B.Tech Curriculum for Mechanical Engineering

SEMESTER-III

Name of the Subject	Type	Subject Code	L-T-P	Credit	Contact Hour
	HSS 2		3-0-0	3	3
Theory of Machines - I	DC 2	ME2L001	3-1-0	4	4
Thermodynamics	DC 3	ME2L105	3-1-0	4	4
Mechanics of Solids	DC 4	ME2L004	3-1-0	4	4
Applied Partial Differential Equations	DC 5	ME2L101	2-0-0	2	2
Measurements and Instrumentation	SDC 3	ME2L102	1-0-3	3	4
Workshop Practices	Lab-4	ME2P001	0-0-3	2	3
Material Testing Laboratory	Lab-5	ME2P004	0-0-3	2	3
Total				24	27

SEMESTER-IV

Name of the Subject	Type	Subject Code	L-T-P	Credit	Contact Hour
	HSS 3		3-0-0	3	3
Theory of Machines - II	DC 6	ME2L005	3-1-0	4	4
Fluid Mechanics	DC 7	ME2L002	3-1-0	4	4
Engineering Materials	DC 8	ME2L103	2-0-0	2	2
Applied Numerical Methods	SDC 4	ME2L104	2-0-2	3	4
Mechanisms and Vibration Laboratory	Lab-6	ME2P101	0-0-3	2	3
Fluid Mechanics Laboratory	Lab-7	ME2P002	0-0-3	2	3
	OE 1		3-0-0	3	3
Total				23	26

Syllabus for 2nd Year (3rd & 4th Semesters)

Subject Code: ME2L001	Name: Theory of Machines-I	L-T-P: 3-1-0	Credit: 4

Pre-Requisite: None

Introduction to Mechanisms: Types of mechanisms (planner and spatial), Links and kinematic pairs, Kinematic diagrams, Classification of kinematic chains, Kinematic inversions, Equivalent linkages, Degrees of freedom and mobility analysis, Grashof Criteria.

Kinematic Analysis of Planar Mechanisms: Loop closure equation, Displacement/position analysis: Graphical and analytical methods, Concept of dead-centre/limiting configurations, Relative instantaneous centres, Aronhold-Kennedy theorem, Velocity analysis: Method of relative I.C.s, Graphical and analytical methods, Acceleration analysis: Graphical and analytical methods.

Synthesis of Mechanisms: Type and number synthesis, Two and three position dimensional synthesis: Position generation, Path generation, Function generation problems, Chebyshev Spacing, Frudenstein's equation.

Cam Follower Mechanism: Classification of cams and followers, Displacement diagram, Standard cam motions, Synthesis of cam follower assembly.

Gears and Gear Trains: Classification of Gears, Fundamental law of gearing, Involumetry, Interference and undercutting, Simple and compound gear trains, Epicyclic gear train, Analysis of planetary gear trains by tabular method, Differentials.

Static and Dynamic Force Analysis: Static force analysis using the principle of virtual work. Dynamic force analysis with d'Alembert's principle.

Dynamics of Reciprocating Engines: Inertia forces, Engine shaking forces & shaking moments, Equivalent masses for connecting rod, Crankshaft turning moments- Single and Multi-cylinder engines, Flywheel design based on engine speed and energy fluctuations.

Compliant Mechanism: Basic introduction and applications

Text/Reference Books:

- Ghosh A., and Malik A.K., Theory of Machines and Mechanism, East-West Press. Norton R.L., Design of Machinery, McGraw-Hill.
- Myszka D.H., Machines and Mechanisms: Applied Kinematic Analysis, Prentice Hall.
- Bevan T., Theory of Machines, CBS Publishers & Distributors, Delhi.
- Shigley J.E., and Uicker J.J., Theory of Machines and Mechanisms, McGraw Hill, Inc.
- Wilson C.E., and Sandler J.P., Kinematics and Dynamics of Machinery, Pearson Education.
- Waldron K.J., and Kinzel G.L., Kinematics, Dynamics, and Design of Machinery, Wiley.
- Hartenberg R.S., and Denavit J., Kinematic Synthesis of Linkages, McGraw-Hill.
- Kimbrell, J. T., Kinematics analysis and synthesis, McGraw-Hill. Howell L.L., Compliant Mechanisms, Wiley.

Subject Code: ME2L105	Name: Thermodynamics	L-T-P: 3-1-0	Credit: 4

Prerequisites: None

Introduction; Thermodynamic equilibrium; Quasi-static process; Zeroth law and reference points in thermometry;

Work and heat transfer; First law for a closed system; Steady flow energy equation; Properties of a pure substance; p–v, p–T, T–s and h–s diagrams;

Properties of gases and gas mixtures; Equations of state; Law of corresponding states;

Second law: Kelvin–Planck and Clausius statements; Causes of irreversibility; Carnot's theorem; Absolute temperature scale; Inequality of Clausius;

Entropy principle; Entropy transfer and entropy generation; Maxwell's equations; Joule–Kelvin effect; Clausius–Clapeyron equation;

Quality of energy; Energy principle; Gouy–Stodola theorem;

Vapour power cycles; Refrigeration cycles; Brayton cycle; Jet propulsion; Turboprop, turbojet and ramjet engines.

Text/Reference Books:

- Thermodynamics: An Engineering Approach, Michael A B and Celgel Y.A, Tata McGraw-Hill
- Fundamentals of classical thermodynamics, Van Wylen G.J and Sonntag R.E, John Wiley & Sons Inc
- Engineering Thermodynamics, Nag P.K., Tata McGraw Hill
- Fundamentals of Engineering Thermodynamics by M. J. Moran and H. N. Shapiro, John Wiley & Sons Inc

Subject Code: ME2L101	Name: Applied Partial Differential Equations	L-T-P: 2-0-0	Credit: 2

Prerequisites: Calculus and Ordinary Differential Equations

Introduction to PDEs: heat and wave equations, classification of PDEs, canonical form;

Fourier series: full and half expansions, orthogonality;

Method of separation of variables (SoV): general method of SoV, solution of heat equation, different boundary conditions and solutions; Solution of Laplace equation, Solution of wave equation: oscillations and modes;

Sturm-Liouville (S-L) eigenvalue problems: their occurrence in heat and wave equation, properties of S-L equations;

PDEs in higher dimensions, unsteady radial dependent PDEs, Bessel and spherical Bessel equations.

Text/Reference Books:

- Applied Partial Differential Equations: initial and boundary value problems by Richard Haberman, 2013.
- Partial Differential Equations for Scientists and Engineers by Stanley Farlow, 2012
- An Introduction to Partial Differential Equations by Y. Pinchover and J. Rebinstein, Cambridge Univ. Press, 2012.

Subject Code: ME2L004	Name: Mechanics of Solids	L-T-P: 3-1-0	Credit: 4

Pre-Requisite: None

Analysis of Stress and Strain: Definition of stress at a point, Stress notation, Symmetry of the stress array on an arbitrarily oriented plane, Transformation of stress, Principal stresses, Mohr's circle representation, Differential equations of motion of a deformable body, Strain theory, Transformation of strain, Principal strains, Small displacement theory, Compatibility equations, Strain measurements and strain rosettes, Stress-strain constitutive relations

Yield Criteria: Theories of failure, Failure analysis under different types of combined loadings

Energy Methods: Castigliano's theorem, Theorem of virtual work

Bending of Beams: Introduction to different beam theories, Straight and asymmetrical bending, Shear center and shear flow in thin-walled beam cross sections, Bending of curved beams

Deflection of Beams: Differential equation of the elastic curve, Moment-area method

Thin-walled Pressure Vessels: Stresses in Thin-walled pressure vessels, Circumferential and hoop stress

Axisymmetric Problems: Thick-walled cylinders subjected to internal and external pressures, Lame's equation, Stresses in composite tubes and shrink fits, Stresses in rotating discs

Thermal Stresses: Thermal stress and thermal strain, Solution of different thermo-mechanical problems.

Column: Buckling of slender columns, Euler buckling load for different end conditions

Text/Reference Books:

- Srinath L.S., Advanced Mechanics of Solids, Tata McGraw – Hill
- Hibbeler R.C., Mechanics of Materials (In SI units), Pearson Education
- Timoshenko S.P., and Young D.H., Elements of Strength of Materials, East West Press
- Popov E.P., Engineering Mechanics of Solids, Prentice-Hall
- Johnston E.R., Beer F.P., Dewolf J.T., and Mazurek D.F., Mechanics of Materials (In SI units) – Tata McGraw – Hill
- Crandall S.H., Dahl N.C., and Lardner T.J., An Introduction To The Mechanics Of Solids, Tata McGraw – Hill
- Boresi A.P., and Schmidt R.J., Advanced Mechanics of Solids, Willey

Subject Code: ME2L102	Name: Measurement and Instrumentation	L-T-P: 1-0-3	Credit: 2

Prerequisite(s): None

Basics of Measurement and Instrumentation: Characteristics of measurement systems: Accuracy, precision, sensitivity, dynamic response, Introduction to data acquisition tools: Arduino, Raspberry Pi, oscilloscopes, Measurement Uncertainty and its significance

Temperature Measurement: Thermocouples, RTDs, Thermistors. Interface temperature sensors with Arduino and Raspberry Pi.

Pressure Measurement: Bourdon tubes, piezoelectric pressure sensors. Use of oscilloscopes to visualize dynamic pressure variations.

Flow Measurement: Thermal Flowmeters, ultrasonic flow meters and differential Pressure flow meters. Interface flow sensors with Arduino for real-time flow monitoring.

Strain and Force Measurement: Strain gauges, load cells, piezoelectric force sensors. Interface a load cell with Arduino using a loadcell amplifier module.

Linear and Angular Displacement Measurement: LVDTs, rotary encoders. Interface an LVDT or rotary encoder with Raspberry Pi for displacement measurement. Design a slider-crank mechanism monitoring system.

Vibration Measurement: Accelerometers, Interface accelerometers with Arduino and visualize vibration data on an oscilloscope. Vibration monitoring system for rotating machinery.

Torque and Power Measurement: Torque transducers and dynamometers.

Text/Reference Books

- Theory and Design for Mechanical Measurements by Figliola R.S., and Beasley D.E, John Wiley & Sons
- Mechanical Measurements by Beckwith T.G., Marangoni R.D., and Lienhard J.H., Pearson.
- Measurements System Application and Design by Doeblin E. O., 5th Ed., McGraw Hill
- Measurements in Heat Transfer by Eckert E. R. G. and Goldstein R. J., 2nd Ed., Springer
- Transducers in Mechanical and Electronic Design by Trietly Harry L., Dekker Marcel, 1st Ed., CRC Press
- Mechanical Measurements by Beckwith T. G., Marangoni R. D., and Lienhard J. H., 6th Ed., Prentice Hall

Subject Code: ME2P004	Name: Materials Testing Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

1. Different tests using UTM (Tensile test, Three point bend test, Compression test etc.)
2. Determination of impact strength of different materials by Charpy & Izod tests
3. Hardness measurement in Rockwell, Vicker's and Brinell hardness testing machines
4. Determination of Endurance limit or fatigue strength of materials by rotary bending machine
5. Finding shear modulus and angle of twist of material in Torsion testing machine
6. Cupping test
7. Asymmetric bending of beam experiment
8. Study of deflection in bending of curved beams
9. Evaluation of spring stiffness in spring compression testing machine
10. Study of buckling behaviour of different columns
11. Stresses in pressure vessels
12. Strain measurements using strain gauges.

Text/Reference Books

- Timoshenko S.P., and Young D.H., Elements of Strength of Materials, East West Press
- Popov E.P., Engineering Mechanics of Solids, Prentice-Hall
- Hibbeler R.C., Mechanics of Materials (In SI units), Pearson Education

Subject Code: ME2P001	Subject Name: Workshop Processes	L-T-P: 0-0-3	Credit: 2
Pre-Requisite(s):			

Turning: facing, drilling, boring, turning-straight, taper, eccentric, grooving, thread cutting, forming etc. in centre lathes.
Milling: surfacing, making regular polygons and cutting gear teeth in milling machines.
Hobbing: gear teeth generation in gear shaping machine and hobbing machine.
CNC Machining: part programming and machining in CNC machining center setting and operation of EDM finishing by grinding Measurement of dimensions, forms and surface finish of machined products.

Text/Reference Books:

- Rao P.N., Manufacturing Technology, Tata McGraw – Hill.
- Jain R.K., Production Technology, Khanna Publishers.
- Lindberg, Process and materials of manufacturing, Prentice-Hall.
- Heine R.W., Loper C.L., and Rosenthal P.C., Principles of Metal Castings, Tata McGraw – Hill.

Subject Code: ME2L005	Name: Theory of Machines-II	L-T-P: 3-1-0	Credit: 4

Pre-Requisite: None

Introduction to Particle Dynamics: Revisit kinematics and kinetics of particles in various coordinate systems, Relative motion in translating frames, Central force motion, Work-energy and impulse-momentum principles.

Kinetics of a System of Particles: Newton's second law, Conservation laws.

Plane Kinematics and Kinetics of Rigid Bodies: Kinematics of rigid bodies in translating ad rotating frames of reference, Instantaneous centre of rotation, Linear and angular momentum, Equations of motion, Work-energy and Impulse-momentum relations.

Spatial Dynamics of Rigid Bodies: Kinematics in rotating frames and relative motion, Angular momentum, Kinetic energy, Euler's equations of motion, Special cases of parallel-plane motion and Gyroscopic motion, Euler angles.

Balancing: Static and dynamic balancing of multi-plane rotating masses, Balancing of single cylinder and multi cylinder inline reciprocating engines, Balancing of V-engines.

Mechanical Governors: Centrifugal and inertia governors, Stability and sensitiveness, Different types of governors: Watt, Porter, Proell, Hartnell etc.

Gyroscopes: Gyroscopic couple, Gyroscopic effect on naval ships, aircrafts, and automobiles.

Introduction to Vibration: Discrete and continuous system vibration, Equation of motion derivation using Newton's approach and energy method.

Free vibration of Single DOF Systems: Undamped translational and rotational system response, Free vibration with viscous damping, Concept of logarithmic decrement.

Forced vibration of Single DOF Systems: Undamped response and concept of resonance, Damped response for harmonic forcing, Base excitation and magnification factor, Motion and force transmissibility.

Text/Reference Books:

- Beer F.P., and Johnston Jr. E.R., Vector Mechanics for Engineers: Dynamics, McGraw-Hill Book Company Inc.
- Kraige L.G., and Meriam J.L., Engineering Mechanics - Dynamics, Wiley.
  Shames I.H., and Rao G.K.M, Engineering Mechanics - Statics and Dynamics, Pearson.
- Hibbeler R.C., Engineering Mechanics –Dynamics, New Jersey: Pearson Prentice Hall.
- Ghosh A., and Malik A.K., Theory of Machines and Mechanism, East-West Press.
- Ogata K, System Dynamics, Pearson Education India.
- Kuo B.C., Golnaraghi F., Automatic Control Systems, Wiley.
  Nise N.S., Control Systems Engineering, Wiley.

Subject Code: ME2L002	Name: Fluid Mechanics	L-T-P: 3-1-0	Credit: 4

Pre-Requisite: None

Introduction: properties of fluids, concept of continuum, pressure and stresses; Fluid statics: pressure variation in a static fluid, force on submerged surfaces, stability of floating bodies; Integral relations for Control volume: Reynolds transport theorem – conservation of mass, linear and angular momentum & energy; Differential relations for fluid flow – Acceleration of fluid (Eulerian & Lagrangian), Differential equation for mass continuity, linear momentum & energy; Inviscid & Irrotational Flows: Euler equation, Bernoulli's equation and its applications; Dimensional Analysis & Similitude; Viscous Flows in Pipes: Laminar & Turbulent Pipe flow, friction factor, Moody diagram, hydraulic diameter, minor and major losses; Introduction to boundary layer.

Text/Reference Books:

- Fox R.W., and McDonald A.T., Introduction to Fluid Mechanics, John Wiley & Sons, Inc.
- White F.M., Fluid Mechanics, Tata McGraw Hill Publishing Company Limited.
- Cengel Y.A., and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, McGraw-Hill Science/Engineering/Math.
- Young, Munson, Huebsch, Okiishi, Fundamentals of Fluid Mechanics, Wiley.
- Som S.K. & Biswas G., Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Publishing Company Limited.

Subject Code:	Subject Name: Engineering Materials	L-T-P: 2-0-0	Credit: 2

Pre-Requisite(s):

Principle of material selection for engineering applications and their manufacturability.

Structure of Solids: atomic and inter-atomic bonding, crystal structure and imperfection in solids - point defects, line defects and volume defects, Diffusion Mechanisms.

Mechanical properties of metals: Stress-strain response. Plastic deformation - Slip Systems, Slip in Single Crystals, Critically resolved shear stress, Plastic Deformation of Polycrystalline Materials, Strengthening mechanisms, Recrystallization.

Ductile and Brittle fracture, Cyclic Stresses: The S–N Curve, Generalized Creep Behaviour.

Phase diagrams- Binary phase diagram, iron-carbon-equilibrium diagrams, Type of steels, Transformation hardening in steels - TTT diagrams. Case hardening: Carburising, Nitriding, Flame hardening.

Non Ferrous Materials: Al alloys, Mg Alloys and Ti Alloys, Precipitation hardening.

Non Metallic Materials: Polymers and Ceramics.

Composites with polymer matrix, metal matrix and ceramic matrix - Fabrication methods of in-situ, ex-situ and Nano composites.

Modern Materials: Bio materials, Shape memory alloys and Nanostructured Materials.

Electrical, Thermal, Optical and Magnetic properties of various materials.

Characterization: Overview of XRD, electron microscopy techniques and Mechanical testing methods.

Corrosion and its prevention.

Text/Reference Books:

- Manufacturing processes for engineering materials (5th Edition)- Kalpakjian and Schmid, Pearson India, 2014
- DeGarmo's Materials and Processes in Manufacturing, Wiley India Edition 2017
- Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th Edition, Mikell P. Groover, Wiley, 2019.
- Materials Science and Engineering: An Introduction, 9th Edition, William D. Callister, David G. Rethwisch, Wiley, 2013.

Subject Code: ME2L102	Name: Applied Numerical Methods	L-T-P: 2-0-2	Credit: 2

Prerequisite(s): None

Introduction: Mathematical preliminaries, Error analysis, Accuracy and convergence

Solution of equations with single variable: Bisection method, Method of false position, Fixed point iteration, Newton-Raphson method, Muller's method

Solution of linear algebraic equations: Gauss elimination method, Pivoting strategies, LU decomposition, Jacobi and Gauss-Seidel iterative techniques

Curve fitting and interpolation: Linear regression, Polynomial regression, Lagrange's interpolating polynomials, Hermite and cubic spline interpolation

Numerical differentiation: Formulation of first-order derivatives and Richardson's extrapolation, Higher-order accurate formulation of first-order numerical differentiation, Higher-order derivatives.

Numerical integration: Newton-Cotes methods, Trapezoidal rule, Simpson's rule

Solution of ordinary differential equations: Euler's method, Stiffness and Stability of the numerical method, Backward step Euler's method, Explicit vs implicit scheme, Runge-Kutta method, System of equations, Multi-step methods, Boundary value problem: Shooting method, Discretization method

Text/Reference Books:

- S. C. Chapra & R. Canale, Numerical Methods for Engineers, McGraw Hill.
- R. L. Burden & J. D. Faires, Numerical Analysis, Cengage Learning.
- Cheney and Kincaid, Numerical Mathematics and Computing, Thomson.
- C. F. Gerald & P. O. Wheatley, Applied Numerical Analysis, Pearson.
- R. W. Hamming, Numerical Methods for Engineers and Scientists, Dover.
- Parvis Moing, Fundamentals of Engineering Numerical Analysis, Cambridge University Press.

Subject Code: ME2P003	Name: Mechanisms and Vibration Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

1. Bifilar and trifilar Pendulum experiments
2. Study of cam-follower mechanism with different types of cams/followers
3. Analysis of a multi-stage spur gear with an intermediate gear
4. Analysis of epicyclic gear train
5. Study of universal governor (Porter, Proell, Hartnell)
6. Determination of gyroscopic couple using a mechanical gyroscope and study of coriolis acceleration
7. Multi-cylinder reciprocating engine balancing
8. Static and dynamic balancing of unbalanced rotating components
9. Study of torsional vibration of rotary systems
10. Free and forced vibration of a single DOF system with and without damping
11. Study of mode shapes for beams and determination of modal frequencies using the resonance method
12. Vibration measurement for different bearing and rotor faults using machine fault simulator.

Text/Reference Books:

- Theory of Machines and Mechanism by Ghosh A., and Malik A.K., , East-West Press.
- Design of Machinery by Norton R.L., McGraw-Hill.
- Theory of Machines and Mechanisms by Shigley J.E., and Uicker J.J., McGraw Hill, Inc.

Subject Code: ME2P002	Name: Fluid Mechanics Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

1. Determine hydrostatic pressure distribution and compute the centre of pressure and total hydrostatic force acting on a submerged vertical plane surface.
2. Measure and evaluate the force transmission efficiency of fluid jets impinging on stationary and moving vanes, applying impulse-momentum principles.
3. Determine the coefficient of discharge of an orifice meter by establishing the relationship between pressure differential and volumetric flow rate.
4. Determine the coefficient of discharge of a venturi meter and compare its metering accuracy with the orifice meter under similar flow conditions.
5. Calculate the Darcy friction factor for different pipe materials and diameters, and validate results against the Moody chart over a range of Reynolds numbers.
6. Quantify minor head losses due to common pipe fittings (bends, valves, expansions, contractions) and express them using the loss coefficient K.
7. Analyse the velocity and pressure distribution in free and forced vortex flows, and verify theoretical profiles using experimental measurements.
8. Apply the electrical analogy to model potential flow fields, and correlate the measured electric potential distribution with theoretical streamline and equipotential patterns.
9. Visualise and interpret laminar, transitional, and turbulent flow patterns using dye injection, and determine the Reynolds number at transition.
10. Identify the onset of cavitation in pump by observing pressure drop, noise, and performance degradation, and relate it to vapour pressure and NPSH.

Text/Reference Books:

- Fox R.W., and McDonald A.T., Introduction to Fluid Mechanics, John Wiley & Sons, Inc.
- White F.M., Fluid Mechanics, Tata McGraw Hill Publishing Company Limited.
- Cengel Y.A., and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, McGraw-Hill Science/Engineering/Math.
- Young, Munson, Huebsch, Okiishi, Fundamentals of Fluid Mechanics, Wiley.
- Som S.K. & Biswas G., Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Publishing Company Limited.

Subject Code: ME2LXXX	Name: Product Design and Development	L-T-P: 3-0-0	Credit: 3

Prerequisite(s): None

Design methodology and design philosophy - types of designs, design models, concurrent Evolution of Products, Industrial & Digital revolution, Globalization and Product innovation

Product development process, Design Teams, organizations, concept development processes

Opportunity and Problem identification, Opportunity horizons, Opportunity funnel

Product planning: Product description, key business goals, Product development Projects

Identifying needs of the product: Customer survey, hierarchy of needs, interpretation of needs, latent needs

Product Specifications: Target specifications, Kano model, Quality Function Deployment, Final specifications

Concept Generation: Method of concept generation, TRIZ, Decision matrix, Perceptual maps, benchmarking, reverse engineering.

Concept Selection & Concept testing: concept combination table, concept screening, concept scoring, concept testing process

Rapid Prototyping: Form design, function design, production design, concurrent design

Design for assembly, Design for manufacturing, Design for Sustainability

Industrial Design: ID principles, ID process, Final design, Process plans. Case studies in different domains/disciplines.

Text/Reference Books:

- Engineering Design by George E. Dieter, McGraw Hill,
- Function and Design by Paul J. G, Dover Publication
- The mechanical Design Process by David G. Ulman, McGraw Hill