MECHANICAL ENGINEERING DEPARTMENT

<table>
<tr><td rowspan="3">Subject: Manufacturing Processes
(Code: MET201)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

- **CO1:** Identify and analyse the functioning of machine tools and estimate the machining time
- **CO2:** Explain and analyse the conventional machining processes
- **CO3:** Analyse the welding process behaviour for fusion and solid state welding techniques
- **CO4:** Explain the basics of casting processes and their applications in manufacturing domain

Detailed Syllabus:

UNIT I

Introduction to manufacturing processes, Introduction to machine tool. Basic elements of machine tool, machine tool drives. Lathe machine: Tool geometry, machining parameters. Lathe operations (Facing, Turning, Drilling, Reaming, Boring), Taper turning by different methods. Milling Machine: types, working principle, milling parameters, operations (slab, end, slot, face milling), up and down milling. Estimating machining time in lathe and milling operations, different types of indexing methods in milling

UNIT II

Drilling: Types of drilling machines, portable, bench, upright, Radial, Spot facing. Drilling process parameters, Estimating machine time. Reaming: Types of reamer, reaming operations. Broaching: Types of broaches, tool material, teeth terminology and other details. Methods of broaching. Working principle and operation of shaping, planning and slotting

UNIT III

Welding: Introduction to welding, Principle of Welding, Classification of welding, Arc Initiation, Characteristic and power of electric arc, Power source characteristics, Modes of metal transfer in Arc welding, Gas welding, SMAW, GTAW, GMAW, Resistance and Thermit welding, High energy beam welding, Solid state welding processes, Underwater Welding, Welding defects, Welding of Plastics

UNIT IV

Casting Processes: Introduction, Industrial applications, casting terminology, mould, types of mould (Grey and Dry sand Mould), Pattern types, allowances, preparation of mould, various stages in the casting process, testing of moulding sand, types of casting processes (Die, Centrifugal, Continuous, and investment casting), Solidification time, Gating and rising system design

Text Book:

1. Ghosh, A. and Malik, A.K., "Manufacturing Science", Affiliated East Press, New-Delhi.

Reference Books:

1. Campbell, J.S., "Principles of Manufacturing Materials and Processes", McGraw-Hill, New-York.
2. Rao, P.N., "Manufacturing Technology", Vol. 2, McGraw-Hill Education, New Delhi.
3. Lindberg, R.A., "Processes and Materials of Manufacturing", Allyn and Bacon, Boston.
4. Schey, J.A., "Introduction to Manufacturing Processes", McGraw-Hill, New-York.
5. Sindo Kou, "Welding Metallurgy", 2nd Edition, Wiley-Interscience.

<table>
<tr><td rowspan="3">Subject: Mechanics of Solids (Code: MET202)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

- **CO1:** Evaluate and solve statically determinate and indeterminate problems
- **CO2:** Determine the resistance and deformation in machine members subjected to axial, flexural and torsional loads
- **CO3:** Evaluate principal stresses, strains and apply the concept of failure theories for design
- **CO4:** Analyze thin and thick cylinders and design closed-coil helical and leaf springs

Detailed Syllabus:

UNIT I

Concept of Resistance and deformation, determinate and indeterminate problems in tension and compression, thermal stresses, pure shear, Young's modulus of elasticity, Poisson's ratio, Modulus of rigidity and Bulk modulus, relation between elastic constants, Stress-strain diagrams for brittle and ductile materials, working stress, Strain energy in tension and compression, Impact loading

UNIT II

Analysis of Stress and Strain, Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal planes, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions, Thin and Thick Cylinders, spherical shells subjected to internal fluid pressure, Wire-wound thin cylinders, Compound cylinders, Shrink fit.

UNIT III

Shear Force and Bending Moment, types of supports and beams, types of loads, articulated beams, Shear Force and Bending Moment diagrams, Theory of Simple Bending, Bending stresses in beams, Efficiency of various cross-sections, Composite beams, Flexural shear stress distribution in different cross sections of beams, Deflection of Beams, Slope and deflection of beams, Double Integration method, Macaulay's method, strain energy method

UNIT IV

Torsion of Circular cross sections, theory of pure torsion, transmission of power in solid and hollow circular shafts, Combined bending and torsion, Springs, Axial load and torque on helical springs, stresses and deformations, strain energy, compound springs, leaf springs, Strain Energy, Castigliano's theorems I and II, Load-deformation diagram, Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.

Text Books:

1. Hibbeler, R. C., *"Mechanics of Materials"* 8th Edition, Pearson Education India, 2011.
2. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers, 2011.
3. Shames, I. H., Pitarresi, J. M., "Introduction to Solid Mechanics", Pearson, 2015.

Reference Books:

1. Popov, E. P., "Engineering Mechanics of Solids", PHI, 2009.
2. Beer, F. Jr., Johnston, E. R., DeWolf, J., Mazurek, D., "Mechanics of Materials", 7th Edition, McGraw-Hill Education, 2014.

<table>
<tr><td rowspan="3">Subject: Fundamentals of Dynamics
(Code: MET203)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Apply the concepts and laws of dynamics to solve complex engineering problems
CO2: Use the concepts of impulse-momentum to develop relations governing particle impacts
CO3: Use Newton's second law to determine trajectory properties of particles under central-force attraction
CO4: Apply the knowledge of dynamics of rigid bodies to systems like ships and airplanes

Detailed Syllabus:

UNIT I
Kinematics of particles, basic concepts, rectilinear motion, plane curvilinear motion, rectangular coordinates (x-y), normal and tangential coordinates (n-t), polar coordinates (r-θ), space curvilinear motion, relative motion (translating axes), constrained motion of connected particles

UNIT II
Kinetics of particles, equations of motion and their solution, impulse, momentum, work and energy, linear impulse and linear momentum, angular impulse and angular momentum, impact, central-force motion, relative motion, kinetics of systems of particles, generalized Newton's second law, work-energy, impulse-momentum, conservation of energy and momentum

UNIT III
Dynamics of rigid bodies, rotation, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, motion relative to rotating axes, plane kinetics of rigid bodies, translation, fixed-axis rotation, general plane motion, mass moments of inertia

UNIT IV
Work energy relations, virtual work, impulse-momentum equation, and three-dimensional dynamics of rigid bodies, gyroscopic motion, and steady precession

Text Book:

1. Meriam, J. L., Kraige, L. G., Bolton, J. N., "Engineering Mechanics: Volume 2, Dynamics", 9th Edition, Wiley, 2018.

Reference Book:

1. Shames I. H. and Rao, G. K., "Engineering Mechanics Statics and Dynamics", Pearson Education India; 4th Edition, 2005.

<table>
<tr><td rowspan="3">Subject: Engineering Thermodynamics (Code: MET204)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2^{nd} Year & 3^{rd} Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Apply the basic concepts of thermodynamics to engineering systems
CO2: Apply various laws of thermodynamics to solve problems involving heat and work transfer
CO3: Design heat engines and heat pumps using the knowledge of basic thermodynamic cycles
CO4: Develop fundamental relations between various thermodynamic properties to evaluate the un-measurable properties

Detailed Syllabus:

UNIT I
Introduction and basic concepts, microscopic and macroscopic views of matter, thermodynamic systems, properties, processes, cycles, thermal equilibrium, the state postulate, Zeroth law of thermodynamics, temperature, temperature scales, thermodynamic equilibrium, energy and the First law of thermodynamics, mechanical forms of work, internal energy, conservation of energy, energy transfer as work and heat, First law for a closed system, specific heats, isothermal, isobaric, and isentropic processes, compressibility.

UNIT II
First law for open systems, enthalpy, First law for cyclic processes, applications, Second law of Thermodynamics, Entropy and the Second law, Various statements of the Second law and their equivalence, Clausius statement, Kelvin-Planck statement, reversible cycles, Carnot cycle, inequality of Clausius, the principle of increase of entropy and its applications, Second law for closed systems, Second law for open systems.

UNIT III
The Maxwell relations, Gibb's function, Helmholtz function, relationship between specific heats, the Clapeyron equation, thermodynamic relations for ideal gases, computation of entropy and internal energy from measurable quantities, process with ideal gases and vapours, Ideal gas mixtures, Dalton's law of partial pressures, Gibbs–Dalton law, Amagat's law of additive volumes

UNIT IV
Internal energy, enthalpy, specific heat and entropy of an ideal gas mixture, air-water vapour mixture**,** complete and incomplete combustion analysis, heating value of fuels, analysis of products of combustion, Orsat apparatus.

Text Books:

1. Moran, M.J., Shapiro, H.J., Boettner, D.D., Bailey, M.B., "Fundamentals of Engineering Thermodynamics", John Wiley, 2018.
2. Cengal, Y., Boles, M., and Kanoglu, M., "Thermodynamics: An Engineering Approach", McGraw Hill, 2019.

Reference Books:

1. Wark, K., "Thermodynamics", McGraw Hill, 2001.
2. Van-Wylen, G.J., "Fundamentals of Classical Thermodynamics", John Wiley, 2001.

<table>
<tr><td rowspan="3">Subject: Fluid Mechanics-I (Code: MET205)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Apply the basic laws of hydrostatics to engineering problems involving static fluids and submerged surfaces

CO2: Evaluate and apply the principles of continuity, momentum, and energy conservation to systems involving fluid motion

CO3: Apply the Bernoulli equation to compute pressure and velocity changes in flow systems of different configuration and appreciate the application of elementary potential theory

CO4: Apply the knowledge of fluid dynamics to determine head losses in circular pipes and use elementary boundary-layer theory to determine lift and drag forces in engineering systems

Detailed Syllabus:

UNIT I

Definition of a fluid, methods of analysis, system and control volume, differential versus integral approach, methods of description, fluid as a continuum, velocity field, timelines, path lines, streak lines, and streamlines, stress field, viscosity, Newtonian and non-Newtonian fluids, surface tension, viscous and inviscid flows, laminar and turbulent flows, the basic equation of fluid statics, pressure variations in a static fluid, manometers, hydraulic systems, hydrostatic force on submerged surfaces, buoyancy and stability, fluids in rigid-body motion

UNIT II

Conservation of mass, control volume formulation, differential control volume, control volume moving with constant velocity, momentum equation for control volume with rectilinear acceleration, the angular-momentum principle, equation for fixed control volume, equation for rotating control volume, the rate of work done by a control volume, differential analysis of fluid motion, stream function and velocity potential, fluid translation, acceleration of a fluid particle in a velocity field, fluid rotation, fluid deformation, momentum equation, Navier-Stokes equations

UNIT III

Incompressible inviscid flow, momentum equation for frictionless flow, Euler's equation, Bernoulli equation, integration of Euler's equation along a streamline, static, stagnation, and dynamic pressures, applications of the Bernoulli equation, the Bernoulli equation interpreted as an energy equation, energy grade line and hydraulic grade line, unsteady Bernoulli equation, irrotational flow, stream function and velocity potential, Laplace's equation, superposition of elementary plane flows

UNIT IV

Dimensional analysis and similitude, non-dimension alization of the basic differential equations, Buckingham Pi theorem, determining the π groups, significant dimensionless groups, flow similarity and model studies, internal incompressible viscous flow, fully developed laminar flow between infinite parallel plates, fully developed laminar flow in a pipe, flow in pipes and ducts, shear stress distribution, turbulent velocity profiles in fully developed pipe flow, energy considerations in pipe flow, kinetic energy coefficient, head loss calculation, major and minor losses, friction factor, restriction flow meters for internal flows, boundary-layer theory, boundary-layer thicknesses, laminar flat-plate boundary layer, momentum integral equation for flow with zero pressure gradient, friction and pressure drag, streamlining, aerodynamic lift

Text Book:

1. Pritchard, P. J., Leylegian, J. C., "Fox and McDonald's Introduction to Fluid Mechanics", Eighth edition, John Wiley and Sons, Inc., 2011.

Reference Books:

1. Shames, I. H., "Mechanics of Fluids", Fourth Edition, McGraw Hill, 2003
2. White , F.M., "Fluid Mechanics", McGraw Hill, 2001

Subject: Machine Drawing & Solid Modelling (Code: MEL201)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester		Total Course Credit: 2		
			L	T	P
			0	0	4
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

CO1: Draw machine elements including keys, couplings, cotters, rivets, bolted and welded joints, using the conventions for engineering components and materials
CO2: Construct an assembly drawing using part drawings of machine components
CO3: Create part drawing of machine components using machine assembly
CO4: Apply geometric modelling techniques in design and analysis

Detailed Syllabus:

UNIT I

Introduction to machine element drawing, review of dimensioning, types of sectioning and use, need and significance of version control in drawings, methods of recording modifications in typical drawings, Introduction to generation of drawings as a design process for machine assembly. Use of datum planes to locate features and machine elements uniquely in assemblies. Standardized representation and types of threads, fasteners, welds.

UNIT II

Introduction to important machine elements such as bearings (rolling contact/sliding contact), Use of appropriate fits for correct functioning, representation of springs and related components, detailing of components involving shafts, bearing, pulleys, gears, belts, brackets for assembly, generation of assembly drawings using standard modeling software including sectioning and bill of materials, evolving details of components from assembly considerations.

UNIT III

Solids Modelling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modelling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modelling methods in CAD software. Data Exchange Formats and CAD Applications.

UNIT IV

Development of three-dimensional models and fabrication/assembly drawings from engineering sketches and orthographic drawings and utilization of three-dimensional models in design work. Introduction to engineering topics such as finite-element analysis (FEA) and computational fluid dynamics (CFD). Additional advanced topics include stress/deflection calculations using beam theory mathematical models.

Text Books:

1. Bhatt, N.D., "Machine Drawing", Charotar Publishing House, 2003.
2. Saxena A. and Sahay B., "Computer-Aided Engineering Design", Anamaya Publishers, New Delhi, 2005.

Reference Books:

1. Sidheswar, N., Kannaiah, P. and Sastry, V.V.S., "Machine Drawing", Tata McGraw Hill Book Company, New Delhi, 2000.
2. Mortenson M. E., "Geometric Modeling", Tata McGraw Hill, 2013.

<table>
<tr><td rowspan="3">Subject: Applied Mathematics for Engineers (Code: MAT205)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Solve problems related to differentiation and integration of complex functions

CO2: Express complex functions in terms of series expansion, classify singularities and the apply the concepts of complex analysis in boundary value problems and potential theory

CO3: Evaluate Laplace, Inverse Laplace transforms, Fourier and Inverse Fourier transforms of various functions and related problems

CO4: Apply the methods of Laplace and Fourier transforms in solving ODE, PDE and Integral equations

Detailed Syllabus:

UNIT I

Complex Variables: Function of a Complex variable, Limit, Continuity and Differentiability of complex function. Cauchy-Riemann Equations, Analytic function, Harmonic functions, Complex Integration Cauchy Integral Theorem and its consequences, Taylor Series, Laurant Series, Classification of Singularities, Residues, Cauchy's Residue Theorem and its Applications, Zeros of Analytic functions.

UNIT II

Boundary Value Problems and Potential Theory, Laplace's Equation and Conformal Mappings, Standard Solution of Laplace equation, Steady–State Temperature Distribution, Steady Two Dimensional Fluid Flow.

UNIT III

Laplace transform, Laplace transform of some elementary functions, Properties of Laplace transform, Differentiation and Integration of Laplace transform, Dirac-delta function and its Laplace transform, Heaviside's expansion theorem, Inverse Laplace transform, Initial and Final value theorems, Convolution theorem, Use of Laplace transforms in the solution of linear differential equation.

UNIT IV

Fourier Transforms, Definition of Fourier transform, Fourier Integral Theorem, Properties of Fourier transform, Fourier sine and cosine, Convolution Theorem, Applications of Fourier transforms to Ordinary and Partial differential equations.

Text Books:

1. Brown, W., and Churchill, R. V., "Complex Variables and Applications," 8^{th} Edition, Mc-Graw Hill International Edition, 2009
2. Debnath, L., and Bhatta, D., "Integral Transforms and their Applications," 2^{nd} Edition, CRC press, 2007

Reference Books:

1. Jeffrey, A., "Complex Analysis and Applications," 2^{nd} Edition, CRC Press, 2005
2. Needham, T., "Visual Complex Analysis," Oxford University Press
3. Jain, R. K., and Iyengar, S. R. K., "Advanced Engineering Mathematics," 3^{rd} Edition, Narosa Pub. House, 2008
4. Spiegel, M. R., "Schaum's Outlines Laplace Transforms," Tata Mc-Graw Hill, 2005

<table>
<tr><td rowspan="3">Subject: Mechanics of Solids Lab (Code: MEL202)</td><td rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Continuous Assessment (40 Marks)</td><td colspan="3">End-Term (60 Marks)</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Determine the tensile or compressive strength of different material and interpret various critical point locations on the stress-strain diagram

CO2: Identify different engineering materials, describe their properties and predict their behaviour under different types of loading

CO3: Determine elastic constants using various flexural and torsion tests

CO4: Determine the mechanical properties of materials by destructive methods

List of Experiments:

1. To study the stress-strain characteristics of (a) Mild Steel and (b) Cast Iron by conducting tension test on UTM
2. To study the stress-strain characteristics of (a) Copper and (b) Aluminum by conducting tension test on Hounsfield Tensometer
3. To find the compressive strength of wood and punching shear strength of G.I. sheet by conducting relevant tests on Hounsfield Tensometer
4. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminum (d) Copper by conducting hardness test
5. To determine the modulus of rigidity by conducting Torsion test on (a) Solid shaft (b) Hollow shaft
6. To find the modulus of rigidity of the material of a spring by conducting compression test
7. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam
8. To determine the modulus of elasticity of the material by conducting deflection test on a propped cantilever beam
9. To determine the modulus of elasticity of the material by conducting deflection test on a continuous beam
10. To investigate the load deflection characteristics of various types of spring and determine their spring rate

<table>
<tr><td rowspan="3">Subject: Manufacturing Processes Lab
(Code: MEL203)</td><td rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 3rd Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Evaluation Policy</td><td>Continuous Assessment
(40 Marks)</td><td colspan="3">End-Term
(60 Marks)</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Describe the geometry of single point cutting tool
CO2: Apply knowledge of metal cutting to perform various machining operations
CO3: Explain the working and use of various components of conventional machine tools
CO4: Investigate the effect of machining process parameters on surface roughness

List of Experiments:

1. To study the construction details and working principle of Lathe Machine.
2. To perform taper turning operation on Lathe Machine
3. To perform step turning operation on Lathe Machine
4. To study the tool geometry of a single point cutting tool.
5. To perform drilling operation on a given work piece using Drilling Machine
6. To perform shaping operation on a given work piece using Shaper Machine
7. To perform external thread cutting operation on Lathe Machine
8. To investigate the effect of turning process parameters on the surface roughness of machined component

<table>
<tr><td rowspan="3">Subject: Applied Thermodynamics (Code: MET251)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2^{nd} Year & 4^{th} Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

- **CO1:** Identify and describe the various components of boilers and power plant
- **CO2:** Explain the operation of steam turbines and steam power plants
- **CO3:** Explain the operation of diesel and gas turbine power plants and address the general challenges in thermal power plants
- **CO4:** Analyze the principles and applications of refrigeration systems and air-conditioning processes using the principles of psychometry.

Detailed Syllabus:

UNIT I

Pure Substance, Ideal and real Gases, perfect gases, Generation of Steam, use of Steam Tables and Mollier diagram, various phases of a substance, triple point and critical point, sub-cooled liquid, saturated liquid, vapor pressure, two-phase mixture of liquid and vapor, saturated vapor and superheated vapor states of a pure substance (with water as an example), dryness fraction and its measurement, representation of the properties of a pure substance on p-T, h-s and p-V diagrams, detailed treatment of properties of steam for industrial and scientific use.

Vapor Power cycles: Carnot vapor power cycle, Effect of pressure & temperature on Rankine cycle, Reheat cycle, Regenerative cycle, Feed water heaters, Binary vapor cycle, combined cycles, Cogeneration, Air standard Cycles, Carnot, Otto, Diesel and dual cycles, work output and efficiency, mean effective pressure, deviation of actual cycles from ideal cycles

UNIT II

Fuels and Combustion: Combustion analysis, Heating Values, Air requirement, Air/Fuel ratio, Standard heat of reaction and effect of temperature on standard heat of reaction, heat of formation, adiabatic flame temperature.

Boilers: Steam generators-classifications, working of fire-tube and water-tube boilers, boiler mountings and accessories, draught and its calculations, air preheater, feed water heater, super heater. Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance, Condensers: classification, Air leakage, Condenser performance parameters

UNIT III

Nozzles: Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, off design operation of nozzle, Effect of friction on nozzle, super saturated flow. Steam Engines: Rankine and modified Rankine cycles, working of stream engine,
Steam Turbines :Classification of steam turbine, Impulse and reaction turbines, Staging, Stage and overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple & compound multistage impulse & reaction turbines & related calculations work done efficiencies of reaction, Impulse reaction Turbines, state point locus, Comparison with steam engines, Losses in steam turbines, Governing of turbines.

UNIT IV

Applications of Refrigeration and Air-conditioning, Thermal Principles for Refrigeration, Vapor Compression System, Reversed Carnot Cycle, Survey of Refrigerants, Designation of Refrigerants, Selection of Refrigerants, Thermodynamic Requirements, Centrifugal compressors, Multistage compression, multi-evaporator system, cascade systems, Condensers, Heat Transfer in Condensers, Evaporators, Heat Transfer in Evaporators, Extended surface Evaporator, Cooling and Dehumidifying coils, Automatic or constant-pressure expansion valve, Psychometric properties, Wet bulb temperature, Psychometric chart, mixing process.

Text Books:

1. Eastop, T. D., "Applied Thermodynamics for Engineering Technologist", Pearson Education, 1990.
2. Arora, C. P., "Refrigeration and Air-conditioning", McGraw Hill, New Delhi,

Reference Books:

1. Helsdon, R. M., Hiller, N., Walker, G. E., "Introduction to Applied Thermodynamics", Elsevier, 1965.
2. Pai, B. U., "Turbomachines", 1st Edition, Wiley.
3. Hundy, G. H., Trott, Albert Runcorn, Welch, T., "Refrigeration, Air Conditioning and Heat Pumps," 5th Edition, Butterworth-Heinemann, Elsevier.

<table>
<tr><td rowspan="3">Subject: Mechanics of Materials
(Code: MET252)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 4th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Apply the fundamental concepts of stress and strain and their relationships to solve problems for three-dimensional elastic solids

CO2: Explain the concept of buckling of columns and solve the problems related to isolated bars

CO3: Solve problems relating to torsional deformation of bars and other simple three-dimensional structures

CO4: Apply principles of linear elasticity in the design and analysis of structures such as curved bars, crane hooks, thin plates

Detailed Syllabus:

UNIT I

Stress in three dimension: Concept of continuum, homogeneity and isotropy, types of force on a body, state of stress at a point, equality of cross shear, Cauchy formula, principal stresses and planes, stress invariants, hydrostatic and deviatoric stress tensor, Mohr's circle for general state of stress, stress transformations, octahedral stresses, differential equation of equilibrium. Strain in three dimension: Types of strain, strain displacement relationship, shear strain, rigid body rotation, principal strain and axes, strain deviator and invariants, compatibility conditions, concept of plane stress and strain, stress strain relationship.

UNIT II

Theories of Elastic Failure: Concept of factor of safety, Maximum Principal Stress Theory, Maximum Principal Strain Theory, Maximum Shear Stress Theory, Strain Energy Theory, Distortion energy theory. Buckling of columns: Concept of buckling and stability, differential equations of compression member with different boundary conditions, eccentrically loaded columns, secant formula, column with initial imperfections, Rankine formula.

UNIT III

Stresses due to rotation: Rotating ring, rotating thin disc, and rotating thin solid and hollow disc, disc of uniform strength, rotating long solids and hollow cylinders. Torsion of non-circular member: St. Venant's theory, approximate solution of rectangular and elliptical sections, rigorous solution, stress function approach, membrane analogy, torsion of thin hollow section, torsion of thin and open sections.

UNIT IV

Bending of curved bars: Introduction, stresses in curved bars (Winkler-Bach theory) having rectangular, circular, triangular and trapezoidal section, stresses in crane hooks. Bending of thin plates: Assumption of plate theory, governing differential equations for deflection of plates, boundary conditions, solution for rectangular plate.

Text Books:

1. Hibbeler, R. C., "*Mechanics of Materials",* 6th Edition, East Rutherford, NJ: Pearson Prentice Hall, 2004
2. Srinath L. S., "Advanced Mechanics of Solids", TMH Publishing Company Limited, 1992

Reference Books:

1. Boresi A. P., Schmidt R. J., Sidebottom O. M., "Advanced Mechanics of Materials", 5th Edition, John Wiley & Sons, 1993
2. Cook, R. D., Young, W. C., "Advanced Mechanics of Materials", Collier Macmillan Publishers, 1985
3. Ugural A. C., S. K. Fenster, "Advanced Mechanics of Materials and Applied Elasticity", Prentice Hall; 5th Edition, 2011

Subject: Theory of Mechanisms and Machines (Code: MET253)	Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester		Total Course Credit: 4		
			L	T	P
			3	1	0
Evaluation Policy	Mid-Term	Class Assessment	End-Term		
	30 Marks	10 Marks	60 Marks		

Course Outcomes: At the end of the course, the student should be able to:

CO1: Select and analyse the kinematic parameters for designing a suitable linkage mechanism
CO2: Explain the working principle of governors and gyroscopes in motion control
CO3: Select and design gear and cam mechanisms for a given input and output motion relationship
CO4: Apply the laws of friction in applications of mechanisms and machines

Detailed Syllabus:

UNIT I
Mechanism and machine, links and kinematic pairs, degrees of freedom, kinematic chain, mechanical advantage, transmission angle, inversions of four bar and slider crank mechanisms, Quick-return mechanism, straight line generators, velocity and acceleration analysis using instantaneous centre method and loop-closure equations, computer-aided analysis of four bar mechanism, graphical and computer-aided synthesis for motion and path generation

UNIT II
Governors, Watt governor, Porter governor, Proell governor, Hartnell governor, controlling force, sensitivity, stability, hunting, isochronism, effort and power of a governor, gyroscope, gyroscopic torque, gyroscopic effects on an airplane and ships, gyroscopic stabilization, stability analysis of a two-wheel vehicle, four-wheel drive on a curved path

UNIT III
Gears, classification, law of gearing, involute and cycloidal profiles, path and arc of contact, contact ratio, interference and undercutting, interchangeable gears, helical, bevel and spiral gears, gear trains, classification, simple, compound, reverted, and epicyclic gear trains, analysis of epicyclic gear trains, sun and planet gears, automobile differential

UNIT IV
Friction, types and laws of friction, screw jack, pivots and collars, bearings, friction clutches, brakes, Cams, classification and terminology, displacement diagrams, derivatives of follower motion, pressure angle and undercutting, motions of the follower, layout of cam profiles, graphical and analytical disc cam profile synthesis

Text Book:

1. Pennock, G. R., Shigley J. E., Uicker, J. J., "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, 2014.

Reference Books:

1. Bevan, T., "Theory of Machines", 3rd Edition, CBS publishers and distributors, 2005.
2. Norton, R. L., "Kinematics and Dynamics of Machinery", Tata McGrawHill, 2009.
3. Ghosh A. and Mallick A. K. "Theory of Mechanisms and Machines" East West Private Limited, New Delhi, 1988.
4. Rattan S. S. "Theory of Machines", 5th Edition, Tata McGrawHill, 2019.

<table>
<tr><td rowspan="3">Subject: Materials Science and Engineering
(Code: MET254)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 4th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Explain the underlying concepts of engineering material chemistry and crystallography
CO2: Determine crystallographic directions and explain imperfections in solids, and processing of engineering materials
CO3: Explain the mechanisms of strengthening and the phase diagrams
CO4: Recognize the need of heat treatment processes and analyse the effect of cooling media on microstructure

Detailed Syllabus:

UNIT I

Introduction to material science and engineering, Importance of materials, Classification of engineering materials, Modern and advanced materials, Atomic structure and bonding, Fundamentals of electron arrangements and modern periodic table, Primary bonds and secondary bonds. Crystallography, Concept of unit cells and lattice arrangements, Crystal structure, Crystal systems, Bravais lattices, Co-ordination number, Atomic packing factor

UNIT II

Miller indices of direction and planes, single crystals, polycrystalline materials, Amorphous material, x-ray diffraction and determination of crystal structures, Imperfections in solids, point defects, line defects and volume defects, dislocations.
Ceramics: structure, types, properties and applications of ceramics, processing of ceramics. Composite materials. Nanomaterials and their potential applications. Plastics: Types of plastics/polymers, polymer structure, thermoplastic and thermosetting polymers, processing of polymers

UNIT III

Deformation and strengthening mechanisms, strain hardening, grain refinement, mechanical alloying, solid solution strengthening, precipitation hardening. Diffusion in solids, Phase diagrams, Solubility limit, Phases, Lever rule, Gibbs phase rule, Iron-Carbon equilibrium diagram. Mechanical properties and testing, Non-Destructive testing

UNIT IV

Heat Treatment: Introduction to heat treatment, different types of heat treatment processes, annealing, normalizing, quenching, tempering, case hardening, Time temperature transformation diagram, Recovery, Recrystallization, Ductile to brittle transition. Micro-structure of various metals and alloys, Micro structure of steel treated with different cooling media.

Text Book:

1. Callister Jr, W. D., Rethwisch, D. G., "Materials Science and Engineering: An Introduction", 8^{th} Edition, John Wiley and Sons.

Reference Books:

1. Raghvan, V., "Materials Science and Engineering", 5^{th} Edition, Prentice Hall India Learning Private Limited, 2005.
2. Ghosh, A., and Malik, A. K., "Manufacturing Science", 2^{nd} Edition, Pearson India, 2010.

<table>
<tr><td rowspan="3">Subject: Non-Traditional Machining and Automation (Code: MET255)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester</td><td colspan="3">Total Course Credit: 4</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>1</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Analyse and assess the importance of automation and industrial automated systems
CO2: Identify and analyse functions and functioning of CNC machines
CO3: Recognize the need of non-traditional machining processes and understand the working of high energy beam machining
CO4: Illustrate underlying mechanisms in non-traditional machining processes along with their applications

Detailed Syllabus:

UNIT I
Introduction to automation and manufacturing automation, types of automation, Introduction to Flexible manufacturing systems (FMS), Elements, types and advantages of FMS, Cellular manufacturing, Types of flexibilities in FMS, test of flexibility, Product processing strategies. Introduction to robotics, Elements of Robotic Systems

UNIT II
Computer numeric control (CNC) machines, Open loop & closed loop CNC machines. Classification, advantages and applications of CNC machines, Introduction to CNC programming, G-codes and M-codes. Absolute and Incremental coordinate system, Adaptive control, Material Handling Equipment, Automated Guided vehicles (AGVs), Analysis of AGVs

UNIT III
Introduction to machining processes. Limitations of traditional machining processes. Introduction, need and applications of non- traditional machining processes. Classification of non- traditional machining processes. Mechanical machining, thermal machining, electrochemical machining. Introduction, working and applications of high energy beam machining processes. Virtual machining

UNIT IV
Introduction, working, process parameters and applications of Abrasive Jet Machining (AJM), Abrasive water jet machining (AWJM), Ultrasonic machining (USM), Electric Discharge Machining (EDM), Electrochemical machining (ECM). Introduction to Wire Electric Discharge Machining (WEDM). Effect of input parameters on material removal in AJM, USM and EDM.

Text Books:

1. Groover, M. P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall Press, United States, 2007.
2. Ghosh, A., and Mallik, A.K., "Manufacturing Science", 2^{nd} Edition, East-West Press, New-Delhi.

Reference Books:

1. Kumar, K., Zindani, D., Davim, J. P., "Advanced Machining and Manufacturing Processes", Springer, Switzerland.
2. Groover, M. P., "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", 5^{th} Edition, Wiley Publication.

<table>
<tr><td rowspan="3">Subject: Basic Electronics (Code: ECT266)</td><td colspan="2" rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester</td><td colspan="3">Total Course Credit: 3</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Mid-Term</td><td>Class Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>30 Marks</td><td>10 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Explain the basic principles associated with semiconductor electronics
CO2: Explain the behavior of different types of diodes and transistors at the circuit level
CO3: Analyze and explain the behavior of operational amplifiers and their applications
CO4: Apply the knowledge of digital logic gates and blocks in designing digital electronic circuits

Detailed Syllabus:

UNIT I
Introduction to semiconductors: Intrinsic and extrinsic semiconductors transport mechanism of charge carriers, electric properties, temperature dependence, and p-n junction diode: current components in p-n junction, characteristics-piece wise linear approximation, and diode circuit's half wave, full wave rectifiers, photo diodes

UNIT II
BJT: Operation and characteristics: CE, CB and CC configuration input, output characteristics biasing and bias stability, low frequency, h-parameter model, analysis and design of transistor amplifier circuits using h-parameters. Multistage amplifiers, transistor as a switch. Introduction to feedback and sinusoidal oscillators, FET's operation and characteristics, JFET model, application at low and high frequency, amplifiers, switching circuits, MOSFET types, operation and characteristics

UNIT III
Operational Amplifier: Operational amplifiers stages, differential amplifier, CMRR, cascade amplifier, ideal and practical operational amplifier characteristics and properties OP-amp applications, inverting and non-inverting amplifiers, difference amplifier, summer differentiator and integrator, rectifiers etc. Instrumentation amplifier

UNIT IV
Digital Logic: Introduction to Boolean theorems and codes, code conversion; Logic gates, combinatorial and sequential blocks

Text Books:

1. Millman, J., Halkias, C., Jit, Satyabrata, "Milman's Electronics Devices and Circuits", Tata McGraw Hill Education, 2010
2. Mano, M Morris, "Digital logic and computer design", Pearson Education India, 2017

Reference Books:

1. Behzad Razavi, "Fundamentals of Microelectronics", Wiley, 2008
2. Mottershed, A., "Electronic Devices and Circuits: An Introduction", Prentice Hall India, 1979.
3. Uyemura, J., "Digital System Design An Integrated Approach", Nelson Engineering, 1999.

<table>
<tr><td rowspan="3">Subject: Thermo-Fluids Lab (Code: MEL251)</td><td rowspan="3">Year & Semester: B. Tech Mechanical Engineering 2nd Year & 4th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Continuous Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>40 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Calibrate flow and discharge measuring devices like the venturimeter and orifice meters
CO2: Determine fluid flow properties and characterize laminar and turbulent flows
CO3: Prepare heat balance sheet for steam boilers
CO4: Determine COP of a refrigerator and identify various parts of a cooling tower

List of Experiments:

Thermal:

1. Determination of calorific value using a Bomb Calorimeter.
2. Study of Various Types of Boilers, Boiler Mountings and Accessories
3. Performance and Energy Balance Test on a Fire Tube/ Water Tube Boiler.
4. Study of Refrigeration System and determination of its COP.
5. Study of a cooling tower.

Fluid Mechanics:

1. To determine the viscosity of a fluid by falling sphere (ball) viscometer.
2. To study the flow through a variable area duct and verify Bernoulli's energy equation.
3. To determine the coefficient of discharge for an obstruction flow meter (Venturimeter/orifice meter).
4. To study the transition from laminar to turbulent flow and to ascertain lower critical Reynolds number.
5. To determine the friction coefficient for pipes of different diameters.
6. To determine the velocity distribution for pipeline flow with a Pitot static probe and to measure pressure with pressure sensors.
7. To study the flow visualization through wind tunnel.

<table>
<tr><td rowspan="3">Subject: Non-Traditional Machining and Automation Lab
(Code: MEL252)</td><td rowspan="3">Year & Semester: B. Tech Mechanical Engineering
2nd Year & 4th Semester</td><td colspan="3">Total Course Credit: 1</td></tr>
<tr><td>L</td><td>T</td><td>P</td></tr>
<tr><td>0</td><td>0</td><td>2</td></tr>
<tr><td rowspan="2">Evaluation Policy</td><td>Continuous Assessment</td><td colspan="3">End-Term</td></tr>
<tr><td>40 Marks</td><td colspan="3">60 Marks</td></tr>
</table>

Course Outcomes: At the end of the course, the student should be able to:

CO1: Explain the working and use of various components of CNC machines.
CO2: Identify the sequence of codes to process a job
CO3: Create CNC programs for turning and milling operations
CO4: Perform machining operation on Wire Electric Discharge Machine

List of Experiments:

1. To Study the fundamentals of CNC Machine
2. To Study the different codes used in CNC Machine
3. To perform drilling operation on CNC Milling Machine
4. To perform slotting operation on CNC Milling machine
5. To perform turning operation on CNC Lathe Machine
6. To produce given profile using CNC Milling Machine
7. To perform machining operation on Wire Electric Discharge Machine (WEDM)
8. To investigate the effect of WEDM process parameters on the surface roughness of the machined component.

Reference Book:

1. Overby, A., "CNC Machining Handbook: Building, Programming and Implementation", McGraw-Hill, 2010.