Derivation of energy equation, concept of thermal boundary layer and derivation of thermal boundary layer equation, flat plate in parallel flow (solution by energy integral method), cylinder in cross flow, internal flows: concept of thermally fully developed flow and its corollaries, fully developed pipe flow, fully developed channel flow with constant wall heat flux and viscous dissipation, turbulent flow in pipes, Reynolds analogy.	LO2 LO3
3.	Free convection: Vertical plate at constant temperature â derivation of governing equation, recognition of dimensionless terms, and solution by integral method, free convection in vertical channel.	LO4
4.	Condensation and Boiling: laminar film condensation over a vertical plate and horizontal circular tube. regimes of boiling heat transfer, correlations for heat flux in boiling. Heat exchangers: classification of heat exchangers, overall heat transfer coefficient, concept of fouling factor, LMTD and NTU methods of analysis for a double pipe heat exchanger, applications to multi-tube, multi-pass heat exchangers.	LO5 LO6
5.	Thermal radiation: Radiation properties, blackbody radiation, Planck’s law, Stefan-Boltzman law, Kirchoff’’s law, radiation exchange between black surfaces, concept of view factor, radiation exchange between non-black surfaces, two surface enclosure, three surface enclosure, concept of radiation shield.	LO7 LO8

Text Books:

Yunus A. Cengel, Heat Transfer A Practical Approach – Tata McGraw Hill – 2010

References:

Lienhard, John H., and John H. Lienhard. A Heat Transfer Textbook. Dover Publications, 2011. ISBN: 9780486479316.

Bergman, Theodore L., Adrienne S. Lavine, Frank P. Incropera, et al. Introduction to Heat Transfer. Wiley, 2011. ISBN: 9780470501962.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**Manufacturing Processes**	3	1	0	4

Course Objective
• To provide basic understanding on the technologies involved in Manufacturing processes. • To impart knowledge about the process and applications of metal casing, forming and welding.
Learning Outcomes
At the end of the course, the student will be able to: • Have a broad understanding of the different Processes and their applications. • Be able to select proper process and their parameters and equipment for manufacturing a component

Unit No	Topics	Learning Outcome
1.	Metal casting: Principle & review of casting processes, Design of patterns, moulds and cores, types and properties of moulding sand, riser and gating system design, solidification and cooling of casting. Casting defects & remedies and inspection.	A complete understanding on casting processes. Students will be able to design pattern, core and gating system.
2.	Metal Forming Processes: Elastic & plastic deformation, yield criteria, hot working and cold working, Bulk deformation processes: applications, operations, equipment and load estimation for Bulk deformation processes (forging, rolling, extrusion, drawing).	A complete understanding of metal forming process. Students will be able to estimate the required force for different forming processes.
3.	Sheet Metal working: applications, operations, equipment and load estimation of Sheet metal processes (shearing, deep drawing, bending), Introduction to Punch and die arrangements.	Will understand applications of sheet metal works. Students will be able to design the tools for different sheet metal operations.
4.	Joining processes: Broad classification of welding processes, working principle, characteristics and application of important welding processes, Precision welding processes and welding defects. Welding inspection techniques.	A complete understanding about different welding process. The students will able to choose the appropriate joining process as per the applications.
5.	Working principle, characteristics and application of Brazing, soldering and abrasive bonding.	Understanding about the joining process for dissimilar materials.

Text Books:

1. Manufacturing Science : Ghosh and Mallick, East-West Press Private Limited. 2nd Edition, 2010

Reference Books:

1. Materials and Processes in Manufacturing, Degarmo, J. T. Black, Prentice Hall of India Pvt Ltd. 11th Edition, 2017
2. Manufacturing Processes for Engineering Materials, Kalpakjian and Schmid, Prentice Hall. 6th Edition, 2016
3. Fundamentals of modern manufacturing processes, M. P. Groover, Wiley India, 3rd Edition, 2009
4. Machining and Metal Working Handbook, Ronal A Walsh and Denis Cormier McGraw Hill Publication. 3rd Edition, 2005.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**MECHANICAL MEASUREMENTS**	3	0	0	3

Course Objective

To provide knowledge of various measuring instruments, highly accurate and precise instruments.

Learning Outcomes

Upon successful completion of this course, students will:
Learn use of measuring instruments, errors and sources of errors

Unit No	Topics	Learning Outcome
1.	Introduction to measurement, definition, purpose and structure of measurement systems, linear and angular measurements, Errors in measuring instruments, sources of errors, types of errors and quantification of different types of errors in measurement; principle of calibration	Introduction to measuring systems
2.	Static and dynamic performance characteristics of measuring instruments, Limits, fits and tolerances; comparators. Interferometry, form and surface finish measurement	Behavior of measuring instruments under different measuring conditions.
3.	Alignment and testing methods for machine tools; tolerance analysis in manufacturing and assembly.	Able to perform testing of machine tool alignment.
4.	Introduction to sensors, transducer and actuator, sensing elements: working principles of resistive, capacitive, inductive, thermoelectric, piezoelectric, piezoresistive, hall effect sensors, optical sensors and encoders, charge coupled devices.	Knowledge about different electronic sensing elements.
5	Principle of measurement of pressure, strain, force, temperature. Introduction to virtual instrumentation.	Knowledge about measurements of different mechanical parameters.

Text Books

1. Experimental Methods for Engineers, J. P Hollman, Tata McGraw-Hill Education, 8E,2011.

Reference Books:

1. Bentley John, P. Principle of Measurement system, Pearson education, 2005.
2. Measurement and Instrumentation in Engineering: Principles and Basic LaboratoryExperiments, Francis L. S. Tse, Ivan E. Morse, Marcel Dekker Inc, New York.
3. Mechanical Measurement, Beckwith Thomas G, Narosa Publishing House .
4. Measurement systems, Application design, E.O. Doeblein, McGraw Hill.
5. Instrumentation, Measurement and Analysis (2/e), Nakra&Chowdhury.

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**Dynamics of Machines**	3	1	0	4

Course Objective

The course aims to equip the students with basic understanding of the dynamics of common moving parts of a machine.

Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Solve three dimensional rigid body problems Do the dynamic analysis of mechanisms
2. Design flywheel for engines.
3. Analyze and modify the design of cams.
4. Understand the dynamic part of an internal combustion engine.
5. Solve balancing problems

Unit No	Topics	Learning Outcome
1.	Introduction: Rigid body dynamics and Gyroscopes	Students will be able to solve engineering problems in rigid body dynamics
2.	Static force analysis: free-body diagram, static equilibrium, analysis of multi-force member, force analysis with friction.	Students will learn to do static force analysis of mechanism
3.	Dynamic force analysis: shaking effect, dynamic equilibrium, dynamic analysis of mechanisms, Dynamics of reciprocating and rotary machineS	Students will learn to find out shaking forces, shaking moments in machines
4.	Turning moment diagram, fluctuation of energy, flywheel, Governors	Students will understand the concept of regulating speed in machines
5.	Balancing of reciprocating and rotary machines, single and multi-cylinder engine balancing.	Students will be able to balance the reciprocating and rotary machines.
6.	Cam dynamics, analysis of disc cam with reciprocating roller follower, analysis of elastic cam system.	Students will be able to do dynamic analysis of CAM Follower system
7.	Introduction to free and forced vibrations, critical speed of shaft, vibration measuring instruments	Students will understand the basics of mechanical vibration

Text book:

Kinematics and Dynamics of Machinery, C. L. Wilson, J. P. Sadler, Pearson, 3rd Ed. 2016

Reference books:

Vector Mechanics for Engineers: Statics and Dynamics, F. P. Beer, E. R. Johnston, P. J. Cornwell, S. Sanghi, Tata McGraw Hill, 10th Ed. 2017
Kinematics, Dynamics and Design of Machinery, K. J. Waldron, G. L. Kinzel,. Wiley 2nd Ed, 2007.

ourse Type	Course Code	Name of Course	L	T	P	Credit
CORE		**Turbomachinery**	3	1	0	4

Course Objective
1. To understand kinematic and dynamic behaviour of fluid while passing through different fluid machines. 2. To understand working and performance characteristics of various hydraulic machines. 3. To provide knowledge about in field application and operational aspects of various hydraulic machines.
Learning Outcomes
Upon successful completion of this course student will: 1. Have a broad understanding of classification of fluid machines used to handle different fluid for different purpose. 2. Have an understanding of basics of rotodynamic machines 3. be able to design different types of fluid machines based on dimensional analysis. 4. be able to understand operation principle of different fluid machines, design or select it for particular purpose and identify the reasons for faults during operation.

Unit No	Topics	Learning Outcome
1.	Introduction to incompressible and compressible flow. Classification and field of application of fluid machines, Jet Striking Plates	Understanding basics of fluid flow. Classification of fluid machines and types of fluid handled by the machines.
2.	Water Turbines: Theory of Rotodynamic Machines-Euler's Equation, components of energy transfer, Classification – Impulse and Reaction Turbines, Construction, Operation, Head and efficiencies, Power calculation and governing of Pelton, Francis and Kaplan turbines; Draft tube; Surge tank.	Basics of rotodynamic machines. Detailed introduction and operation of different hydraulic turbines.
3.	Application of dimensional analysis in fluid machines - Unit quantities and Specific speed.	Utility of dimensional analysis to design and analyze the performance of fluid machines.
4.	Centrifugal Pumps: Types; Heads and efficiencies; Construction of impeller and casing; Multi-stage pumps; Specific speed; Model testing; Characteristic curves; NPSH; Cavitation; Selection of centrifugal pump.	This unit demonstrates the operation principle of centrifugal pump handling water.
5.	Reciprocating Pumps: Classification with constructional details; Theory; Indicator diagram; Effect of acceleration of piston; Effect of friction in pipes; Air vessel and its effects; NPSH. Rotary Positive Displacement Pumps: Types and constructional details.	This unit demonstrates the operation principle of reciprocating pump handling liquid.
6.	Air compressors, selection steps and testing procedure of fluid machines.	This unit demonstrates the operation principle of air compressor.

Text Books:
Introduction to Fluid Mechanics, S.K. Som, Gautam Biswas and Suman Chakraborty, 3rd Edition, 2011, McGraw Hill Publication

Reference Books:
1. Fluid Mechanics, Victor L Streeter, E. Benjamin Wylie and K.W. Bedford, 9th Edition, McGraw Hill Publication
2. Mechanics of Fluids, I.H. Shames, 3rd edition, 2013, Tata McGraw Hill Publication

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**FLUID SYSTEM LAB**	0	0	3	2

Course Objective
1. To understand kinematic and dynamic behaviour of fluid while passing through different fluid machines. 2. To understand working and performance characteristics of various hydraulic machines. 3. To provide knowledge about in field application and operational aspects of various hydraulic machines.
Learning Outcomes
Upon successful completion of this course student will: 1. Have a broad understanding of classification of fluid machines used to handle different fluid for different purpose. 2. Have an understanding of basics of rotdynamic machines 3. be able to design different types of fluid machines based on dimensional analysis. 4. be able to understand operation principle of different fluid machines, design or select it for particular purpose and identify the reasons for faults during operation.

Unit No	Topics	Learning Outcome
1	Study on impact of jets on different blades	
2	Study of construction and working of different types of pumps	
3	Performance test on two stage reciprocating air compressor testing rig.	
4	Performance test on blower testing rig	
5	Performance test on multistage centrifugal pump	
6	Performance test on Pelton turbine	
7	Performance test on Francis turbine	
8	Performance test on Kaplan turbine	

Course Type	Course Code	Name of Course	L	T	P	Credit
CORE		**HEAT TRANSFER LAB**	0	0	3	2

Experiment No	Title of the Experiment
1.	Thermal conductivity estimation of compound flat slabs
2.	Thermal conductivity estimation of compound annular pipes
3.	Forced convection heat transfer from Pin-Fin apparatus
4.	Natural convection heat transfer from vertical heated pipe
5.	Transient heat transfer (Lumped analysis)
6.	Estimation of Stefan-Boltzmann's constant
7.	Emissivity measurement
8.	Heat transfer in counter flow heat exchanger
9.	Heat transfer in parallel flow heat exchanger
10.	Boiling heat transfer