

Sardar Patel University, Balaghat (M.P.)



Curriculum

For

B.Tech.

Mechanical Engineering

From Session: 2024-25



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: Machine Component Design Subject Code: BME051

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

1. To recognize the type of stresses that is occurring in a particular physical system.
2. To apply appropriate simplifying mathematical model of a physical machine components on the light of theory of failures.
3. To recognize the particular design problem regime (wear, fatigue, creep etc) that is present in a typical engineering system.
4. To recognize the type of failure in a Multi DOF system and will be able to recognize the life and condition of the system (total useful run time estimation).
5. To design the mechanical system using Pro-E/Think 3 for geometrical and manufacturing easy.

UNIT – I

Stress concentration and fatigue: causes of stress concentration; stress concentration in tension, bending and torsion; reduction of stress concentration, theoretical stress concentration factor, notch sensitivity, fatigue stress concentration factor, cyclic loading, endurance limit, S-N Curve, loading factor, size factor, surface factor. Design consideration for fatigue, Goodman and modified Goodman's diagram, Soderberg equation, Gerber parabola, design for finite life, cumulative fatigue damage factor.

UNIT – II

Shafts: Design of shaft under combined bending, twisting and axial loading; shock and fatigue factors, design for rigidity; Design of shaft subjected to dynamic load; Design of keys and shaft couplings.

UNIT – IV

Springs: Design of helical compression and tension springs, consideration of dimensional and functional constraints, leaf springs and torsion springs; fatigue loading of springs, surge in spring; special springs, Power Screws design of power screw and power nut, differential and compound screw, design of simple screw jack.

UNIT –IV

Brakes & Clutches: Materials for friction surface, uniform pressure and uniform wear theories, Design of friction clutches: Disk, plate clutches, cone & centrifugal clutches. Design of brakes: Rope, band & block brake, Internal expanding brakes, Disk brakes.

UNIT – V

Journal Bearing: Types of lubrication, viscosity, hydrodynamic theory, design factors,

temperature and viscosity considerations, Reynold's equation, stable and unstable operation, heat dissipation and thermal equilibrium, boundary lubrication, dimensionless numbers, Design of journal bearings,

Rolling-element Bearings: Types of rolling contact bearing, bearing friction and power loss, bearing life; Radial, thrust & axial loads; Static & dynamic load capacities; Selection of ball and roller bearings; lubrication and sealing.

Suggested List of Experiments

Design and draw any 5 components from each unit using any designing software.

Reference Books:

- ❖ Shingley J.E; Machine Design;TMH
- ❖ Sharma and Purohit; Design of Machine elements;PHI
- ❖ Wentzell Timothy H; Machine Design; Cengagelearning
- ❖ Mubeen; Machine Design; KhannaPublisher
- ❖ Ganesh Babu K and Srithar K; Design of Machine Elements;TMH
- ❖ Sharma and Agrawal; Machine Design; Kataria & Sons

Course Outcomes:

1. Identify the types of stresses occurring in different physical systems.
2. Develop appropriate mathematical models for machine components based on the theory of failures.
3. Recognize specific design challenges, such as wear, fatigue, and creep, in typical engineering systems.
4. Identify the types of failures in multi-degree-of-freedom (DOF) systems and estimate the system's remaining useful life.
5. Design mechanical systems using Pro-E/Creo or Think3 software, considering both geometric and manufacturing ease.



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: Internal Combustion Engine Subject Code: BME052

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

CO-1 Understand heat engine operation & determine the performance of engine at various load and will be able to draw the heat balance sheet.

CO-2: - Explain the different process occurring Heat engine.

CO-3 Recognize the new technologies used in engine like MPFI, CRDI, DOHC, TBI etc.

CO-4: - compute percentage emission of exhaust gases occurring in engine.

CO-5: - determine & compare the performance of naturally aspirated engine and supercharged/turbocharged engine and the effect of mixture strength on output of the engine.

UNIT – I

Internal Combustion Engine: S.I. and C.I. engines of two and four stroke cycles, real cycle analysis of SI and CI engines, determination of engine dimensions, speed, fuel consumption, output, mean effective pressure, efficiency, factors effecting volumetric efficiency, heat balance, performance characteristics of SI and CI engines, cylinder arrangement, firing order, power balance for multi-cylinder engines, valve timing.

UNIT – II

Combustion in SI engines: Flame development and propagation, ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, physical and chemical aspects of detonation, effect of engine and fuel variables on knocking tendency, knock rating of volatile fuels, octane number, H.U.C.R., action of dopes, pre-ignition, its causes and remedy, salient features of various type combustion chambers, valve timing and firing order.

UNIT – V

Combustion in C.I. Engines: Times base indicator diagrams and their study, various stages of combustion, delay period, diesel knock, octane number, knock inhibitors, salient features of various types of combustion chambers, fuel, ignition, cooling, exhaust and lubrication systems; Simple problems on fuel injection, various types of engines, their classification and salient features. Rotary I. C. engines, their principles of working.

UNIT – IV

I.C. Engine System: Fuels, ignition systems, cooling, exhaust/scavenging and lubrication system. Fuel metering in SI engine: Fuel injection in SI engine (MPFI & TDI), Theory of carburetion, simple problems on carburetion. Fuel metering in CI engines: Fuel injection in CI engine and simple problems, various types of engines, their classification and salient features.

Fuels: Conventional fuels and alternate fuels, engine exhaust emission, carbon monoxide, unburnt hydro carbon, oxides of nitrogen, smoke, density, measurement and control, hydrogen as alternate fuel.

UNIT – V

Supercharging: Effect of attitude on mixture strength and output of S.I. engines, low and high pressure super charging, exhaust, gas turbo-charging, supercharging of two stroke engines.

Suggested List of Experiments

1. To Study four strokes spark ignition (S.I) Engine and differences between S.I. and C.I engines.
2. To study two Strokes S.I. engine and differences between two strokes and four strokes engines.
3. To study battery ignition system for four cylinders S.I. engines and requirements of ignition system
4. To study magneto ignition system for SI engine having four cylinders and differences between magneto and battery Ignition system.
5. Study of carburetor with compensating and starting Jet devices.
6. Determination of Brake power (BP), friction power (FP) and Indicated power (IP) of four stroke single cylinder diesel engine with rope break dynamometer.
7. To determine Mechanical efficiency, Brake thermal efficiency and indicated thermal efficiency of four strokes, four-cylinder petrol engine
8. To draw heat balance sheet for four strokes, four-cylinder petrol engines.

Reference Books:

- ❖ A course in IC engines by M.L. Mathur & R.P.Sharma
- ❖ Internal Combustion Engines by V.Ganeshan
- ❖ Internal Combustion Engines Theory & Practice by G.F.Taylor
- ❖ Introduction to IC Engines by Richard Stone
- ❖ Internal Combustion Engines by Domkundwar, Dhanpat Rai Publications

Course Outcomes:

1. Understand the operation of heat engines and determine their performance at various loads, including the ability to draw a heat balance sheet.
2. Explain the different processes occurring within heat engines.
3. Recognize new technologies used in engines, such as Multi-Point Fuel Injection (MPFI), Common Rail Direct Injection (CRDI), Dual Overhead Camshaft (DOHC), and Throttle Body Injection (TBI).
4. Compute the percentage of exhaust gas emissions produced by engines.
5. Determine and compare the performance of naturally aspirated engines with supercharged/turbocharged engines, analysing the effect of mixture strength on engine output.



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: Manufacturing Process-II Subject Code: BME053

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

1. To define and describe the standards of measurements and relate the significance of various instruments with their particular practical applications
2. To demonstrate ability of applying the theoretical knowledge of tool geometry, tool materials and cutting fluids
3. To recognize basic theory and terminologies of pattern making and classification of molding and casting processes.
4. Explain the welding process and its classification in detail.

UNIT – I

Lathe: Classification of machine tools and their basic components; lathe- specification, components & accessories, various operations on lathes, capstan & turret lathes, tool layout, methods of thread production, machining time, single point cutting tools, tool signature and nomenclature.

UNIT – II

Grinding: Types of grinding machines, surface, cylindrical and internal grinding, grinding wheels, specifications, wheel turning and dressing without eccentricity, center-less grinding.

UNIT – V

Milling: Vertical, horizontal and universal type machines, specifications and classifications of milling machines, universal dividing head plain and different indexing, gear cutting, milling cutters.

Drilling & Broaching: Fixed spindle, radial and universal drilling machines, drilling time, broaching principle, broaches and broaching machines.

UNIT – IV

Shapers: Classification and specifications, principal parts, quick return mechanism, shaper operations, speed feed, depth of cut, machining time. Surface qualities, equipment used for rating surfaces, rms. CLA value, causes for surface irregularities.

Gear Cutting: Die casting, methods of forming gears, generating process, Gear shaping, gear shaving, gear grinding gear testing.

UNIT – V

Mechatronics: Introduction to control systems, analog control, transfer function, procedure for writing transfer function, signal flow diagram, introduction to electronic components like switches, magnetic type, electromagnetic type, transducers and other sensors, servo motors, basics of CD-ROM players, PLC, applications, CNC machines.

Suggested List of Experiments

1. To prepare the plain turning job on lathe.
2. To prepare step turning operations as per drawing.
3. To prepare taper turning operation as per drawing.
4. To perform the boring operation on lathe.
5. To perform drilling and tapping operation as per drawing.

Reference Books:

- ❖ Rao PN; Manufacturing Technology vol I and II; TMH
- ❖ Hazra Chadhary; Workshop Tech.II; Media Promoter and Pub
- ❖ Lindberg RA; Processes and Materials of Manufacturing; PHI.
- ❖ Raghuvanshi BS; Work shop technology Vol-I, II; Dhanpat Rai Delhi
- ❖ Alciatori DG, Histan MB; Introduction to Mechatronics and Measurement system; TMH
- ❖ HMT; Production Processes; TMH

Course Outcomes:

1. Define and describe measurement standards, and explain the significance of various instruments in practical applications.
2. Demonstrate the application of theoretical knowledge related to tool geometry, tool materials, and cutting fluids in manufacturing processes.
3. Recognize the fundamental theories and terminologies of pattern making, and classify various moulding and casting processes.
4. Explain the welding processes in detail, including their classifications and applications in engineering.



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: Mechanical Measurement & Control Subject Code: BME054

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

1. To understand the principles and techniques of mechanical measurements.
2. To familiarize students with various measurement systems and instruments used in mechanical engineering.
3. To introduce the concepts of control systems and their applications in mechanical systems.
4. To develop the ability to design and analyze control systems for stability and performance.

UNIT I

Introduction to Measurement Systems: Importance and scope of mechanical measurements, measurement system components.

Static and Dynamic Characteristics of Instruments: Accuracy, precision, sensitivity, linearity, hysteresis, calibration, response time, dynamic response.

Measurement Errors: Types of errors, error analysis, statistical analysis of measurement data.

UNIT II

Displacement Measurement: Linear and angular displacement measurement techniques; potentiometers, linear variable differential transformers (LVDTs), optical encoders.

Velocity Measurement: Mechanical, electrical, and optical methods; tachometers, stroboscopes, laser Doppler velocimetry.

Acceleration Measurement: Accelerometers (piezoelectric, capacitive, strain gauge-based), vibration measurement.

UNIT III

Force and Torque Measurement: Load cells, strain gauges, dynamometers, torque transducers.

Pressure Measurement: Manometers, Bourdon tubes, diaphragm and bellows gauges, piezoelectric pressure sensors.

Temperature Measurement: Thermocouples, resistance temperature detectors (RTDs), thermistors, infrared thermometers, pyrometers.

UNIT IV

Basic Concepts of Control Systems: Open-loop and closed-loop systems, feedback, transfer function, block diagrams, signal flow graphs.

Mathematical Modelling of Systems: Modelling of mechanical systems, electrical systems, and electromechanical systems using differential equations.

Time Domain Analysis: Transient and steady-state response, time domain specifications, stability, Routh-Hurwitz criterion.

UNIT V

Frequency Domain Analysis: Bode plots, Nyquist plots, gain margin, phase margin.

Stability Analysis: Root locus method, Nyquist criterion, stability in frequency domain.

Controller Design: Proportional (P), Integral (I), Derivative (D), PI, PD, PID controllers; tuning methods (Ziegler-Nichols, Cohen-Coon).

State-Space Analysis: State-space representation, solution of state equations, controllability, observability.

UNIT VI

Sensors: Types of sensors used in control systems, their characteristics and applications (e.g., temperature, pressure, position sensors).

Actuators: Hydraulic, pneumatic, and electric actuators; servomotors, stepper motors.

Data Acquisition Systems: Analog-to-digital conversion, digital-to-analog conversion, sampling, data logging, interfacing sensors with microcontrollers/PLCs.

Reference Books:

- ❖ Measurement Systems: Application and Design by Ernest O. Doebelin
- ❖ Mechanical Measurements by Thomas G. Beckwith, Roy D. Marangoni, and John H. Lienhard V
- ❖ Modern Control Engineering by Katsuhiko Ogata
- ❖ Automatic Control Systems by Benjamin C. Kuo
- ❖ Instrumentation, Measurement, and Analysis by B.C. Nakra and K.K. Chaudhry
- ❖ Control Systems Engineering by Norman S. Nise
- ❖ Process Control Instrumentation Technology by Curtis D. Johnson
- ❖ Principles of Measurement Systems by John P. Bentley

Course Outcomes:

1. Understand the principles and techniques of mechanical measurements.
2. Familiarize students with various measurement systems and instruments utilized in mechanical engineering.
3. Introduce concepts of control systems and their applications in mechanical systems.
4. Develop the ability to design and analyze control systems for stability and performance.



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: Industrial Organization and Management Subject Code: BME055

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

1. Explain how firms acquire market power and how they use this market power once acquired;
2. Analyse how competing firms interact strategically;
3. Describe the current state of knowledge in the field of industrial organization.
4. Appreciate the strategic role of OM in creating and enhancing a firm's competitive Advantages.
5. Understand key concepts and issues of OM in both manufacturing and service Organizations.
6. Apply analytical skills and problem-solving tools to resolve the operational issues

UNIT – I

Industrial Organization: Promotion of business, Forms of Business organization (public and private), Merits and Demerits (Sole proprietorship, Partnership, Joint Hindu family business, joint Stock Companies, Joint ventures), Duties and responsibilities of organization and administration, Organizational Structure-Line, staff and Functional organization, their advantages and disadvantages.

Operation Management: Concepts, Scope & Importance of Manufacturing & Operations, Management, Interrelationship between Materials & Operations Management.

UNIT – II

Purchasing and Procurement: Purchasing, Types of purchasing, Limitations, purchasing principles, Procedures, Fundamental objectives of purchasing, Methods of purchasing, sources of supply and supplier selection, Roles and responsibilities of purchasing professionals.

Inventory Management and Inventory Control: Concept, Types and Classification, Functions, Max Min system, Inventories and Demand Uncertainty, Inventory control techniques (Economic Order Quantity, VED analysis, Periodic Ordering Quantity and ABC analysis), Methods of Quality Assurance namely sampling, SQC, vender rating.

UNIT – V

Cost Analysis: Fixed and Variable cost, Direct and Indirect cost, Production cost, Incremental cost, Profit Break even analysis, break-even point, Usefulness of break-even chart, make or buy decision, budget, types of budgets, budget applications, Analyzing Budget variations.

Financial Planning: Nature, Scope, Sources of Finance, Equipment, Plant and Machinery, Industrial Finance in India, main Sources of Industrial Finance, Necessity & Significance of Industrial Finance, Small Scale Industries, New Challenges before SSIs, Industrial Legislation in India, Industrial Development & Regulation, Role of Foreign capital in Industrial Development (FDI) in Indian Industries.

UNIT – IV

Material Handling/Stores Management: Material handling, Principles, Selection of material handling equipment like Industrial trucks, cranes and hoist, functions of store keeping, Classification of materials, Physical control on materials, Storage System, Stores location and Layout, Centralization and Decentralization of stores, Merit control on materials, Storage System, Stores location and Layout, Centralization and Decentralization of stores, Merits and Demerits of Codification.

Growth and Structural Change of the Corporate Sector: Corporate Sector and the Development Process, Growth patterns, Technology and Employment; Job Evaluation concept- Process, Objectives, Advantages, Essentials of successful Job evaluation, Merit Rating, Objectives, Methods of Merit Rating.

UNIT – V

Wage Administration and Industrial Relations: Real wages and Money wages, Characteristics of good wage incentive system, Financial and Non-Financial Incentives, Group incentives, Depreciation, Assets and Liabilities, Quality Assurance, Indian Trade Union Act, Standing Orders Act, Indian Factories Act, Excise Duty.

Supply Chain Dimensions and Logistics: Objectives, Importance, Supply chain strategies and drivers, Obstacles, Information Technology in supply chain, Management-Supplier relationship, Logistics interfaces with other areas-Approach to analyzing logistics systems, Techniques of Logistics System Analysis- Factors affecting the Cost and Importance of Logistics.

NOTE: At least two case studies of Annual Report of any industry should be given as an Assignment. **(Hand Written)**

Reference books:

- ❖ Operations Management Theory and Practice, B. Mahadevan, Pearson Education, Second impression 2007
- ❖ Production & Operations management- Dr. N.G. Nair- Tata McGraw Hills., Delhi.
- ❖ Operations Now, Eyrton J Finch, Tata Mc Graw Hill, 3rd Edition,2008
- ❖ Production and Operations Management- Prof. K. Ashwathappa, K Sridhar Bhat, Himalaya Publications
- ❖ Production and Operations Management, Text and cases, Upendra Kachru, first edition excel Books.
- ❖ Materials & Finance Management – Vivek Mishra, Dhanpat Rai &Co.

Course Outcomes:

1. Explain how firms acquire and utilize market power.
2. Analyze the strategic interactions among competing firms.
3. Describe the current state of knowledge in industrial organization.
4. Appreciate the strategic role of operations management (OM) in enhancing competitive advantages.
5. Understand key concepts and issues in OM for both manufacturing and service organizations.
6. Apply analytical skills and problem-solving tools to address operational issues.



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: Python Lab Subject Code: BME056P

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

1. To introduce students to the basics of Python programming with a focus on its applications in mechanical engineering.
2. To develop problem-solving skills using Python for mathematical modelling, simulation, and data analysis.
3. To provide hands-on experience in using Python for automating engineering tasks and performing computational analyses.

Unit-I

Introduction to Python: Overview of Python programming and its relevance in engineering. Setting up the Python environment (Anaconda, Jupyter Notebook). Basics of Python syntax, variables, data types, and operators. Writing and executing simple Python programs.

Control Structures and Functions: Conditional statements: if, elif, else. Loops: for, while. Functions: defining and calling functions, function arguments, and return values. Practice problems on control structures and functions.

Unit-II

Python Data Structures: Lists, tuples, dictionaries, and sets. Operations on data structures: indexing, slicing, appending, updating, and deleting elements. Applications of data structures in engineering problems.

NumPy for Numerical Computation: Introduction to NumPy: Arrays, array operations, and matrix manipulations. Implementing vectorized operations and avoiding loops. Solving linear algebra problems using NumPy. Case studies: Matrix operations in mechanical simulations.

Unit-III

Data Visualization with Matplotlib: Basics of Matplotlib for plotting data. Creating line plots, bar charts, histograms, and scatter plots. Customizing plots: titles, labels, legends, and colours. Visualizing engineering data and interpreting results.

Data Handling with Pandas: Introduction to Pandas: Series and Data Frame. Reading and writing data from/to CSV, Excel, and other file formats. Data cleaning, manipulation, and aggregation using Pandas. Analysing mechanical engineering datasets.

Unit-IV

SciPy for Scientific Computing: Overview of SciPy library and its modules. Solving differential equations using SciPy. Performing optimization tasks relevant to mechanical engineering. Case study: Solving a mechanical system using SciPy.

Symbolic Computation with SymPy: Introduction to symbolic computation and SymPy. Solving algebraic equations and calculus problems symbolically. Applications in mechanical

engineering: Stress-strain analysis, beam deflection. Hands-on practice with symbolic mathematics in engineering contexts.

File Handling and Automation: Reading from and writing to text files in Python. Automating repetitive tasks using Python scripts. Case study: Automating the processing of large datasets in engineering projects.

Unit-V

Python in Mechanical Engineering Applications: Introduction to specific applications in mechanical engineering using Python. Simulating heat transfer problems, fluid dynamics, and kinematics. Developing custom Python scripts for mechanical engineering tasks.

Mini Project Development: Students work on a mini-project that integrates Python programming with mechanical engineering applications. Example projects: Thermal analysis of a component, dynamic simulation of a mechanical system, data-driven analysis of mechanical properties. Project review and feedback sessions.

Project Presentation and Evaluation: Students present their mini-projects, demonstrating the application of Python in solving engineering problems. Evaluation based on project complexity, code quality, and presentation skills.

Revision and Practice: Revision of key concepts covered in the lab. Additional practice problems and open lab for doubts and queries. Preparation for the final lab examination.

References Books:

- ❖ Python for Engineers by Paul Deitel and Harvey Deitel
- ❖ Python Programming for Mechanical Engineers by Andrew Pinkham
- ❖ Automate the Boring Stuff with Python by Al Sweigart

Online Resources:

- ❖ Python documentation (<https://docs.python.org/>)
- ❖ Tutorials on Python libraries (NumPy, Pandas, Matplotlib) from official sites and platforms like Real Python, W3Schools.
- ❖ Coursera, edX, and Udemy courses on Python programming and its applications in engineering.

Course Outcomes:

1. Students will demonstrate an understanding of the basic syntax, data structures, and programming concepts in Python.
2. Apply Python programming to develop mathematical models, perform simulations, and conduct data analysis to solve mechanical engineering problems.
3. demonstrate proficiency in using relevant Python libraries (such as NumPy, SciPy, and Matplotlib) for data manipulation, numerical analysis, and visualization in engineering applications.



SARDAR PATEL UNIVERSITY, BALAGHAT (MP)

School of Engineering and Technology

Syllabus

Subject Name: CAE Lab Subject Code: BME057P

Course: B.Tech. Branch: Mechanical Semester: V Sem

Academic Session: 2024-25

Course Contents

Course Objectives:

1. To introduce students to CAE tools and their applications in mechanical engineering analysis and design.
2. To develop proficiency in using CAE software for finite element analysis (FEA), computational fluid dynamics (CFD), and optimization.
3. To enable students to analyse and simulate real-world mechanical engineering problems using advanced computational methods.
4. To bridge the gap between theoretical knowledge and practical engineering applications through hands-on experience with industry-standard CAE tools.

Unit-I

Introduction to CAE: Overview of CAE, its importance in mechanical engineering. Introduction to different CAE software and their applications. Setting up the CAE environment, familiarization with the user interface.

Finite Element Analysis (FEA) Basics: Introduction to FEA: Theory and applications. Understanding elements, nodes, meshing, boundary conditions, and loads. Hands-on practice: Creating a simple FEA model, applying loads, and boundary conditions.

Unit-II

Stress and Deformation Analysis: Analysing static stress, strain, and deformation in mechanical components. Case study: Analysis of a cantilever beam or a truss structure. Result interpretation: Stress contours, deformation plots, and safety factor.

Modal and Harmonic Analysis: Introduction to modal analysis: Natural frequencies and mode shapes. Harmonic analysis: Evaluating the response of structures under harmonic loading. Hands-on practice: Analysing a mechanical component for vibrational characteristics.

Unit-III

Thermal Analysis: Introduction to thermal analysis: Steady-state and transient heat transfer. Setting up thermal simulations: Thermal loads, convection, conduction, and radiation. Case study: Thermal analysis of a heat sink or a mechanical component exposed to thermal loads.

Computational Fluid Dynamics (CFD) Basics: Introduction to CFD: Theory, governing equations (Navier-Stokes), and applications. Meshing techniques for fluid domains, boundary conditions, and solver settings. Hands-on practice: Setting up a basic CFD simulation for internal or external flow.

Unit-IV

Fluid Flow and Heat Transfer Analysis: CFD analysis of fluid flow through pipes, nozzles, or around aerodynamic bodies. Analysing heat transfer in fluids: Convection, conduction, and

thermal boundary layers. Case study: CFD analysis of a heat exchanger or airflow over a car body.

Non-Linear Analysis: Introduction to non-linear analysis: Material non-linearity, geometric non-linearity, and contact problems. Hands-on practice: Setting up and solving a non-linear problem (e.g., rubber seal compression). Result interpretation and validation against linear analysis.

Dynamic Analysis: Introduction to dynamic analysis: Time-dependent loading, impact analysis. Performing transient dynamic analysis: Setting up time steps, loading conditions, and solving. Case study: Impact analysis of a drop test on a mechanical component.

Unit-V

Design Optimization: Introduction to design optimization techniques: Shape, size, and topology optimization. Setting up optimization problems in CAE tools: Defining objectives and constraints. Hands-on practice: Optimizing a mechanical component for weight reduction while maintaining strength.

Mini Project Development: Students work on a mini-project that integrates multiple aspects of CAE (FEA, CFD, thermal analysis). Example projects: Stress analysis of a mechanical assembly, CFD analysis of a complex fluid system, thermal management in an electronic device. Project review and feedback sessions.

Project Presentation and Evaluation: Students present their mini-projects, demonstrating the application of CAE tools in solving engineering problems. Evaluation based on project complexity, simulation accuracy, and presentation quality. Revision of key concepts and techniques covered in the lab.

Reference Books:

- ❖ Finite Element Procedures by Klaus-Jürgen Bathe
- ❖ The Finite Element Method in Engineering by Singiresu S. Rao
- ❖ Introduction to Computational Fluid Dynamics by Anil W. Date
- ❖ Practical Stress Analysis with Finite Elements by Bryan J. Mac Donald

Online Resources:

- ❖ ANSYS and Abaqus official documentation and tutorials.
- ❖ CFD Online (www.cfd-online.com) for forums, tutorials, and resources.
- ❖ Online courses on platforms like Coursera, edX, and Udemy for FEA, CFD, and CAE tools.

Course Outcomes:

1. Understand the principles and applications of CAE tools in mechanical engineering.
2. Gain proficiency in CAE software for finite element analysis (FEA), computational fluid dynamics (CFD), and optimization.
3. Analyze and simulate real-world mechanical engineering problems using advanced computational methods.
4. Bridge theoretical knowledge and practical applications through hands-on experience with industry-standard CAE tools.
5. Evaluate and optimize engineering solutions based on simulation results.