Mechanical Engineering

Semester IV						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME209T	Heat Transfer	3	0	0	6
2	ME211T	Manufacturing Processes II	3	0	0	6
3	ME207T	Mechanical Measurements	3	0	0	6
4	ME304T	Theory of Machines	3	0	0	6
5	ME310T	Partial Differential Equations (PDEs) for Engineers	3	0	0	6
6	ME204L	Solid Mechanics Lab	3	0	0	3
7	ME202L	Fluid Mechanics Lab	3	0	0	3
8	ME213T	Dynamics and Vibrations	3	0	0	6
		Total Credits				**42**

Mechanical Engineering

1	**Title of the course** (L-T-P-C)	**Mechanical Measurements** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	1. **Introduction**: generalized measurement system, static calibration, calibration, random errors, uncertainty analysis, dynamic characteristics. Zero, first and second order measurement systems. 2. **Temperature measurement**: Introduction to temperature measurement. Thermocouples: laws governing their use; Static and Dynamic characteristics. Other measurement techniques. 3. **Pressure measurement**: Manometers, elastic transducers, static and dynamic characteristics. Other devices for measurement. 4. **Flow measurement**: obstruction meters, variable area meters, velocity measurement. 5. **Strain measurement:** electrical type strain gauges, metallic resistance strain gauge, selection and installation of strain gages, circuitry for strain measurement, temperature compensation, calibration, semi-conductor strain gauges, stress analysis methods 6. **Force and torque measurement:** standards, elastic transducers, strain gage load cells, hydraulic and pneumatic systems, torque measurement, combined force and moment measurement. 7. **Measurement of motion**: LVDT, general theory of seismic instruments, vibrometers and accelerometers, piezoelectric accelerometers and vibrometers-circuitry and calibration, exciter systems, vibration test methods. 8. **Signal conditioning:** Operational amplifiers, filters. 9. **Sampling, and data acquisition:** Sampling concepts, Bits and words, number systems, Analog to digital conversion and digital to analog conversion, data acquisition systems and components, analog input/output communication, Digital input/output communication.
4	**Texts/References**	1. Measurement systems: Application and Design, "E.O. Doebelin, Fourth Ed., 1990, McGrawHill. 2. Richard S. Figliola and Donald E. Beasley, Theory and Design for Mechanical Measurements, John Wiley and Sons.

1	**Title of the course** (L-T-P-C)	**Manufacturing Processes II** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Material Removal Processes: Mechanics of Machining, tool geometry and materials, chip formation, tool temperature, tool wear, tool life, surface finish, machinability. Optimization of machining processes. Machine Tools: Generation of surfaces by machining, basic operations on shaping, slotting and planning machines, lathe, drilling and boring machines and grinding machines. Process Parameters and setups. Production Machines: Capstan and turret lathes, automats, broaching machines, centreless grinding machines. Special purpose machines for thread cutting and gear cutting (hobbing and shaping). Finishing processes honing, laping burnishing and deburring. Introduction to modern machining processes: EDM, ECM, LASER, Jigs and fixtures, principles of location and clamping, synthesis of simple jigs and fixtures. Principles of assembly engineering, theory of dimensional chains, fully interchangeable and selective assembly. Introduction to Numerical Control.
4	**Texts/References**	**1.** G. Boothroyd and W. A. Knight, Fundamentals of Machining and Machine Tools, Marcel Dekker, 1989. **2.** A. Ghosh and A. K. Mallik, Manufacturing Science, Affiliated East West Press, 1985. HMT, Production Technology, Tata McGraw Hill, 1980. **3.** J. Mcgeough, Advanced Methods of Machining, Chapman and Hall, 1988. **4.** M. F. Spotts, Dimensioning and Tolerancing for Quality Productions, Prentice Hall, 1983.

1	**Title of the course** (L-T-P-C)	**Heat Transfer** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Introduction: Typical heat transfer situations, Modes of heat transfer, Introduction to laws, some heat transfer parameters • Conduction: Fourier's law and thermal conductivity, Differential equation of heat conduction, boundary conditions and initial conditions, Simple one dimensional steady state situations – plane wall, cylinder, sphere (simple and complex situations), concept of thermal resistance, concept of U, critical radius. variable thermal conductivity (exercise), Special one dimensional steady state situations: heat generation, pin fins, Other fin configurations (exercise), Two dimensional steady state situations, Transient conduction, Lumped capacitance model, One dimensional transient problems: analytical solutions, 1D Heisler charts, Product solutions, Numerical methods in conduction, Steady state 1D and 2D problems, 1D transient problems: Explicit and implicit • Radiation: Basic ideas, spectrum, basic definitions, Laws of radiation, black body radiation, Planck's law, Stefan Boltzman law, Wien's Displacement law, Lambert cosine law, Radiation exchange between black surfaces, shape factor, Radiation exchange between gray surfaces – Radiosity-Irradiation method, Parallel plates, Enclosures (non-participating gas), Gas radiation Forced Convection: Concepts of fluid mechanics, Differential equation of heat convection, Laminar flow heat transfer in circular pipe: constant heat flux and constant wall temperature, thermal entrance region, Turbulent flow heat transfer in circular pipe, pipes of other cross sections, Heat transfer in laminar flow and turbulent flow over a flat plate, Reynolds analogy, Flow across a cylinder and sphere, flow across banks of tubes, impinging jets • Natural Convection: Introduction, governing equations, Vertical plate – Pohlhausen solution, horizontal cylinder, horizontal plate, enclosed spaces Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow, multi-pass and cross flow heat exchanger, NTU approach: parallel, counter- flow, shell and tube, cross flow heat exchanger Condensation and Boiling: Dimensionless parameters, boiling modes, correlations, forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation • Mass Transfer: Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.
4	**Texts/References**	**1.** Incropera FP and Dewitt DP, Fundamentals of Heat and Mass Transfer, 5th e, John Wiley & Sons, 2010. **2.** Cengel YA, Heat and Mass Transfer - A Practical Approach, Third edition, McGraw-Hill, 2010. **3.** Holman JP, Heat Transfer, McGraw-Hill, 1997.

1	**Title of the course** (L-T-P-C)	**Theory of Machines** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Introduction**: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of mechanism, Machine. Kinematic Chains and Inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain **Velocity and Acceleration Analysis of Mechanisms (Graphical & Analytical Methods)**: Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms **Gears:** Gear terminology, law of gearing, Characteristics of involute action, Path of contact. Arc of contact, Contact ratio Interference in involute gears. Methods of avoiding interference, Back lash. Gear Trains: Simple gear trains, Compound gear trains for large speed. reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains **Cams:** Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion **Static & Dynamic Force Analysis**: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams. Static force analysis of four bar mechanism and slider-crank mechanism without friction. D'Alembert's principle, Inertia force, inertia torque. Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems **Balancing of Rotating Masses**: Static and dynamic balancing. Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing several rotating masses by balancing masses in same plane and in different planes **Balancing of Reciprocating Masses**: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Radial engine – Direct and reverse crank method **Introduction to Vibrations**
4	**Texts/References**	**1.** B. Paul, Kinematics and Dynamics of Planar Mechanisms, Prentice Hall, 1979. **2.** J.J. Uicker, G.R. Pennock, and J.E. Shigley, Theory of Machines and Mechanisms (3rd edition), Oxford University Press, New York, 2005. **3.** S.S. Rattan, Theory of Machines (2nd edition), Tata McGraw Hill, New Delhi, 2005. **4.** R.L. Norton, Design of Machinery (3rd edition), Tata McGraw Hill, New Delhi, 2005.

1	**Title of the course** (L-T-P-C)	**Fluid Mechanics Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Exposure to Fluid Mechanics
3	**Course content**	**List of Experiments:** • Stability of floating bodies for determining the metacentre and buoyancy • Reynolds experiment for laminar/turbulent flow visualisation • Measurement of discharge coefficient for different shaped orifices with varying head • Demonstration of Bernoulli's principle • Visualisation of Free and Forced vortices • Demonstration of linear momentum and impact forces of Jet for different deflection angles • Pressure loss in pipe friction for laminar/turbulent flow • Minor losses in Pipe system (fittings: bend, elbow, contraction/expansion) • Major losses in Pipe system: Effect of pipe material, dimensions • Fluidized Granular Bed • Submerged Jet • Flow Measurement by Venturi-meter, Orifice-meter & Rota-meter • Heleshaw Apparatus • Hydraulic Jump • Course project set-up
4	**Texts/References**	**1.** Yunus A. Cengel, John M. Cimbala, Fluid Mechanics, Tata McGraw Hill Education, 2011. **2.** F.M.White, Fluid Mechanics, Seventh Edition, Tata McGraw Hill Education, 2011. **3.** Philip J.Pritchard, Alan T.Mcdonald,RobertW.Fox, Introduction to Fluid Mechanics, Wiley, 2009. **4.** John F. Douglas, J. M. Gasoriek, Lynne Jack and John Swaffield, Fluid Mechanics, Pearson, 2008.

1	**Title of the course** (L-T-P-C)	**Partial Differential Equations (PDEs) for Engineers** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Fourier series, Fourier transform, and their properties, Discrete Fourier Transform and Fast Fourier Transform Basic Concepts in PDEs: linearity, homogeneity, characteristics, boundary and conditions, fundamental theorem on superposition Wave equation and its solutions: modelling a vibrating string, modelling a linear wave equation in a compressible fluid, solution using Fourier series, solution using method of d'Alembert, solution using Fourier–Bessel series Diffusion equation and its solutions: modelling thermal, concentration, and momentum diffusion, solution using Fourier series, solution using Fourier integrals, solution using method of similarity solutions Two-dimensional wave and diffusion equations and their solutions using Fourier series Laplace equation and its solution Laplace transform and its properties, solution of PDEs using Laplace transforms Method of similarity solutions with examples such as Blasius boundary layer, transient heat conduction in semi-infinite solid
4	Texts/References	**Textbooks:** **1.** Kreyszig, E.. Advanced Engineering Mathematics, John Wiley Sons, 2010. **2.** Walter A. Strauss, Partial Differential Equations. Wiley, 2018. **References:** **1.** Sandro Salsa. Partial Differential Equations in Action: From Modelling to Theory. Springer. 2008. **2.** Peter J. Olver, Introduction to Partial Differential Equations Springer, 2014. **3.** Stanley J. Farlow. Partial Differential Equations for Scientists an Engineers. Dover. 1993.

1	**Title of the course** (L-T-P-C)	**Solid Mechanics Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**List of Experiments:** • Calibration of photoelastic material using a disk under diametral compression, a beam under four-point bending and an uni-axial tensile specimen; and SCF evaluation in a circular ring, acrane hook and a plate with hole. • Stresses in thin pressure vessels using strain gauges; • Deflection of curved beams – a ring, a semi-circular ring, a quadrant and an angular davit • Stability of columns – To evaluate the buckling load for different materials (Steel, Copper,Aluminium and Brass) under different end conditions (Hinge-Hinge and Hinge-fixed condition) • Hardness test – Rockwell, Vickers and Brinell Hardness test • Impact testing machine: Izod and Charpy test • Torsion testing machine • Tests of UTM: Tension (Ductile and Brittle), compression (brittle and ductile), bending ofbeam, leaf spring characteristics
4	**Texts/References**	S. Crandall, N. Dahl, S. Lardner, An Introduction to Mechanics of Solids, Tata MG Hill, 2012. E.P. Popov, Engineering Mechanics of Solids, Prentice Hall, 2012. Gere abd Goodno, Mechanics of Materials, 7th ed., Cengage Learning India, 2012.Gere and Timoshenko, Mechanical of Materials, CBS Publishers,1986.

1	**Title of the course** (L-T-P-C)	**Dynamics and Vibrations** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Module 1: Dynamics of particles and rigid bodies in different coordinate systems, General plane motion, systems of rigid bodies Module 2: Introduction To Vibration And The Free Response Module 3: Response To Harmonic Excitation and General Forced Response Module 4: Multiple-Degree-Of-Freedom Systems 2DOF, eigenvalues and natural freqs., modal analysis, modal analysis of forced response Module 5: Design For Vibration Suppression vibration isolators/absorbers, whirling of shafts, rotating disks Module 6: Distributed-Parameter Systems (strings, bars, beams, plates) Module 7: Vibration Testing And Experimental Modal Analysis. Case studies of vibration problems with simplified assumptions
4	**Texts/References**	Textbooks: 1. Engineering Vibrations (4th Edition) by Daniel J Inman (ISBN: 9789332518483) 2. Mechanical Vibrations, (6th Edition) by SS Rai (ISBN: 935306256X) 3. Structural Dynamics: Vibrations and Systems by M Mukhopadhyay (ISBN 9788180520907)