Department of Mechanical Engineering

Program: B. Tech in Mechanical Engineering

Regulation: R20 **Course Outcomes** **No. of course: 61**

I-I	**Course Code: C101** **Course Name:** Calculus & Differential Equations (M-I)
CO1	Explain the concepts of sequences, series, convergence tests, mean value theorems, and their significance in mathematical analysis.
CO2	Apply differential equation techniques to solve higher-order differential equations and engineering applications involving electrical circuits, simple harmonic motion, and orthogonal trajectories.
CO3	Analyze functions of several variables using partial differentiation, Jacobians, Taylor's series, and optimization techniques for solving engineering problems.
CO4	Evaluate multiple integrals in Cartesian, polar, cylindrical, and spherical coordinate systems to determine areas and volumes of engineering applications.
CO5	Evaluate improper integrals using Beta and Gamma functions and apply their properties to solve mathematical and engineering problems.

I-I	**Course Code: C102** **Course Name:** Engineering Physics
CO1	Explain the principles of interference, diffraction, and polarization and their applications in optical systems.
CO2	Apply the concepts of lasers and optical fibres in modern engineering and communication systems.
CO3	Analyze the properties and applications of dielectric and magnetic materials in engineering fields.
CO4	Explain the principles of acoustics and ultrasonics and their applications in engineering and non-destructive testing.
CO5	Apply crystallographic concepts and X-ray diffraction techniques for crystal structure determination.

I-I	**Course Code: C103** **Course Name:** Programming for Problem Solving
CO1	Explain the fundamentals of computers, C programming concepts, data types, operators,

	expressions, input/output statements, storage classes, and the structure of C programs.
CO2	Apply decision-making statements, bitwise operators, looping constructs, and control structures to develop C programs for solving computational problems.
CO3	Apply arrays, strings, structures, unions, and user-defined data types to develop programs for engineering applications.
CO4	Analyze pointer concepts, pointer arithmetic, memory allocation techniques, arrays, and processor commands to solve programming problems efficiently.
CO5	Develop structured C programs using functions, recursion, file handling, and binary/text input-output operations to solve real-world engineering problems.

I-I	**Course Code: C104** **Course Name:** Communicative English
CO1	Demonstrate listening, speaking, reading, and writing skills for effective communication in academic and social contexts.
CO2	Apply appropriate grammatical structures, vocabulary, and pronunciation patterns in oral and written communication.
CO3	Analyze literary and non-literary texts and employ critical reading and writing techniques.
CO4	Apply functional English and communication strategies in interpersonal and professional situations.
CO5	Evaluate and develop academic writing, presentation, and professional communication skills for career advancement.

I-I	**Course Code: C105** **Course Name:** Engineering Drawing
CO1	Explain the principles of engineering drawing, geometrical constructions, curves, and scales.
CO2	Apply orthographic projection principles for points and straight lines in different orientations.
CO3	Analyze and draw projections of planes inclined to one or both reference planes.
CO4	Apply projection and development techniques for engineering solids.
CO5	Develop engineering drawings through conversion of orthographic and isometric views

	using conventional and CAD techniques.

I-I	**Course Code: C106** **Course Name:** Engineering Physics Lab
CO1	Conduct experiments on wave optics, lasers, optical fibers, ultrasonics, and interference phenomena to determine optical parameters using standard laboratory techniques.
CO2	Perform experiments to determine the mechanical, magnetic, dielectric, and elastic properties of engineering materials using standard experimental methods
CO3	Analyze quantum and modern physics phenomena by determining fundamental physical constants and interpreting experimental observations.

I-I	**Course Code: C107** **Course Name:** Programming for Problem Solving USING C LAB
CO1	Develop C programs Develop C programs using basic programming constructs, operators, decision-making statements, loops, functions, and mathematical computations to solve simple engineering problems.
CO2	Implement C programs using arrays, matrices, strings, and searching/sorting techniques to solve computational problems.
CO3	Develop C programs using functions, pointers, structures, and dynamic memory allocation for solving complex programming problems.

I-I	**Course Code: C108** **Course Name:** English Communication Skills Laboratory
CO1	Demonstrate correct pronunciation, stress, intonation, and listening comprehension skills using IPA and audio-based communication activities.
CO2	Apply effective verbal communication skills through JAM sessions, group discussions, role plays, and mock interviews in academic and professional contexts.
CO3	Deliver effective individual and group presentations using PowerPoint with appropriate verbal, non-verbal, and presentation skills.

I-II	**Course Code: C109** **Course Name:** Linear Algebra & Numerical Methods (M-II)
CO1	Apply matrix algebra, eigenvalues, eigenvectors, and linear system solution techniques to solve engineering problems.
CO2	Analyze matrices using the Cayley–Hamilton theorem, diagonalization, quadratic forms, and singular value decomposition for engineering applications
CO3	Apply iterative numerical methods to solve algebraic, transcendental, and simultaneous equations, and determine eigenvalues and eigenvectors.
CO4	Apply interpolation techniques to estimate unknown values using finite difference methods and polynomial interpolation.
CO5	Analyze numerical integration techniques and numerical methods for solving ordinary differential equations with initial conditions.

I-II	**Course Code: C110** **Course Name:** Engineering Chemistry
CO1	Explain the synthesis, properties, processing techniques, and engineering applications of polymers, plastics, elastomers, composites, biodegradable polymers, and conducting polymers.
CO2	Analyze electrochemical cells, batteries, fuel cells, corrosion mechanisms, corrosion control methods, and protective coatings used in engineering applications.
CO3	Analyze the properties, characterization techniques, preparation methods, and engineering applications of nanomaterials, refractories, lubricants, and cement.
CO4	Apply the principles of fuel technology to determine calorific values, analyze coal and petroleum products, and evaluate conventional and alternative fuels for engineering applications.
CO5	Evaluate water quality, hardness, boiler troubles, water softening methods, wastewater treatment, and purification techniques for industrial and domestic applications.

I-II	**Course Code: C111** **Course Name:** Engineering Mechanics
CO1	Explain the basic concepts of engineering mechanics, systems of forces, moments, couples, and friction, and determine the resultant of force systems.

CO2	Apply equilibrium principles and free body diagrams to analyze coplanar and spatial force systems and trusses.
CO3	Determine the centroid, centre of gravity, area moment of inertia, mass moment of inertia, and products of inertia of simple and composite bodies.
CO4	Apply the principles of kinematics and kinetics to analyze the rectilinear and curvilinear motion of particles using work-energy and impulse-momentum methods.
CO5	Analyze the kinematics and kinetics of rigid bodies undergoing translation, rotation, and plane motion using work-energy and impulse-momentum principles.

I-II	**Course Code: C112** **Course Name:** Basic Electrical & Electronics Engineering
CO1	Explain and apply the fundamental concepts of electrical circuits, Ohm's law, Kirchhoff's laws, series-parallel circuits, star-delta transformations, and analyze basic electrical networks.
CO2	Analyze the construction, working principles, characteristics, testing, speed control, and applications of DC machines.
CO3	Analyze the construction, operation, performance, testing, and applications of transformers, alternators, synchronous motors, and three-phase induction motors.
CO4	Apply the operating principles and characteristics of PN junction diodes, rectifiers, and operational amplifiers in basic electronic circuits.
CO5	Analyze the operation and performance of transistors, amplifiers, frequency response, and feedback amplifiers used in electronic systems

I-II	**Course Code: C113** **Course Name:** Thermodynamics
CO1	Explain the fundamental concepts of thermodynamics, thermodynamic systems, properties, processes, work, heat, temperature measurement, and the Zeroth Law of Thermodynamics.
CO2	Apply the First Law of Thermodynamics to closed and open systems, evaluate energy interactions, and analyze the performance of engineering devices such as nozzles, turbines, compressors, and heat exchangers.
CO3	Analyze the Second Law of Thermodynamics, entropy, availability, thermodynamic potentials, Carnot cycle, and the limitations of energy conversion processes.

CO4	Analyze the thermodynamic properties of pure substances, phase transformations, steam processes, property diagrams, and steam calorimetry.
CO5	Evaluate the behavior of ideal and real gases, gas mixtures, equations of state, psychrometric properties, and air-vapor mixtures for engineering applications.

I-II	**Course Code: C114** **Course Name:** Workshop Practice Lab
CO1	Demonstrate basic carpentry operations by preparing standard wood joints using appropriate tools and safety practices.
CO2	Perform fitting and blacksmithing operations to fabricate engineering components with the required dimensions and accuracy using standard workshop practices.
CO3	Demonstrate electrical wiring, sheet metal fabrication, and basic computer hardware assembly using appropriate tools, techniques, and safety procedures.

I-II	**Course Code: C115** **Course Name:** Engineering Chemistry Laboratory
CO1	Perform volumetric analysis to determine the concentration of acids, bases, metal ions, and water hardness using standard analytical techniques.
CO2	Determine chemical parameters using pH-metric, conductometric, and potentiometric methods for quantitative chemical analysis.
CO3	Analyze engineering materials and chemical samples using colorimetric methods, adsorption techniques, and polymer preparation experiments for engineering applications.
I-II	**Course Code: C116** **Course Name:** Basic Electrical & Electronics Engineering Lab
CO1	Perform standard tests on DC machines and evaluate their performance characteristics using appropriate laboratory instruments and procedures.
CO2	Analyze the performance characteristics of AC machines, including transformers, alternators, and induction motors through standard laboratory tests.
CO3	Perform experiments on electronic devices and circuits, including diodes, transistors, rectifiers, amplifiers, and operational amplifiers, and interpret their characteristics.

II-I	**Course Code: C201** **Course Name:** Vector Calculus, Fourier Transforms and PDE(M-III)
CO1	Apply vector differentiation, vector integration, and vector integral theorems to solve engineering problems.
CO2	Apply Laplace transform techniques, including shifting theorems, transforms of derivatives and integrals, unit step, Dirac delta, periodic functions, inverse Laplace transforms, and convolution theorem to solve ordinary differential equations.
CO3	Analyze periodic functions using Fourier series, Fourier integrals, Fourier sine and cosine transforms, finite Fourier transforms, inverse transforms, and convolution theorem for engineering applications
CO4	Solve first-order partial differential equations using Lagrange's method and standard nonlinear techniques, and solve second-order linear partial differential equations with constant coefficients.
CO5	Apply the method of separation of variables to solve one-dimensional wave, heat, and two-dimensional Laplace equations arising in engineering applications.

II-I	**Course Code: C202** **Course Name:** Mechanics of Solids
CO1	Explain the behavior of engineering materials under different loading conditions and determine simple and complex stresses, strains, principal stresses, strain energy, resilience, and impact loading effects.
CO2	Analyze shear force and bending moment in beams subjected to different loading conditions and construct shear force and bending moment diagrams.
CO3	Apply bending and shear stress theories to determine stresses in beams and design simple beam sections for engineering applications.
CO4	Analyze beam deflection using double integration, Macaulay's method, and moment-area method, and evaluate torsional stresses, angle of twist, and power transmission through circular shafts.
CO5	Analyze stresses, strains, and deformation in thin and thick cylinders, spherical shells, wire-wound cylinders, and compound cylinders subjected to internal and external pressure.

II-I	**Course Code: C203** **Course Name:** Fluid Mechanics & Hydraulic Machines
CO1	Analyze fluid properties, pressure measurement techniques, buoyancy, and stability of submerged and floating bodies.
CO2	Apply the principles of fluid kinematics, fluid dynamics, and closed conduit flow to solve engineering problems.
CO3	Analyze boundary layer phenomena and apply dimensional analysis techniques to fluid flow systems.
CO4	Evaluate the performance and working principles of hydraulic turbines and turbo machinery.
CO5	Analyze the performance characteristics of hydraulic turbines, pumps, and fluid power systems for engineering applications.

II-I	**Course Code: C204** **Course Name:** Production Technology
CO1	Analyze mechanisms, kinematic pairs, kinematic chains, and inversions of mechanisms used in mechanical systems
CO2	Apply the principles of lower pair mechanisms, steering gears, and Hooke's joints for motion transmission applications.
CO3	Determine velocity, acceleration, and instantaneous centers of mechanisms using graphical and analytical methods.
CO4	EEvaluate the motion characteristics of cams, followers, belt drives, and chain drives in power transmission systems.
CO5	Analyze the working principles and performance of gears, gear trains, and differential mechanisms used in automobiles and machinery.

II-I	**Course Code: C205** **Course Name:** Kinematics of Machinery
CO1	Analyze mechanisms, kinematic pairs, kinematic chains, and inversions of mechanisms used in mechanical systems.
CO2	Apply the principles of lower pair mechanisms, steering gears, and Hooke's joints for motion transmission applications.

CO3	Determine velocity, acceleration, and instantaneous centers of mechanisms using graphical and analytical methods.
CO4	EEvaluate the motion characteristics of cams, followers, belt drives, and chain drives in power transmission systems.
CO5	Analyze the working principles and performance of gears, gear trains, and differential mechanisms used in automobiles and machinery.

II-I	**Course Code: C206** **Course Name:** Computer Aided Engineering Drawing Practice
CO1	Explain the behavior of engineering materials under different loading conditions and determine simple and complex stresses, strains, principal stresses, strain energy, resilience, and impact loading effects.
CO2	Analyze shear force and bending moment in beams subjected to different loading conditions and construct shear force and bending moment diagrams.
CO3	Apply bending and shear stress theories to determine stresses in beams and design simple beam sections for engineering applications.

II-I	**Course Code: C207** **Course Name:**Fluid Mechanics & Hydraulic Machines Lab
CO1	Conduct experiments on impact of jets and Pelton turbines and analyze their performance characteristics.
CO2	Evaluate the performance and efficiencies of Francis and Kaplan turbines under different operating conditions.
CO3	Perform tests on pumps, flow measuring devices, and pipelines to determine performance parameters and flow characteristics.

II-I	**Course Code: C208** **Course Name:** Production Technology Lab
CO1	Develop engineering drawings with appropriate dimensioning, tolerances, and standard data exchange formats using CAD software.
CO2	Create surface and parametric solid models using CAD modelling techniques and standard modelling operations.

CO3	Develop and assemble mechanical components using CAD software to generate complete engineering assemblies and design documentation.

II-I	**Course Code: C209** **Course Name:** Drafting and Modeling Lab
CO1	Perform pattern making, moulding sand testing (sieve analysis, clay content, moisture content, strength, and permeability tests), and mould preparation for different casting components using standard foundry practices.
CO2	Perform gas cutting, gas welding, manual metal arc welding, sheet metal operations, deep drawing, and extrusion processes for the fabrication of engineering components.
CO3	Demonstrate injection moulding, blow moulding, powder compaction and sintering, TIG/MIG welding, resistance spot welding, brazing, soldering, and plastic moulding processes for modern manufacturing applications.

II-II	**Course Code: C210** **Course Name:** Material Science & Metallurgy
CO1	Explain the crystal structure of metals, alloy formation, crystal imperfections, equilibrium diagrams, phase transformations, and binary phase diagrams used in engineering materials.
CO2	Explain the classification, structure, properties, and engineering applications of ferrous and non-ferrous metals and alloys.
CO3	Explain heat treatment processes, TTT diagrams, hardenability, surface hardening, age hardening, and cryogenic treatment for improving material properties.
CO4	Explain powder metallurgy processes including powder production, compaction, sintering, secondary operations, and industrial applications.
CO5	Explain the classification, manufacturing methods, properties, and applications of ceramics, composites, cermets, glasses, and nanomaterials used in engineering.

II-II	**Course Code: C211** **Course Name:** Complex Variables and Statistical Methods
CO1	Explain the concepts of continuity, differentiability, analyticity, Cauchy–Riemann equations, harmonic functions, Milne–Thomson method, complex integration, Cauchy's integral theorem, Cauchy's integral formula, and generalized integral formula for

	functions of a complex variable.
CO2	Apply and analyze Taylor's, Maclaurin's, and Laurent series expansions, determine singularities and residues, and evaluate contour and real integrals using the residue theorem.
CO3	Apply the concepts of probability, Bayes' theorem, random variables, probability distributions, mathematical expectation, and variance to solve engineering problems.
CO4	Apply the principles of sampling theory, sampling distributions, Central Limit Theorem, statistical distributions, and estimation techniques in engineering data analysis
CO5	Apply and analyze statistical hypothesis testing methods, including tests for means and proportions, to interpret engineering and scientific data and support decision-making.

II-II	**Course Code: C212** **Course Name:** Dynamics of Machinery
CO1	Explain and apply the principles of friction, lubrication, friction clutches, brakes, and dynamometers, including their construction, working, performance characteristics, and engineering applications
CO2	Analyze and evaluate the static and dynamic force analysis of four-bar and slider-crank mechanisms, inertia effects, turning moment diagrams, fluctuation of energy, and flywheel design for mechanical systems.
CO3	Analyze and evaluate the effects of gyroscopic precession on moving vehicles and the performance characteristics of Watt, Porter, Proell, Hartnell, and Hartung governors, including sensitiveness, isochronism, and hunting.
CO4	Analyze and evaluate the balancing of rotating and reciprocating masses, multi-cylinder engines, locomotive balancing, hammer blow, swaying couple, and tractive effort using analytical and graphical methods.
CO5	Analyze and evaluate the vibration characteristics of mechanical systems, including free and forced vibrations, damping, vibration isolation, beam vibrations, Dunkerley's method, Rayleigh's method, whirling of shafts, critical speeds, and torsional vibrations of rotor systems.

II-II	**Course Code: C213** **Course Name:** Thermal Engineering-I
CO1	Explain the principles of air-standard cycles, actual engine cycles, performance factors, classification, construction, working principles, and engine systems of internal combustion engines.
CO2	Apply the principles of combustion in spark ignition and compression ignition engines to analyze combustion phenomena, knocking characteristics, fuel requirements, combustion chambers, and engine performance.
CO3	Analyze the performance of internal combustion engines by conducting performance tests, measuring engine parameters, determining power, frictional losses, and preparing heat balance sheets.
CO4	Evaluate the performance of gas turbine power plants by analyzing thermodynamic cycles, regeneration, intercooling, reheating, and closed-cycle gas turbine systems.
CO5	Evaluate the operating principles, thermodynamic performance, and applications of jet propulsion and rocket propulsion systems for aerospace and engineering applications.

II-II	**Course Code: C214** **Course Name:** Industrial Engineering and Management
CO1	Explain the concepts, principles, functions, and applications of Industrial Engineering, productivity measurement, scientific management, management theories, and the role of industrial engineers.
CO2	Apply the principles of plant location, plant layout, maintenance strategies, and quantitative techniques for improving manufacturing system efficiency.
CO3	Apply work study techniques including method study, time study, work sampling, PMTS, micro-motion study, MTM, ergonomics, flow process charts, string diagrams, and Therbligs for productivity improvement.
CO4	Analyze statistical quality control techniques, sampling inspection methods, control charts, Total Quality Management, ISO quality systems, and Six Sigma concepts for quality improvement.
CO5	Apply the principles of human resource management, job evaluation, merit rating, wage incentive plans, value engineering, enterprise resource planning, and supply chain

	management in industrial organizations.

II-II	**Course Code: C215** **Course Name:** Mechanics of Solids and Metallurgy Lab
CO1	Perform mechanical testing of engineering materials by conducting tensile, bending, and torsion tests and analyze their mechanical behavior under different loading conditions.
CO2	Evaluate the mechanical properties of engineering materials through hardness, compression, impact, spring, and punch shear tests and interpret the test results.
CO3	Investigate the microstructure and hardenability of ferrous and non-ferrous materials by performing metallurgical experiments and correlate the microstructure with material properties and heat treatment.

II-II	**Course Code: C216** **Course Name:** Machine Drawing Practice
CO1	Explain and draw machine elements including screw threads, bolts, nuts, keys, cotter joints, knuckle joints, riveted joints, shaft couplings, and bearings using standard engineering drawing conventions.
CO2	Prepare assembly drawings of machine components such as gear pumps, fuel pumps, connecting rods, pistons, stuffing boxes, screw jacks, swivel vice, plummer block, tailstock, and tool post from part drawings.
CO3	Develop manufacturing drawings by applying limits and fits, geometrical tolerances, surface finish symbols, and dimensional tolerances for machine components using standard engineering practices.

II-II	**Course Code: C217** **Course Name:** Theory of Machines Lab
CO1	Perform experiments to analyze the dynamic behavior of mechanical systems by determining whirling speed, gyroscopic motion, free and forced vibrations, and balancing of rotating masses.
CO2	Analyze the performance and motion characteristics of governors, flywheels, cam-follower mechanisms, and slider-crank/four-bar mechanisms through experimental investigations.

CO3	Evaluate the performance and operating characteristics of power transmission and lifting mechanisms including belt drives, screw jacks, and gear systems for mechanical engineering applications.
II-II	**Course Code: C218** **Course Name:** Python Programming Lab
CO1	Apply data preprocessing techniques and develop machine learning models for classification and association rule mining using Python or Weka.
CO2	Build, evaluate, and compare machine learning algorithms including clustering and neural network models for data analysis applications.
CO3	Develop computer vision applications involving image labeling, image classification, and facial recognition using modern AI tools.

III-I	**Course Code: C301** **Course Name:** Thermal Engineering-II
CO1	Explain the Rankine cycle, combustion process, boilers, boiler mountings and accessories, draught systems, boiler performance, efficiency, and heat balance.
CO2	Apply thermodynamic principles to determine steam nozzle performance, critical pressure ratio, steam flow characteristics, and impulse turbine performance.
CO3	Analyze the performance of reaction steam turbines and steam condensers by evaluating velocity diagrams, efficiencies, condenser performance, and cooling water requirements.
CO4	Evaluate the performance of reciprocating and rotary compressors by comparing efficiencies, work requirements, multistage compression, and operating characteristics.
CO5	Analyze the performance of centrifugal and axial flow compressors by evaluating velocity triangles, energy transfer, pressure rise, efficiencies, and operating characteristics.

III-I	**Course Code: C302** **Course Name:** . Design of Machine Members-I
CO1	Explain the design considerations, material selection, manufacturing aspects, stress analysis, theories of failure, factor of safety, and stiffness concepts used in the design of machine members.
CO2	Apply the principles of fatigue design, stress concentration, endurance strength, and failure criteria to design machine elements subjected to fluctuating loads.
CO3	Analyze riveted, welded, bolted, keyed, cotter, and knuckle joints subjected to static and

	eccentric loading conditions for safe and reliable operation.
CO4	Evaluate the design of shafts and shaft couplings considering strength, rigidity, combined loading, and standard engineering practices.
CO5	Design mechanical springs for static and fatigue loading by considering stresses, deflection, energy storage, and engineering design requirements.

III-I	**Course Code: C303** **Course Name:** Machining, Machine Tools & Metrology
CO1	Explain the fundamentals of metal cutting, machining theory, cutting tool geometry, chip formation, tool wear, machinability, cutting fluids, tool materials, machining economics, and machining parameters.
CO2	Apply the working principles, operations, machining parameters, and machining time calculations of lathe, shaping, slotting, and planning machines for machining applications.
CO3	Analyze the construction, working principles, machining operations, indexing methods, cutting parameters, and machining time calculations of drilling, boring, and milling machines.
CO4	Evaluate finishing processes, limits and fits, tolerance systems, inter changeability, gauges, and standard engineering practices for precision manufacturing applications.
CO5	Develop appropriate methods for surface roughness measurement and precision inspection using optical measuring instruments for quality control in manufacturing.

III-I	**Course Code: C304** **Course Name:** Finite element methods
CO1	Explain the fundamental concepts of the finite element method, stress-strain relationships, equilibrium equations, variational methods, potential energy concepts, and one-dimensional finite element analysis.
CO2	Apply finite element discretization techniques to formulate bar elements, assemble global stiffness matrices, generate meshes, impose boundary conditions, and analyze truss structures.
CO3	Analyze beam structures using finite element formulations by developing element stiffness matrices, load vectors, and determining beam responses under different loading conditions.

CO4	Evaluate two-dimensional finite element models using constant strain triangles, axisymmetric formulations, higher-order and isoparametric elements, and numerical integration techniques.
CO5	Develop finite element models for steady-state heat transfer and free vibration problems by formulating mass matrices, evaluating eigenvalues and eigenvectors, and interpreting engineering responses.

III-I	**Course Code: C305** **Course Name:** Sustainable energy technologies
CO1	Explain the principles of solar radiation, photovoltaic energy conversion, solar energy collection, storage systems, and various solar energy applications.
CO2	Apply the principles of wind energy and biomass energy conversion systems to evaluate their performance, energy generation, and engineering applications.
CO3	Analyze geothermal, ocean thermal, tidal, and wave energy conversion systems and evaluate their energy extraction methods and performance characteristics.
CO4	Evaluate energy-efficient electrical and mechanical systems including energy-efficient motors, lighting systems, HVAC controls, fuel cells, compressors, and pumps for sustainable energy utilization.
CO5	Create sustainable green manufacturing solutions by selecting eco-friendly materials, renewable manufacturing techniques, and environmentally responsible production systems.

III-I	**Course Code: C306** **Course Name:** Machine Tools Lab
CO1	Explain the construction, working principles, specifications, and applications of general-purpose machine tools used in manufacturing processes.
CO2	Perform machining operations such as turning, drilling, reaming, tapping, shaping, and slotting using conventional machine tools by following standard machining practices and safety procedures.
CO3	Produce engineering components by performing milling operations, indexing, and gear cutting to achieve the required dimensional accuracy and surface finish.

III-I	**Course Code: C307** **Course Name:** Thermal Engineering Lab

CO1	Conduct experiments to determine valve timing, port timing, and the physical properties of fuels and lubricants, including flash point, fire point, viscosity, and calorific value using standard testing equipment.
CO2	Analyze the performance, combustion, heat balance, frictional losses, volumetric efficiency, air-fuel ratio, cooling characteristics, and operating parameters of I.C. engines through standard performance tests.
CO3	Evaluate the performance of air compressors and demonstrate the assembly, disassembly, and maintenance of automobile engines and boilers with their mountings and accessories.

III-I	**Course Code: C308** **Course Name:** Advanced Communication Skills Lab
CO1	Demonstrate effective interpersonal communication skills by applying appropriate vocabulary, role-play techniques, reading comprehension, and listening strategies in academic and professional contexts.
CO2	Develop professional communication skills through technical writing, oral presentations, public speaking, and written communication using appropriate formats and presentation techniques.
CO3	Apply group discussion, interview, and soft skills to communicate confidently, collaborate effectively, and demonstrate professional competence in workplace and career-oriented situations.

III-I	**Course Code: C309** **Course Name:** Summer Internship
CO1	Formulate and apply mathematical, science and engineering principles to solve real time engineering problems
CO2	Test the existing data, communicate and conduct research on complex problems using modern tools
CO3	Validate the obtained results on contemprory issues related to society and environment

III-II	**Course Code: C310** **Course Name:** Heat Transfer
CO1	Explain the fundamental modes of heat transfer and analyze steady-state conduction through plane, cylindrical, spherical, composite systems, and extended surfaces.

CO2	Evaluate transient heat conduction and analyze convective heat transfer using dimensional analysis, Buckingham π theorem, continuity, momentum, energy equations, and non-dimensional correlations.
CO3	Analyze forced and free convection heat transfer in external and internal flows using boundary layer concepts, empirical correlations, and engineering applications.
CO4	Analyze boiling, condensation, and heat exchanger performance using LMTD and NTU methods.
CO5	Evaluate radiation heat transfer between surfaces using radiation laws, emissivity, shape factors, and radiation network analysis.

III-II	**Course Code: C311** **Course Name:** Design of Machine Members-II
CO1	Explain the design principles of journal bearings, rolling contact bearings, connecting rods, crankshafts, pistons, cylinders, and cylinder liners for machine applications.
CO2	Apply design procedures for curved beams, crane hooks, C-clamps, power screws, nuts, and ball screws considering strength and failure criteria.
CO3	Analyze belt, rope, chain, spur gear, and helical gear drives by evaluating power transmission, stresses, efficiency, and design parameters.
CO4	Design machine tool elements including levers, brackets, crank pins, wall boxes, hangers, wire ropes, sheaves, and drums for engineering applications..
CO5	Apply design methodologies for machine tool elements, levers, brackets, and wire ropes used in mechanical systems.

III-II	**Course Code: C312** **Course Name:** Introduction to Artificial Intelligence and Machine Learning
CO1	Explain the fundamentals of Artificial Intelligence, intelligent agents, rationality, neural networks, perceptrons, backpropagation, genetic algorithms, and their engineering applications.
CO2	Apply knowledge representation, logical reasoning, Bayesian learning, concept learning, inference techniques, K-nearest neighbour, and machine learning fundamentals to solve engineering problems.
CO3	Analyze supervised and unsupervised learning algorithms including Decision Trees, SVM,

	K-Means, PCA, Kernel PCA, and distance-based methods for classification and clustering tasks.
CO4	Evaluate machine learning algorithms using model evaluation, model selection, and ensemble learning methods including Bagging, Boosting, and Random Forests
CO5	Develop intelligent solutions using deep generative models, deep Boltzmann machines, deep autoencoders, and sequence/time-series deep learning models for real-world application

III-II	**Course Code: C313** **Course Name:** Automobile Engineering
CO1	Explain the construction, components, working principles, lubrication systems, turbocharging, supercharging, maintenance, and servicing of automobile engines and power units.
CO2	Explain the construction, working principles, operation, and applications of automobile transmission systems including clutches, gearboxes, propeller shafts, differentials, rear axles, wheels, and tyres.
CO3	Explain the principles, construction, working, and applications of steering systems, suspension systems, and their components used in automobiles.
CO4	Explain the construction, working principles, operation, and applications of braking systems and automobile electrical systems used in modern vehicles.
CO5	Analyze automobile engine specifications, safety systems, engine servicing procedures, sensors, actuators, onboard diagnostic systems, and automobile electronic systems used in modern vehicles.

III-II	**Course Code: C314** **Course Name:** Industrial Robotics
CO1	Explain the fundamentals of robotics, robot anatomy, drive systems, end effectors, and industrial robot configurations.
CO2	Apply homogeneous transformations and kinematic principles to analyze robotic manipulator motion.
CO3	Analyze robot dynamics using Jacobian matrices, Lagrange-Euler, and Newton-Euler formulations.

CO4	Analyze robot trajectory planning, path generation, obstacle avoidance, and robot programming techniques.
CO5	Apply robotic actuators, sensors, and robotic systems in manufacturing and automation applications.

III-II	**Course Code: C315** **Course Name:** Heat Transfer Lab
CO1	Conduct experiments to determine thermal properties and heat transfer characteristics in conduction, convection, radiation, and heat exchangers using standard laboratory equipment.
CO2	Evaluate heat transfer phenomena including condensation, boiling, critical heat flux, emissivity, Stefan–Boltzmann constant, and Lambert's laws through experimental investigation.
CO3	Analyze heat transfer processes using virtual laboratory simulations for conduction, heat exchangers, and radiation to interpret the thermal performance of engineering systems.

III-II	**Course Code: C316** **Course Name:** CAE&CAM Lab
CO1	Perform finite element analysis of structural, thermal, vibration, and buckling problems using modern simulation tools.
CO2	Develop CNC part programs for turning and milling operations using standard programming techniques.
CO3	Generate automated CNC tool paths and demonstrate rapid prototyping and virtual 3D printing applications using CAD/CAM software.

III-II	**Course Code: C317** **Course Name:** Measurements & Metrology Lab
CO1	Perform calibration and measurement of pressure, temperature, displacement, strain, flow, speed, and vibration using mechanical and electronic measuring instruments.
CO2	Perform dimensional measurements, machine tool alignment tests, and calibration using precision metrology instruments.
CO3	Analyze engineering components through angle, taper, thread, surface roughness, and geometric measurements using standard metrology techniques.

III-II	**Course Code: C318** **Course Name:** Artificial Intelligence and Machine Learning Lab
CO1	Apply data preprocessing techniques and develop machine learning models for classification and association rule mining using Python or Weka.
CO2	Build, evaluate, and compare machine learning algorithms including clustering and neural network models for data analysis applications.
CO3	Develop computer vision applications involving image labeling, image classification, and facial recognition using modern AI tools.

III-II	**Course Code: C319** **Course Name:** summer internship
CO1	Formulate., and apply mathematical, science and engineering principles to solve real time engineering problems
CO2	Test the existing data, communicate and conduct research on complex problems using modern tools
CO3	Validate the obtained results on contemprory issues related to society and environment

IV-I	**Course Code: C401** **Course Name:** Unconventional Machining Processes
CO1	Explain the need, classification, principles, material removal mechanisms, process parameters, capabilities, limitations, and applications of abrasive jet, water jet, abrasive water jet, magnetic abrasive finishing, and abrasive flow finishing processes.
CO2	Explain the working principles, mechanics of material removal, process parameters, tooling, economics, recent developments, applications, and limitations of ultrasonic machining.
CO3	Apply the principles of electrochemical machining, electrochemical grinding, honing, deburring, chemical machining, and estimate material removal rate while explaining tool design, surface finish, and machining accuracy.
CO4	Analyze the working principles, process parameters, tool selection, dielectric fluids, machining characteristics, surface quality, and applications of EDM, EDG, and Wire EDM processes.

CO5	Analyze the principles, process parameters, material removal mechanisms, machining characteristics, efficiency, accuracy, and industrial applications of electron beam machining, laser beam machining, and plasma arc machining.

IV-I	**Course Code: C402** **Course Name:** Power Plant Engineering
CO1	Explain the layout, working principles, fuel handling systems, combustion methods, draught systems, feed water treatment, cooling systems, and pollution control equipment used in steam power plants.
CO2	Apply the principles of diesel and gas turbine power plants, including plant layouts, auxiliaries, supercharging, combined cycle operation, and performance comparison.
CO3	Analyze the operation and performance of hydroelectric and nuclear power plants, including dams, reactors, plant auxiliaries, and radioactive waste management.
CO4	Evaluate the combined operation of different power plants and the role of instrumentation and control systems in efficient power generation and plant monitoring.
CO5	Develop economical and environmentally sustainable solutions for power generation by analyzing power plant economics, energy auditing, load characteristics, and pollution control methods.

IV-I	**Course Code: C403** **Course Name:** Non-Destructive Evaluation
CO1	Explain the fundamentals, industrial applications, principles, equipment, procedures, and safety aspects of radiographic testing used in non-destructive evaluation.
CO2	Apply the principles of ultrasonic testing to inspect engineering materials and interpret defects based on ultrasonic testing procedures and acceptance criteria.
CO3	Analyze liquid penetrant testing and eddy current testing techniques by selecting appropriate inspection methods and evaluating their effectiveness and limitations.
CO4	Evaluate magnetic particle testing procedures, equipment, calibration methods, inspection results, and suitability for defect detection in engineering components.
CO5	Evaluate infrared and thermal testing techniques for non-destructive inspection of engineering components by selecting appropriate thermal inspection methods for industrial applications.

IV-I	**Course Code: C404** **Course Name:** Additive Manufacturing
CO1	Explain the fundamentals, classification, principles, processes, materials, applications, advantages, and limitations of liquid-based rapid prototyping systems including SLA and SGC.
CO2	Apply the principles of solid-based and powder-based rapid prototyping systems including FDM, LOM, SLS, and 3DP for suitable engineering applications.
CO3	Analyze rapid tooling techniques including indirect and direct rapid tooling methods for manufacturing engineering applications.
CO4	Evaluate rapid prototyping data formats, STL file generation, STL file errors, repair techniques, and data exchange methods used in rapid prototyping systems.
CO5	Develop appropriate rapid prototyping solutions by selecting suitable RP technologies for engineering, aerospace, automotive, biomedical, jewellery, GIS, and other industrial applications.

IV-I	**Course Code: C405** **Course Name:** Safety Engineering
CO1	Explain the concepts of industrial safety management, safety organizations, safety committees, and statutory requirements.
CO2	Apply accident prevention techniques, personal protective equipment, safety training, and accident investigation procedures in industrial environments.
CO3	Analyze industrial safety legislation, occupational health hazards, ergonomics, and workplace safety practices.
CO4	Analyze fire hazards and apply appropriate fire prevention, protection, and emergency response systems.
CO5	Evaluate building fire safety measures, structural fire protection systems, and compliance with fire safety regulations.

IV-I	**Course Code: C406** **Course Name:** Universal Human Values: Understanding Harmony
CO1	Develop self-awareness and understanding of relationships with family, society, and nature, and evaluate their impact on sustainable living.

CO2	Analyze real-life problems and propose responsible and sustainable solutions considering human values and societal well-being.
CO3	Exhibit effective communication and interpersonal skills in understanding and maintaining human relationships in diverse environments.
CO4	Demonstrate ethical behavior, responsibility, and commitment in personal and professional decision-making.
CO5	Exhibit effective communication and interpersonal skills in understanding and maintaining human relationships in diverse environments.

IV-I	**Course Code: C407** **Course Name:** Mechatronics Lab
CO1	Perform experiments to analyze the characteristics and operation of transducers, sensors, amplifiers, and instrumentation systems used for engineering measurements.
CO2	Develop PLC ladder programs, MATLAB programs, and SIMULINK models to analyze and simulate automation and control systems.
CO3	Design and simulate hydraulic, pneumatic, electro-hydraulic, and electro-pneumatic circuits using Automation Studio for industrial automation applications.

IV-II	**Course Code: C408** **Course Name:** Project work
CO1	Apply mechanical engineering principles, modern engineering tools, and research methodologies to identify, analyze, and solve real-world engineering problems through project work and industrial exposure.
CO2	Design and develop innovative mechanical components, systems, or processes using appropriate engineering design practices, CAD/CAM tools, simulation techniques, experimentation, and performance evaluation.
CO3	Demonstrate professional competence by preparing technical reports, delivering effective presentations, working collaboratively in teams, managing engineering projects, and applying ethical, societal, and sustainable engineering practices.