B.TECH. – MECHANICAL ENGINEERING COURSE STRUCTURE – R23

(Applicable from the academic year 2023-24 onwards)

MINOR COURSES

Course Code	**Name of the Minor Course offered**
23MEM1	Mechanics of Materials
23MEM2	Principles of Manufacturing Processes
23MEM3	Fundamentals of Fluid Mechanics & Hydraulic Machines
23MEM4	Basic Thermodynamics
23MEM5	Robotics
23MEM6	Computer Aided Design
23MEM7	Strength of Materials and Fluid Mechanics Lab
23MEM8	Computer Aided Design and Drafting Lab
23MEM9	Manufacturing Processes and Robotics Lab

23MEM1- MECHANICS OF MATERIALS

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVE:

The objective of the course is to develop the ability to predict the behaviour of rigid solid bodies under the action of external forces in real world scenario and compute the deformations in mechanical members due to various loads.

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

CO1: Apply free body diagram concepts to analyze rigid bodies in static conditions. **(Apply-L3)**

CO2: Identify the location of centroid and evaluate the moment of inertia of plane sections. (**Apply-L3**)

CO3: Compute the stresses and deformations of a member subjected to various types of loading. **(Applying-L3)**

CO4: Construct the shear force and bending moment diagrams along the length of beam. **(Applying-L3)**

CO5: Comprehend the variation of bending and shear stresses across the cross section of the beams. **(Understanding-L2)**

UNIT– I

SYSTEM OF FORCES: Introduction, Basic terminology in Mechanics, laws of Mechanics, characteristics of force, system of forces-types, Resolution and Composition of forces, Resultant of coplanar concurrent force system, Resultant of coplanar non-concurrent force system-moment of a force and couple.

EQUILIBRIUM OF SYSTEM OF FORCES: Free Body Diagram, Lami's theorem, Equilibrium of a rigid body subjected to coplanar concurrent forces and non-concurrent forces, Equilibrium of connected bodies.

UNIT– II

CENTROID AND AREA MOMENT OF INERTIA: Introduction, centroid, axis of symmetry, centroid of simple figures from first principles, centroid of simple composite sections, area moment of inertia, polar moment of inertia, theorems of moment of inertia, moment of inertia of rectangle, circle, semi-circle, I and T cross sections.

UNIT– III

SIMPLE STRESSES AND STRAINS: Stress and strain due to axial force, Hooke's law, Strains, Poisson's ratio, Stepped bars - Stresses in composite bars due to axial force - Relationship between elastic constants.

UNIT– IV

SHEAR FORCE AND BENDING MOMENT: Relationship between loading, shear force and bending moment - Shear force and bending moment diagrams for cantilever, simply supported beams subjected to concentrated loads and uniformly distributed loads only - Maximum bending moment and point of contra flexure.

UNIT– V

STRESSES IN BEAMS: Theory of simple bending - Assumptions - Derivation of flexure equation – Section modulus - Normal stresses due to flexure applications.

SHEAR STRESSES: Derivation of formula – Shear stress distribution across beam cross sections like Rectangular, Circular sections only.

TEXTBOOKS:

1. S.S. Bhavikatti and K.G. Rajashekarappa, Engineering Mechanics, New Age, 2012.
2. N.H. Dubey, Engineering Mechanics, Mc Graw Hill, 2013.
3. E.P. Popov, Engineering Mechanics of Solids, PHI Learning, 2009.
4. Sadhu Singh, Strength of Materials, Khanna Publishers, 2013.

REFERENCES:

1. A.K.Tayal, Engineering Mechanics, Umesh Publications, 2012.
2. S.Ramamrutham, Strength of Materials, Dhanpat Rai& Sons, 2011.
3. R.K.Bansal, “Strength of Materials”, Laxmi Publishers, 2013.

23MEM2- PRINCIPLES OF MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

PRE-REQUISITES: Engineering Physics, Applied Mathematics

COURSE EDUCATIONAL OBJECTIVES:

This course aims to introduce the fundamental concepts of manufacturing processes used in industries, including casting, forming, machining, finishing, and modern techniques such as 3D printing. It is designed to give students of all engineering branches a basic understanding of how components are made, their material behaviour, and common production methods used in real-world applications.

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

CO1	Understand the properties of engineering materials and basic casting and welding processes with their advantages and limitations. (**Understanding – L2**)
CO2	Identify key forming and sheet metal processes used in manufacturing, along with their practical significance. (**Understanding – L2**)
CO3	Demonstrate the working principles and applications of cutting tools and conventional machine tools such as lathe, slotter, and shaper. (**Applying – L3**)
CO4	Apply the knowledge of drilling, milling, and finishing processes for basic manufacturing applications. **(Applying – L3)**
CO5	Apply the principles of additive manufacturing and distinguish between 3D printing processes with respect to their capabilities and uses. **(Applying – L3)**

UNIT – I: ENGINEERING MATERIALS, CASTING AND WELDING PROCESSES

ENGINEERING MATERIALS: Classification of engineering materials – mechanical and thermal properties – selection criteria for manufacturing.

CASTING: Basic principles – casting steps – types of casting (sand, die, investment - brief overview) – advantages, limitations, and applications – common casting defects (introductory level).

WELDING: Basic concepts – types of welding processes (arc, gas, resistance – introductory) – welding joints – advantages, limitations, and typical applications – safety precautions.

UNIT – II: FORMING AND SHEET METAL OPERATIONS

FORMING PROCESSES: Basic concept of plastic deformation – classification – forging, rolling, extrusion, and wire drawing – working principles – major applications, advantages, and limitations.

SHEET METAL OPERATIONS: Bending, punching, blanking, deep drawing – tools used, process parameters, advantages, limitations, and typical applications in industry.

UNIT – III: METAL CUTTING AND CONVENTIONAL MACHINE TOOLS

FUNDAMENTALS OF METAL CUTTING: Introduction to machining – chip formation – types of chips – cutting tool materials – tool geometry – single point and multi-point tools – tool wear (concept only).

MACHINE TOOLS: Lathe, slotter, shaper, and planner – constructional features – working principles – operations performed – specifications – advantages and limitations – industrial applications.

UNIT – IV: DRILLING, MILLING AND FINISHING PROCESSES

DRILLING AND MILLING MACHINES: Construction and working principles – types of drilling and milling machines – tools used – specifications – common operations – applications.

FINISHING PROCESSES: Introduction to grinding, lapping, honing, polishing – types of grinding wheels – purpose of finishing – advantages and limitations of each process.

UNIT – V: ADDITIVE MANUFACTURING AND 3D PRINTING

3D PRINTING CONCEPTS: Introduction to additive manufacturing – comparison with subtractive manufacturing – working principles of major 3D printing processes: FDM, SLA, SLS – commonly used materials.

APPLICATIONS AND LIMITATIONS: Advantages – limitations – typical applications across industries – role in prototyping, custom parts, electronics, and biomedical fields – future scope.

TEXTBOOKS:

1. Kalpakjian S. and Schmid S.R., Manufacturing Engineering and Technology, Pearson Education.
2. Hajra Choudhury S.K., Elements of Workshop Technology Vol. 1 & 2, Media Promoters.
3. Rao P.N., Manufacturing Technology Vol. I & II, McGraw Hill Education.

REFERENCE BOOKS:

1. Ghosh A. and Mallik A.K., Manufacturing Science, East-West Press.
2. Degarmo E.P., Black J.T., Kohser R.A., Materials and Processes in Manufacturing, Wiley.
3. Campbell J., Complete Casting Handbook, Elsevier.
4. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies, Springer.

23MEM3- FUNDAMENTALS OF FLUID MECHANICS AND HYDRAULIC MACHINES

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

The students completing this course are expected to Understand the properties of fluids, manometry, hydrostatic forces acting on different surfaces, Understand the kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations and understand the theory of boundary layer.

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

CO1	Understand the properties of fluids, manometry, hydrostatic forces acting on different surfaces. **(Understanding-L2)**
CO2	Comprehend the kinematics of fluid flows. **(Understanding-L2)**
CO3	Elaborate surface forces and losses in pipe flows. **(Understanding-L2)**
CO4	Apply the boundary layer theory to determine flow separation in fluid flow systems. **(Apllying-3)**
CO5	Distinguishes the performance parameters of turbines and pumps. **(Understanding-L2)**

UNIT-I

FLUID STATICS: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

UNIT-II

FLUID KINEMATICS: Introduction, flow types--Steady & Un Steady, Uniform and Non Uniform, Laminar, Turbulent, Rotational and Irrotational Flows. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them.

UNIT-III

FLUID DYNAMICS: surface and body forces –Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend. Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipespipes in series and pipes in parallel total energy line hydraulic gradient line.

UNIT-IV

BOUNDARY LAYER THEORY: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

UNIT-V

HYDRAULIC TURBINES: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working principle.

PERFORMANCE OF HYDRAULIC TURBINES: Geometric similarity, Unit and specific quantities.
CENTRIFUGAL PUMPS: classification, working,
RECIPROCATING PUMPS: Classification and Working,

TEXT BOOKS:

1. Y.A. Cengel, J.M.Cimbala, Fluid Mechanics, Fundamentals and Applications,6/e,McGraw Hill Publications, 2019
2. Dixon, Fluid Mechanics and Thermodynamics of Turbo machinery, 7/e, Elsevier Publishers, 2014.

REFERENCE BOOKS:

1. P N Modi and S M Seth, Hydraulics & Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017.
2. RK Bansal, Fluid Mechanics and Hydraulic Machines, 10/e, Laxmi Publications (P)Ltd, 2019.
3. Rajput, Fluid Mechanics and Hydraulic Machines, S Chand & Company, 2016
4. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S K Kataria &Sons, 2013.

23MEM4- BASIC THERMODYNAMICS

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

The objective of this course is to provide a thorough understanding of the fundamental concepts and laws of thermodynamics, enabling students to analyze energy systems and thermal processes. It aims to develop the ability to apply thermodynamic principles to solve practical engineering problems related to energy conversion and system efficiency.

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

CO1	Understand the basics of thermodynamics and its relevance in practical systems. **(Understanding-L2)**
CO2	Apply the first law of thermodynamics to solve the conversions efficiencies of systems. **(Applying-L3)**
CO3	Interpret the working principles in heat engines, refrigerators and in heat pumps. **(Applying-L3)**
CO4	Use property tables and diagrams for solving thermodynamic problems. **(Applying-L3)**
CO5	Compute the performance parameters of various thermodynamic cycles. **(Applying-L3)**

UNIT 1: BASIC CONCEPTS OF THERMODYNAMICS

Thermodynamic systems and control volumes, Surroundings, boundaries, types of systems, Macroscopic vs. microscopic approach, Properties, state, process, and cycle, Thermodynamic equilibrium, quasi-static processes, Temperature and Zeroth Law of Thermodynamics, Concept of continuum.

UNIT 2: FIRST LAW OF THERMODYNAMICS

Energy, work, and heat, First law applied to closed systems, Internal energy and specific heats, First law for open systems (control volume), Steady flow energy equation and its applications (turbines, compressors, heat exchangers)

UNIT 3: SECOND LAW OF THERMODYNAMICS

Limitations of First Law, Introduction, Source, Sink, Heat engines, refrigerators, heat pumps, air conditioners, Kelvin-Planck and Clausius statements, Reversibility and irreversibility, Carnot's theorem.

UNIT 4: PROPERTIES OF PURE SUBSTANCES

Phases of pure substances, P-v, T-s, and h-s diagrams, Steam tables and Mollier charts, Phase change processes, Use of property tables and diagrams in solving problems.

UNIT 5: THERMODYNAMIC CYCLES

Introduction, Carnot Cycle, Otto, Diesel, Dual cycles, Brayton cycle, and Bellcoleman cycle, Efficiency comparison, Actual vs. ideal cycles.

TEXTBOOKS:

1. Basic Thermodynamics – P.K. Nag,
2. Thermodynamics: An Engineering Approach – Yunus A. Cengel and Michael A. Boles

REFERENCE BOOKS:

1. Fundamentals of Classical Thermodynamics – Sonntag & Van Wylen
2. Basic and Applied Thermodynamics – P. K. Nag
3. Thermodynamics – J.P. Holman

23MEM5- ROBOTICS

L	T	P	C
3	0	0	3

PRE-REQUISITES: Basic knowledge of Engineering Mechanics and Manufacturing Processes

COURSE EDUCATIONAL OBJECTIVES:

This course introduces students to the fundamentals of robotics with a focus on anatomy, actuation, sensing, kinematics, and programming. The course also integrates emerging trends like collaborative robots, AI vision, and simulation tools, enabling students from various disciplines to explore applications in automation, smart systems, and robotics.

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

- **CO1** Understand the anatomy, classification, and components of industrial and service robots. (**Understanding – L2**)
- **CO2** Understand the working principles of actuators and sensors used in robotic systems. (**Understanding – L2**)
- **CO3** Apply basic kinematic models and transformations for robot motion. (**Applying – L3**)
- **CO4** Apply programming and simulation tools to perform trajectory planning and basic robot control. **(Applying – L3)**
- **CO5** Understand and apply the role of vision systems, collaborative robotics, and AI in modern robotic applications. **(Applying – L3)**

UNIT – I: INTRODUCTION TO ROBOTICS AND ROBOT ANATOMY

ROBOTICS BASICS: Definition – Types of robots: industrial, service, mobile, and collaborative – Classification based on configuration (Cartesian, cylindrical, SCARA, articulated) – Applications in manufacturing, healthcare, surveillance, and logistics.

ROBOT STRUCTURE: Basic components – Links, joints, actuators – Degrees of freedom – Workspace – Drive systems – Types of end-effectors (grippers, tools) – Selection criteria.

UNIT – II: ACTUATORS AND SENSORS IN ROBOTICS

ACTUATORS: Working principles of electric (DC, stepper, servo), pneumatic, and hydraulic actuators – Selection based on control, cost, and response – Comparison of actuation systems.

SENSORS: Position, proximity, force/torque, vision, and tactile sensors – Feedback systems – Signal conditioning – Interfacing with microcontrollers/embedded systems – Basic sensor fusion concepts.

UNIT – III: KINEMATICS AND TRANSFORMATIONS

COORDINATE SYSTEMS AND TRANSFORMATIONS: Robot frames – 2D and 3D transformations – Homogeneous transformation matrices – Forward kinematics using transformation matrices.

KINEMATICS: Introduction to Denavit–Hartenberg (D-H) representation – Forward and inverse kinematics for simple manipulators – Workspace analysis – Joint vs Cartesian control.

UNIT – IV: ROBOT PROGRAMMING AND TRAJECTORY PLANNING

TRAJECTORY PLANNING: Joint and Cartesian trajectory generation – Interpolation techniques (linear, circular) – Motion control – Simulation using tools like RoboDK or ROS (overview).

ROBOT PROGRAMMING: Programming methods – Online and offline programming – Basics of robot languages: RAPID (ABB), URScript (Universal Robots), Python for robots.

UNIT – V: MACHINE VISION, AI, AND RECENT TRENDS IN ROBOTICS

MACHINE VISION: Basics of image acquisition – Vision system architecture – Image preprocessing – Feature extraction – Use of OpenCV – Applications in inspection, object tracking, and navigation.

RECENT TRENDS: Collaborative robots (Cobots) – Human-robot interaction – AI integration in robotics – Introduction to reinforcement learning in robotics – Cloud robotics – IoT-enabled robots – Applications in smart industries and warehouses.

TEXTBOOKS:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Systems & Applications, 2nd Ed., Wiley India.
2. R.K. Mittal & I.J. Nagrath, Robotics and Control, Tata McGraw-Hill.

REFERENCE BOOKS:

1. Mikell P. Groover et al., Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Ed., Pearson.
3. Robert J. Schilling, Fundamentals of Robotics: Analysis and Control, PHI.

23MEM6- COMPUTER AIDED DESIGN

L	T	P	C
3	0	0	3

PRE-REQUISITES: Basics of Machine Drawing, Programming, and any exposure to Engineering Graphics or Design Tools

COURSE EDUCATIONAL OBJECTIVES:

This course introduces students to computer-aided design principles with a focus on geometric modeling and techniques are wireframe modeling, surface modeling and solid modeling,

Design applications, collaborative engineering and expert systems. The course is structured to bridge design and digital manufacturing, offering interdisciplinary relevance across domains like CAD, robotics, and automation.

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

CO1	Explain CAD systems and curve representation techniques. (Understanding – L2)
CO2	Describe representation techniques for various surface entities. (Understanding – L2)
CO3	Describe different solid modeling techniques and translate different formats of CAD/CAM data. (Understanding – L2)
CO4	Describe various design applications of machine components and appraise the collaborative engineering. (Understanding – L2)
CO5	Apply expert systems in CAD. (Applying – L3)

UNIT – I: INTRODUCTION TO CAD SYSTEM

CAD SYSTEM: Product cycle, scope and applications of CAD/CAM, coordinate systems, basic features, datum features, modeling strategies.

CURVES: Curve entities, curve representation, parametric representation of analytic and synthetic curves, Hermite cubic spline, Bezier curve, B-spline curve, curve manipulation.

UNIT – II: SURFACE MODELING

SURFACE MODELING: Surface entities, surface representation, surface analysis, analytic surface, synthetic surface, Hermite Bi-cubic surface, Bezier surface, B-Spline surface, coons surface, blending surface, surface manipulation.

UNIT – III: SOLID MODELLING and CAD/CAM DATA EXCHANGE

Solid modelling: Solid entities, solid representation, boundary representation, constructive solid geometry, sweep representation.

CAD/CAM data exchange: Types of translators, IGES, STEP, processors.

UNIT – IV: DESIGN APPLICATIONS and COLLABORATIVE ENGINEERING

DESIGN APPLICATIONS: Mass properties on CAD system, assembly modeling, mating conditions, bottom-up and top-down assembly approach.

COLLABORATIVE ENGINEERING: Distributed computing, virtual reality modelling language, collaborative design

UNIT – V: EXPERT SYSTEMS

EXPERT SYSTEMS: Artificial intelligence in CAD, application of artificial intelligence in design, structure of expert system, building an expert system, strategies of knowledge acquisition, knowledge representation, Inference process, neural network.

TEXTBOOKS:

1. Ibrahim Zeid, Mastering CAD/CAM, McGraw Hill, 2015.

2. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publisher, 2015.

REFERENCE BOOKS:

1. Ibrahim Zeid, CAD/CAM Theory and Practice, 2nd Edition, McGraw Hill International, 2016.
2. P N Rao, CAD/CAM, 2nd Edition, Tata McGraw Hill, 2010.

23MEM7 - STRENGTH OF MATERIALS AND FLUID MECHANICS LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: Mechanics of Materials

COURSE EDUCATIONAL OBJECTIVE:

The main objective of this course is to demonstrate the concepts of theory of machines and to impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

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

CO1: Verify various laws of mechanics. **(Applying-L3)**

CO2: Evaluate the mechanical properties of materials by conducting various tests. **(Applying-L3)**

CO3: Identify the need and use of various flow measuring devices and compute major losses in pipes. **(Applying-L3)**

CO4: Apply the Bernoulli's equation for energy balance of fluid flow system. **(Applying-L3)**

LIST OF EXPERIMENTS:

At least 10 experiments are to be conducted

STRENGTH OF MATERIALS LAB

1. Verification of polygon law of forces
2. Verification of Law of Moment using Bell Crank Lever
3. Determination of mechanical properties of tensile specimen on UTM
4. Determination of Impact strength of given material specimen
5. Determination of rigidity modulus of material on Torsion Testing machine
6. Determination of Young's modulus of Simply Supported Beam material.

FLUID MECHANICS LAB

1. Calibration of Venturimeter.
2. Calibration of Orificemeter.
3. Verification of Bernoulli's Theorem.
4. Determination of friction factor for a given pipeline.
5. Determination of loss of head due to sudden contraction in a pipeline.
6. Determination of flow rate of a fluid by using Turbine flow meter.

REFERENCES: Lab Manuals

23MEM8 - COMPUTER AIDED DESIGN AND DRAFTING LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: Engineering Graphics

COURSE EDUCATIONAL OBJECTIVE:

The main objective of this course is to improve the skill sets of students in drafting packages (Auto CAD/CATIA) and enable them to draw the diagrams related to mechanical engineering components/applications.

COURSE OUTCOMES: After completion of the course students will be able to:

CO1: Understand the Auto-CAD basics for 2D sketches used in industries. **(Understanding - L2).**

CO2: Draw the machine components using 3D modelling commands. **(Applying –L3)**
CO3: Edit the 3D solid Models using solid editing commands. **(Understanding - L2)**

CO4: Extract the Orthographic views of the models in Wire Frame, Surface & Solid Modelling. **(Applying –L3)**

Exercises to be conducted using Auto CAD software:

Expt. No.	Type of Drawings	Name of the Experiment
1.	Basic drawing Commands	Exercise on Basic Drawing Commands
2.	Modify commands	Exercise on Modify Commands
3.	Isometric Diagrams using 2D commands	Exercise on isometric views
4.	3D Modelling Commands	Exercise on 3D Modelling Commands-I
5.		Exercise on 3D Modelling Commands-II
6.		Exercise on 3D Modelling Commands-III
7.	3D Solid Editing Commands	Exercise on 3D Solid Editing Commands-I
8.		Exercise on 3D Solid Editing Commands-II
9.		Exercise on 3D Solid Editing Commands-III
10.	Wire Frame, Surface & Solid Modelling	Perform Wire Frame, Surface & Solid Modelling from 3D Models
11.	Drafting	Extraction of Ortho Graphics Views from 3D model-I
12.		Extraction of Ortho Graphics Views from 3D model-II

WEB REFERENCES:

1. https://www.slideshare.net/qarni888/auto-cad-introduction
2. https://www.slideshare.net/Vgroksoo7/presentation-on-auto-cad
3. https://www.autodesk.in/shortcuts/autocad
4. https://www.youtube.com/watch?v=uy2GvFwVJU4&list=PL970B66C256FA05E1

https://www.youtube.com/watch?v=HDTwvQ06zDI&list=PL970B66C256FA05E1&index=62

23MEM9- MANUFACTURING PROCESSES AND ROBOTICS LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: Principles of Manufacturing Processes, Robotics.

COURSE EDUCATIONAL OBJECTIVE:

1. To provide hands-on experience with basic manufacturing processes such as casting, welding, forming, machining, and 3D printing.
2. To familiarize students with conventional machine tools and basic metrology instruments.
3. To introduce students to fundamental robotic operations, programming, and simulation techniques.

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO1: Demonstrate basic manufacturing operations such as welding, casting, forming, and machining with proper safety precautions. **(Applying-3)**

CO2: Perform machining operations using lathe, drilling, and milling machines, and verify part dimensions using basic measuring tools. **(Applying-3)**

CO3: Operate 3D printing equipment for simple prototyping tasks and understand process steps. **(Applying-3)**

CO4: Execute simple robotic programming tasks using simulation and physical robots for basic pick-and-place and path planning. **(Applying-3)**

PART-A: MANUFACTURING PROCESSES LAB

At least six experiments may be conducted.

List of Experiments:

1. **Arc Welding Practice** – Performing bead-on-plate weld using arc welding setup; observe weld characteristics and safety measures.
2. **Sand Casting Demonstration** – Preparation of sand mould, pouring, solidification, and pattern removal.
3. **Sheet Metal Operation** – Performing basic operations like bending, cutting, and blanking using hand tools.
4. **Lathe Operations** – Facing, turning, step turning, taper turning, and threading on a mild steel rod.
5. **Drilling and Tapping** – Performing drilling, tapping, and countersinking operations on a given workpiece.
6. **Milling Machine Operation** – Simple slot cutting or gear cutting operation using plain or vertical milling machine.
7. **Grinding Operation** – Surface or cylindrical grinding to achieve the desired surface finish.
8. **3D Printing** – Introduction to slicing software, setup, and printing of a simple CAD model using FDM printer.
9. **Basic Metrology Practice** – Use of Vernier calliper, micrometre, and dial gauge for dimensional inspection.

PART-B: ROBOTICS LAB

At least four experiments may be conducted.

List of Experiments:

- **Introduction to Robot Anatomy and Axes Configuration** – Identifying parts, joints, and degrees of freedom of a robotic arm.
- **Pick and Place Operation** – Programming a robot (real or simulated) to pick and place an object at a specified location.
- **Path Programming using RoboAnalyzer / igus Robot Control Software** – Joint interpolation and linear path planning.
- **Forward and Inverse Kinematics Visualization** – Simulate the kinematic chain of a robot and interpret position/orientation.
- **Gripper Mechanism Demonstration** – Operating and analyzing a two-finger or suction-based gripper using a robotic arm.
- **Human-Robot Interaction Demo** – Using sensors or interface to control basic robot motion.

HONORS

IN

THERMAL SYSTEMS ENGINEERING

23TEH1- ADVANCED THERMAL ENGINEERING

L	T	P	C
3	0	0	3

PRE-REQUISITES: Thermodynamics

COURSE EDUCATIONAL OBJECTIVE:

The main objective of this course is to provide the knowledge on internal combustion engines with emphasis on pollutants and their control strategies, heat release rate and cylinder pressure analysis. The focus is on explaining the possible utilization of alternate fuels and their performance. On the other hand, economic and environmental aspects of alternative fuels usage will be illustrated.

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

- **CO1:** Analyse the combustion phenomenon of IC Engines and also the performance parameters. **(Analyzing-L4)**
- **CO2:** Describe the modern developments in IC Engines. **(Understanding-L2)**
- **CO3:** Demonstrate the working of gas turbines and compressors. **(Understanding-L2)**
- **CO4:** Apply various techniques to generate power from solar energy. **(Applying-L3)**
- **CO5:** Evaluate the performance parameters of refrigeration systems. **(Analyzing-L4)**

UNIT-I

I.C Engines: Classification - Working principles of SI and CI engines, Valve and Port Timing Diagrams, Otto, diesel and dual cycles, its comparison, Measurement, Testing and Performance.

COMBUSTION IN SPARK-IGNITION ENGINES: Stages of combustion in SI Engine- Flame Front propagation-Factors influencing flame speed- Rate of pressure rise-Analysis of Cylinder Pressure data- Heat release analysis-Abnormal combustion- Effects of Knocking- Effect of various parameters on Knocking- SI Engine Combustion chambers.

COMBUSTION IN COMPRESSION-IGNITION ENGINES: Stages of combustion in CI Engine-Factors effecting Ignition delay- Detonation in CI Engine-Types of injection systems in Diesel engines- Combustion chambers in CI Engines- Analysis of Cylinder Pressure data- Heat release analysis.

UNIT-II

MODERN DEVELOPMENTS IN IC ENGINES: Lean burn engines, Ceramic and adiabatic engines, Working principle of dual fuel engines, Multi-fuel engines, Stratified charged engines, Wankel engine, Features of Rotary engine, Variable compression-ratio engines, Methods of obtaining variable compression-ratio, Surface-ignition engines, Free Piston engines, Homogeneous charge compression-ignition engines.

UNIT-III

GAS TURBINES: Introduction, Classification, working and application of Gas Turbines, Ideal and Actual Cycles; Effect of Inter cooling, Reheating, Regeneration on gas turbine performance.

COMPRESSORS: Reciprocating and Rotary Compressors Introduction, Classification, Reciprocating compressors –Single, double and multistage compressors working principle, Power requirement of reciprocating compressors, efficiencies, Rotary compressors, Axial flow and centrifugal compressors.

UNIT-IV

SOLAR ENERGY: Performance Analysis of Non-concentrating Solar Collectors, Useful Heat Output Of A Non-concentrating Solar Collector, Efficiency Of Non-concentrating Solar Collectors, Performance Analysis Of Concentrating Solar Collectors, Efficiency of Concentrating Solar Collectors, Performance Of A Line-Focus Concentrating Collector, Performance Of Point-Focus Concentrating Collectors, Solar Thermal Electrical Power Plants and its Performance Parabolic Trough Solar Power Plants, Solar Power Tower Power Plants, Parabolic Dish/Stirling Engine System, Compact Linear Fresnel Reflector, Integrated Solar Combined-Cycle System (ISCC).

UNIT-V

REFRIGERATION: Introduction-Necessity and applications, unit of refrigeration, Heat Engine, Refrigerator and Heat Pump-C.O.P and Types of Refrigeration. Simple Vapour Compression refrigeration cycle, P-h charts, Factors affecting performance of VCR cycle, Actual VCR cycle. Introduction-Multi stage or Compound Compression-Multi Evaporator system-Cascade System.

CRYOGENICS: Introduction, Joules Thomson effect, production of dry ice, liquefaction of Hydrogen, Liquefaction of helium, Linde system, Claude system & its analysis, application of cryogenics.

TEXT BOOKS

1. Thermal Engineering - Mahesh Rathore- McGraw Hill publishers
2. Heat Engineering /V.P Vasandani and D.S Kumar/Metropolitan Book Company, New Delhi

REFERENCES

1. John B. Heywood, Internal Combustion Engine Fundamentals, 3rd edition, McGraw-Hill series, 2008.
2. V.Ganesan, Internal Combustion Engines, 4th edition, Tata McGraw Hill Education Private Limited, 2013.
3. S.S. Thipse, Alternative Fuels- Concepts, Technologies and Developments, 2nd edition, Jaico Publishing House, 2010.
4. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar / Dhanpatrai.2012.

23TEH2- ADVANCED FLUID MECHANICS

L	T	P	C
3	0	0	3

PRE-REQUISITES: Fluid Mechanics

COURSE EDUCATIONAL OBJECTIVE:

The main objective of this course is to provide the knowledge on the advanced concepts of fluid mechanics and its applications.

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

- **CO1:** Describe the laminar flow of viscous and in compressible fluids with governing equations. **(Understanding-L2)**
- **CO2:** Apply the boundary layer concepts for solving complex fluid flow problems. **(Applying-L3)**
- **CO3:** Discuss the features of turbulence and compressible fluid flow. **(Understanding-L2)**
- **CO4:** Apply the gas dynamics concepts to solve the problems of air flow in nozzles. **(Applying-L3)**
- **CO5:** Describe the fluid flow problems with friction in ducts. **(Understanding-L2)**

UNIT-I

BASIC CONCEPTS: Continuum hypothesis – Eulerian and Lagrangian descriptions. Derivation of general differential equations – continuity momentum and energy of incompressible flow- Navier Stokes equation for Viscous Fluids (Rectangular Coordinate Systems)- Euler"s equations for ideal fluids- Bernoulli"s equations (one dimensional) – applications.

LAMINAR FLOW VISCOUS INCOMPRESSIBLE FLUIDS: Flow similarity – Reynolds number, flow between parallel flat plates, Couette-flow, plane Poiseuille flow, Hagen – Poiseuille flow.

UNIT-II

LAMINAR BOUNDARY LAYER: Boundary layer concept, Prandtl"s approximations, Blassius solution for a flat plate without pressure gradient – momentum integral equation – Von-Kerman integral relation – Pohlhausen method of obtaining approximate solutions. Displacements thickness, momentum thickness and energy thickness. Boundary layer separation and control. Kerman integral equation.

UNIT-III

INTRODUCTION TO TURBULENCE: Origin of turbulence, nature of turbulent flow – Reynolds equations and Reynolds stresses, velocity profile.

COMPRESSIBLE FLUID FLOW BASICS: Mach number, Flow pattern in compressible flow, classification of compressible flow, isentropic flow, stagnation properties.

UNIT-IV

GAS DYNAMICS: Compressible flow through duct and nozzles – area velocity relations. Flow through convergent and convergent divergent nozzles. Real nozzles flow at design conditions. Introduction to normal compression shock – normal shock relations. Introduction to Fanno Raleigh equations.

UNIT-V

FLOW IN DUCTS WITH FRICTION: Fanno line, adiabatic constant area- Flow of perfect gas, chocking due to friction in constant area flow- Introduction to constant area flow with heat transfer (Raleigh line)

REFERENCE BOOKS

1. "Foundations of Fluid Mechanics", Yuan S.W. Prentice Hall – Eastern economy edition, 1983.
2. " Gas Dynamics", Zucrwo M.J. and Hoffman J.D.Vol-I & Vol-II, John Wiley and Sons Inc. 1977.
3. "Fundamentals of Compressible Flow", - Yahya S.M. Wiley Eastern.
4. "A Brief Introduction to Fluid Mechanics" Young, Munsen and Okiisyi, 2nd Edition, John Wiley, 2000.
5. " Fluid Mechanics, Frank.M.White 5th Edn – McGraw Hill, 2005.
6. D. Rama Durgaiah. (Fluid Mechanics and Machinery –New Age Publishers
7. William F. Hughes & John A. Brighton -Fluid Dynamics Tata McGraw-Hill
8. Schlichting H – Boundary Layer Theory (Springer Publications).
9. Pai - An Introduction to Compressible Flow.
10. Shapiro - Dynamics & Theory and Dynamics of Compressible Fluid Flow.

23TEH3- ADVANCED HEAT TRANSFER

L	T	P	C
3	0	0	3

PRE-REQUISITES: Thermodynamics

COURSE EDUCATIONAL OBJECTIVE:

To transform the physics of heat conduction, convection and radiation problem into its equivalent mathematical model. Also to analyze the internal, external forced and natural convection problems, radiation exchange between the surfaces and concepts of LMTD and NTU in heat exchangers.

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

- **CO1:** Develop the mathematical model by understanding the physics of heat conduction/convection /thermal radiation problem into its equivalent mathematical model. **(Applying-L3)**
- **CO2:** Solve the internal external forced convection and natural convection problems using analytical methods. **(Applying-L3)**
- **CO3:** Compute the heat transfer aspects in phase change processes. **(Applying-L3)**
- **CO4:** Find radiant energy exchange in thermal radiation systems. **(Applying-L3)**
- **CO5:** Determine the LMTD and NTU aspects in heat exchangers. **(Applying-L3)**

UNIT-I

STEADY STATE HEAT CONDUCTION: Review of basic concepts of conduction, convection and radiation, Initial and boundary conditions, Methods of formulation: lumped, differential and integral formulations.

TRANSIENT HEAT CONDUCTION: Formulation of transient heat conduction problems with time independent boundary conditions in different geometries and their analytical solutions: method of separation of variables, method of Laplace transforms. Differential formulation of steady two-dimensional heat conduction problems in different geometries and their analytical solutions, method of superposition.

UNIT-II

FORCED CONVECTION: External laminar forced convection for flow over a semi-infinite flat plate; Integral and similarity solutions for different thermal boundary conditions; viscous dissipation effects in laminar boundary layer flow over a semi-infinite flat plate, Internal laminar forced convection: exact solutions to solution for rectilinear flows, axisymmetric rectilinear flows, and axisymmetric torsional flows; Solution for fully developed flow through a pipe with different thermal boundary conditions, Flow in the thermal entrance region of a circular duct.

FREE CONVECTION: External laminar free convection: integral and similarity solutions for semi-infinite vertical plate with different thermal boundary conditions

UNIT-III

BOILING: Regimes of boiling processes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

CONDENSATION: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

UNIT-IV

RADIATION: Basic definitions, Radiant energy exchange between two differential area elements. Radiation shape factor: properties and algebra. Radiant energy exchange between two surfaces. Radiant energy exchange in enclosures: enclosures composed of black and diffuse-grey surfaces. Electrical network analogy. Radiation in participating media: Radiative heat transfer equation, Radiant energy exchange in presence of absorbing and transmitting media, radiant energy exchange in presence of transmitting, reflecting, and absorbing media and radiation shields.

UNIT-V

HEAT EXCHANGERS: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

TEXT BOOKS:

1. Myers, G.E., 1971, Analytical methods in conduction heat transfer, McGraw Hill, New York.
2. Kays, W. M. and Crawford, M. E., 2005, Convective Heat and Mass Transfer, 3rd ed., McGraw Hill.
3. Howell, J.R., Mengüc, M.P., Daun, K., and Siegel, R., 2020, Thermal radiation heat transfer, CRC press, New York.
4. Heat Transfer by J.P; HOLMAN, Tata McGraw-Hill
5. Heat Transfer by P.K.Nag, TMH

REFERENCES:

1. Fundamentals of Heat Transfer by Incropera& Dewitt, John Wiley
2. Fundamentals of Engineering, Heat& Mass Transfer by R.C.Sachdeva, New Age.
3. Fundamentals of Heat and Mass Transfer,5th Ed. / Frank P. Incropera/John Wiley
4. Sparrow, E.M., 2018, Radiation heat transfer, Routledge, New York.
5. Modest, M.F., and Mazumder, S., 2021, Radiative heat transfer, Academic press, New York.
6. Introduction to Heat Transfer/SK Som/PHI
7. Kakac, S. Yener, Y., and Pramuanjaroenkij. A., 2014, Convective Heat Transfer, 3rd ed., CRC Press

23TEH4- POWER PLANT ENGINEERING

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVE:

This course provides understanding of the power plant engineering fundamentals which includes the details of steam, hydro, gas nuclear, combined cycle power plants along with the economics of power generation and the environmental aspect of power generation are also being addressed in this course.

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

- **CO1:** Describe the energy scenario, the energy generation sources and various circuitry systems in power plants. **(Understanding – L2)**
- **CO2:** Illustrate the working of gas turbine and hydro power plants. **(Understanding – L2)**
- **CO3:** Understand the principles of nuclear power plants. **(Understanding – L2)**
- **CO4:** Comprehend the combined operations of different power plants and plant instrumentation and its control. **(Understanding – L2)**
- **CO5:** Calculate the economics of power generation from various power plants, pollution issues from power plant systems. **(Applying – L3)**

UNIT – I

Introduction to the sources of energy – resources and development of power in India.

STEAM POWER PLANT: Plant layout, working of different circuits, fuel handling equipment, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems. Combustion: properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, dust collectors, cooling towers and heat rejection.

UNIT – II

GAS TURBINE POWER PLANT: Introduction – classification, construction – layout with auxiliaries. Cogeneration of Power and Process heat. Waste heat recovery systems.

HYDRO ELECTRIC POWER PLANT: Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.

UNIT – III

NUCLEAR POWER PLANT: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation.

TYPES OF REACTORS: Pressurized water reactor, boiling water reactor, sodium, graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.

UNIT – IV

COMBINED OPERATIONS OF DIFFERENT POWER PLANTS: Introduction, advantages of combined working, load division between power stations, storage type hydro electric plant in combination with steam plant, run of river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro electric and gas turbine stations, Coordination of different types of power plants.

POWER PLANT INSTRUMENTATION AND CONTROL: Importance of measurement and instrumentation in power plant, measurement of water purity, gas analysis, O2 and CO2 measurements, measurement of smoke and dust, measurement of moisture in carbon dioxide circuit.

UNIT – V

POWER PLANT ECONOMICS:

Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises.

ENVIRONMENT AND POLLUTION: Pollutants and pollution standards – methods of pollution control.

TEXT BOOKS:

1. A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai & Co.
2. Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub
3. Power Plant Engineering/Er. R. K. Rajput/ Laxmi Pub/2016

REFERENCES:

1. Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2. Power station Engineering – ElWakil / McGrawHill.
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers

23TEH5-HYBRID VEHICLES

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVE:

This course aims to provide a thorough understanding of various configurations of electric vehicles and hybrid vehicles, including their components and performance analysis. It also covers the properties and types of batteries used in these vehicles, and explains the working principles of different hybrid configurations. Furthermore, the course enables students to analyze recent advancements and technological developments in hybrid vehicle systems.

COURSE OUTCOMES*:* At the end of the course the students would be able to

- **CO1:** Discuss the fundamentals of EV system, vehicle mechanics and its performance. **(Understanding-L2)**
- **CO2:** Describe the electric vehicle modelling like rolling resistance, efficiency and general issue considerations. **(Understanding-L2) (Understanding-L2)**
- **CO3:** Learn about the introduction of batteries related to Electric Vehicles, Electric Vehicles testing and its performance. **(Understanding-L2)**
- **CO4:** Illustrate the hybrid vehicles. **(Understanding-L2)**
- **CO5:** Understand the advancements in hybrid vehicles. **(Understanding-L2)**

UNIT – I: INTRODUCTION TO ELECTRIC VEHICLES

Sustainable transportation, EV system, EV Advantages, Vehicle Mechanics, Performance of EVs, Electric Vehicle drive train, EV transmission configurations and components, Tractive effort in normal driving, Energy consumption, EV market, Types of Electric Vehicle in use today, Electric vehicles for the future.

UNIT – II: ELECTRIC VEHICLE MODELLING

Rolling resistance, Transmission efficiency, Consideration of vehicle mass, Tractive effort, Modelling Vehicle Acceleration, Modelling Electric Vehicle Range, Aerodynamic Considerations, Ideal Gear Box steady state Model, EV Motor Sizing, General issues in Design.

UNIT – III: BATTERIES

Introduction to Electric Vehicle battery, Electric Vehicle battery efficiency, Electric Vehicle battery capacity, Electric Vehicle battery charging, Electric Vehicle battery fast charging, Electric Vehicle battery, Electric Vehicle battery fast charging, Electric Vehicle battery testing and performance.

UNIT-IV: HYBRID ELECTRIC VEHICLES

HEV Fundamentals **-**Architectures of HEVs- Interdisciplinary Nature of HEVs - State of the Art of HEVs -Advantages and Disadvantages - Challenges and Key Technology of HEVs - Concept of Hybridization of the Automobile-Plug-in Hybrid Electric Vehicles Design and Control Principles of Plug-In Hybrid Electric Vehicles - Fuel Cell Hybrid Electric Drive Train Design - HEV Applications for Military Vehicles.

UNIT - V: RECENT DEVELOPMENTS IN HYBRID VEHICLES

Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles, the Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks -Sizing Ultra capacitors for Hybrid Electric Vehicles.

TEXT BOOKS:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. Ali Emadi, "Advanced Electrical Hybrid Vehicles" CRC Press, 2015, Taylor & FrancisGroup.
3. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives",John Wiley & Sons, 2011.

REFERENCES:

1. T. Denton, "Electric and Hybrid Vehicles",Routledge,2016.
2. S. Onori, L. Serrao andG. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.

23TEH6- COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVE:

To gain the knowledge on the fundamentals and governing equations of fluid dynamics, Develop understanding of numerical discretization methods, Train students in basic CFD modelling, meshing, and simulation using software tools in CFD to solve engineering problems.

COURSE OUTCOMES*:* At the end of the course the students would be able to

CO1: Understand the mathematical foundation of CFD. **(Understanding-L2)**

CO2: Apply numerical methods to solve fluid flow problems. **(Applying-L3)**

CO3: Model and discretize the basic fluid and heat transfer systems. **(Applying-L3)**

CO4: Develop the algorithms to solve the fluid flow problems. **(Applying-L3)**

CO5: Apply boundary conditions and mesh generation in CFD for solving simple engineering applications. **(Applying-L3)**

UNIT-I

INTRODUCTION TO CFD: Importance of CFD in engineering, Scope and applications in industry, CFD vs. experimental and analytical methods, Overview of CFD software tools, Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

UNIT-II

GOVERNING EQUATIONS OF FLUID FLOW: Conservation laws: mass, momentum, and energy, Navier-Stokes equations, Classification of partial differential equations (PDEs): elliptic, parabolic, hyperbolic, Initial and boundary conditions, multi-step methods in hyperbolic, nonlinear problems, second order one-dimensional wave equations. Explicit and implicit schemes, Runge-Kutta method.

UNIT-III

DISCRETIZATION TECHNIQUES: Finite Difference Method (FDM): basic concepts, Forward, backward, and central difference schemes, Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, Finite Volume Method (FVM - formulations for two and three-dimensional problems Finite Element Method (FEM) - Standard Galerkin's Methods, Transient Problems – Generalized Galerkin's Methods, Example Problems. brief introduction, Stability, consistency, and convergence

UNIT-IV

SOLUTION METHODS: Solution algorithms for steady and unsteady problems, Iterative solvers (Jacobi, Gauss-Seidel, SOR), SIMPLE and SIMPLER algorithms for pressure-velocity coupling, Grid independence and error analysis.

UNIT-V

MESH GENERATION AND BOUNDARY CONDITIONS: Structured and unstructured meshes, Grid quality and refinement, Boundary condition types: inlet, outlet, wall, symmetry, periodic, Best practices in mesh generation, Case studies in internal and external flows, Heat transfer modeling using CFD

TEXTBOOKS:

1. Computational Fluid Dynamics: The Basics with Applications – John D. Anderson
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method – H.K. Versteeg and W. Malalasekera
3. Computational fluid dynamics, T. J. Chung, Cambridge University press, 2002.

REFERENCE BOOKS:

- Numerical Heat Transfer and Fluid Flow – S.V. Patankar
- Fundamentals of Computational Fluid Dynamics – Tapan K. Sengupta
- CFD software manuals and user guides (e.g., ANSYS Fluent, OpenFOAM)

23TEH7 -ADVANCED THERMAL ENGINEERING LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVE:

Advanced Thermal Engineering lab is mainly focused to make the graduates to acquire the knowledge on engine testing and exhaust emission analysis, solar thermal systems parabolic trough collector, and solar PV systems and its performance measurements.

COURSE OUTCOMES*:* At the end of the course the students would be able to

CO1: Determine the performance and emission parameters of internal combustion engines. **(Applying-L3)**

CO2: Estimate the performance characteristics of solar PV system. **(Applying-L3)**

CO3: Evaluate the performance parameters of Refrigeration system. **(Applying-L3)**

CO4: Analyse the characteristics of solar parabolic trough collector. **(Applying-L3)**

LIST OF EXPERIMENTS

1. Performance Test on 4 stroke diesel engine using diesel and biofuel
2. Measurement of exhaust emissions of diesel engine
3. To evaluate the performance of a solar parabolic trough system under different atmospheric and design parameters with water and oil used as working fluids.
4. Performance Test on Variable Compression Ratio single cylinder 4-Stroke diesel Engine By using Eddy Current Dynamometer
5. Performance characteristics of solar parabolic concentrator test
6. Study of IV characteristics of solar radiation energy
7. Performance Test on Reciprocating Air – Compressor.
8. Performance analysis of solar flat plate collector test
9. COP estimation of vapour compression refrigeration system
10. Performance analysis of Air conditioning unit

REFERENCES:

Advanced Thermal engineering lab manual

23TEH8- ADVANCED HEAT TRANSFER LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: Thermodynamics, Thermal Engineering

COURSE EDUCATIONAL OBJECTIVE:

The objective of this laboratory course is to gain hands on experience on the modes of heat transfer in various heat transfer equipment's used for different applications by conducting experiments.

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

CO1 Estimate the heat transfer performance in thermal systems. **(Applying-L3)**

CO2 Determine the value of heat transfer coefficient from convection apparatus. **(Applying-L3)**

CO3 Compare the LMTD and NTU parameters in multi-pass heat exchangers. **(Analyzing-L4).**

CO4 Compute the value of heat transfer coefficients in free and forced convection using CAE Software tools. **(Applying-L3)**

CORE EXPERIMENTS

1. Boiling Heat Transfer and Critical Heat Flux
2. Heat transfer in convection apparatus.
3. Transient Heat Conduction in Composite Walls
4. Microscale or Nanofluid Heat Transfer
5. Multipass heat exchangers

SIMULATION EXPERIMENTS

1. Conduction through Composite Walls using ANSYS
2. Heat Transfer in Finned Surfaces using ANSYS
3. Convection in Internal Flows (Pipes/Channels) Using ANSYS
4. Cooling of Electronic Components using ANSYS
5. Thermal Stress Analysis in Solids using ANSYS

REFERENCES

- Lab Manuals

Data Hand Book:

- C.P. Kothandaraman and Subramanian, Heat and Mass Transfer Data Book, New Age International Publications, 7th Edition, Reprint 2012

NOTE: Heat and Mass Transfer Data Hand Book by C.P. Kothandaraman and Subramanian- New Age Publications is to be allowed in Examination.

23TEH9-COMPUTATIONAL FLUID DYNAMICS LAB

L	T	P	C
0	0	3	1.5

PRE-REQUISITES: Thermodynamics

COURSE EDUCATIONAL OBJECTIVE:

To solve the problems of fluid flow and heat transfer and build up the skills in the actual implementation of CFD methods for 1D and 2D heat conduction and convection problems and acquire skills in thermal analysis of the same.

COURSE OUTCOMES*:* At the end of the course the students would be able to

CO1 Develop codes for solution of algebraic and differential equations. **(Analyzing-L4)**

CO2 Develop skills in the actual implementation of CFD methods with their own codes. **(Analyzing-L4)**

CO3 Analyze real-life engineering applications with the help of CFD. **(Analyzing-L4)**

CO4 Design thermal engineering equipment using CFD. **(Analyzing-L4)**

CO5 Analyze and validate output of written codes with analytical solution. **(Analyzing-L4)**

LIST OF EXPERIMENTS:

1. Steady State heat transfer analysis through circular fins.
2. Steady State heat transfer analysis of a heat sink.
3. Steady State thermal analysis of a steel bar.
4. Steady State thermal analysis of a cylinder.
5. Steady State heat transfer analysis through composite slab.
6. Transient thermal analysis of convection of bar in air.
7. A turbulent fluid flow and heat transfer problem in a mixing elbow using Ansys fluent.
8. Fluid flow analysis of a radiator using Ansys fluent.
9. Fluid flow fluent analysis of a helical coil.
10. Fluid flow fluent analysis of two phase flow in a horizontal pipe.
11. Analysis of water flow in converging pipe using Ansys fluent.
12. Analysis of two dimensional laminar flow using Ansys fluent.

REFERENCES: CFD Lab Manual