Curriculum for Dual Degree Programme
B. Tech. (Mechanical Engineering) and M. Tech. (Manufacturing Engineering)

Subject Name	Subject Code	L-T-P	Credit	Contact Hour
SEMESTER - III				
Theory of Machines - I	**ME2L001**	3-1-0	4	4
Basic Electronics	**EC2L005**	3-1-0	4	4
Transform Calculus ***(Mathematics – V)***	**MA2L005**	3-0-0	3	3
Introduction to Material Science and Engineering	**ID2L001**	2-0-0	2	2
Introduction to Bioscience and Technology	**ID2L002**	2-0-0	2	2
Fluid Mechanics	**ME2L002**	3-1-0	4	4
Workshop Processes	**ME2P001**	0-0-3	2	3
Basic Electronics Laboratory	**EC2P005**	0-0-3	2	3
Fluid Mechanics Laboratory	**ME2P002**	0-0-3	2	3
Project Seminar	**ME2S001**	0-0-0	2	0
		Total	**27**	**28**
SEMESTER – IV				
Thermodynamics	**ME2L003**	3-0-0	3	3
Partial Differential Equations ***(Mathematics – IV)***	**MA2L004**	3-1-0	4	4
Environmental Science, Technology and Management	ID2L003	2-0-0	2	2
Breadth-1			3/4	3/4
Mechanics of Solids	**ME2L004**	3-1-0	4	4
Theory of Machines - II	**ME2L005**	3-1-0	4	4
Lateral - 1			3/4	3/4
Machines & Mechanisms Laboratory	**ME2P003**	0-0-3	2	3
Materials Testing Laboratory	**ME2P004**	0-0-3	2	3
		Total	**27/29**	**29/31**
SEMESTER – V				
Lateral Theory-2			3/4	3/4
Heat Transfer	**ME3L001**	3-1-0	4	4
Design of Machine Elements	**ME3L002**	3-0-0	3	3
Casting, Welding and Forming	**ME3L003**	3-0-0	3	3
Systems & Control	**ME3L004**	3-0-0	3	3
Thermo-Fluid Lab - 1	**ME3P001**	0-0-3	2	3
Casting, Welding and Forming Laboratory	**ME3P002**	0-0-3	2	3
Machine Design Practice	**ME3P003**	0-0-3	2	3
		Total	**22/23**	**25/26**

SEMESTER - VI				
Lateral Theory-3	**ME3LXXX**		3/4	3/4
IC Engines	**ME3L005**	3-0-0	3	3
Refrigeration & Air-Conditioning	**ME3L006**	3-0-0	3	3
Elective-1	**ME3LXXX**	3-0-0	3	3
Machine Tool & Machining (MTM)	**ME3L007**	3-0-0	3	3
Power Plant Engineering	**ME3L008**	3-0-0	3	3
Thermo-Fluid Lab - 2	**ME3P004**	0-0-3	2	3
MTM Laboratory	**ME3P005**	0-0-3	2	3
		Total	**22/23**	**24/25**
INDUSTRIAL SUMMER TRAINING				

Elective Courses B. Tech. – M. Tech Dual Degree (Manufacturing Engineering)

Subject Name	Code	L-T-P	Credit	Contact Hour
Elective – I (Semester VI)				
Operations Research	ME3L012	3-0-0	3	3
Computational Fluid Dynamics	ME3L013	3-0-0	3	3
Robotics	ME3L014	3-0-0	3	3
Intermediate Fluid Mechanics	ME3L015	3-0-0	3	3

Subject Code: ME2L001	Name: Theory of Machines - I	L-T-P: 3-1-0	Credit: 4
Pre-Requisite: None			

Introduction: - Analysis & Synthesis, Terminology, Definition, Types of Mechanism (Planner, Spatial), Mobility, Classification of Mechanisms, Inversions Movability Criteria.
Position Analysis - Graphical Method. Analytical Method. Velocity Analysis- Graphical Method, Analytical Method. Instant Centers of Velocity. Acceleration Analysis- Graphical Method, Analytical Method.
Design of Mechanism:- Cam Design: - Introduction, classification of cams & followers. Displacement diagram, Graphical layout of cam profiles, standard cam motions. Gears - Terminology and definition, fundamental law of gearing, Involute properties, interference and Undercutting, Content Ratio, Involumetry, Types of Gears. Gear Train - Simple and Compound Gear Train, Epicyclic Gear Train, Analysis of Planetary Gear by formula and tabular Method, Differentials. Synthesis of linkages- Type, Number and Dimensional Synthesis Function Generation, Path Generation, Two, Three and Four Position Synthesis, Precision Positions, Structural Error, Chebyshev Spacing, Frudenstein's Equation.
Dynamics of Machines: - Static Force - Introduction, Analysis with & without formation, Methodology of Virtual Work. Dynamic Force Analysis - Introduction, Inertia Forces & D. Alembert's Principle, Principle of Superposition, Shaking forces & moments, Complex Algebra Approach. Dynamics of reciprocating Engines - Engine types, Indicator Diagrams, Dynamic Analysis, Equivalent Masses, Inertia Forces, Crankshaft torques, Engine Shaking Forces. Fly Wheel -Dynamic Theory, Integration Techniques, Multicylinder Engine Torque Summation.

Text/Reference Books:

1. Norton R.L., *Design of Machinery*, McGraw-Hill.
2. Myszka D.H., *Machines and Mechanisms: Applied Kinematic Analysis*, Prentice Hall.
3. Bevan T., *Theory of Machines*, CBS Publishers & Distributors, Delhi.
4. Shigley J.E., and Uicker J.J., *Theory of Machines and Mechanisms*, McGraw Hill, Inc.
5. Ghosh A., and Malik A.K., *Theory of Machines and Mechanism*, East-West Press.
6. Wilson C.E., and Sandler J.P., *Kinematics and Dynamics of Machinery*, Pearson Education.

Subject Code: EC2L005	Name: Basic Electronics	L-T-P: 3-1-0	Credit: 4
Pre-Requisite: None			

Semiconductor devices: Diode, BJT, MOSFET, their structures and principle of operations; Amplifiers: Functionality, specifications (voltage gain, current gain, input resistance, output resistance, dynamic range, bandwidth, linearity, power efficiency etc.), effect of cascading, various applications and typical circuits; Filters: Low pass, high pass, band pass and band stop filters, single and higher order passive filter topologies (RC and LC); Feedback: Basic concept of negative and positive feedback, application of negative feedback in amplifiers, effect on gain, bandwidth, input resistance, output resistance and desensitivity to parameter variations; Oscillators: Barkhausen criterion, sinusoidal and non-sinusoidal oscillators, applications and typical circuits; Operational amplifier: Differential mode of operation, common mode rejection, typical op-amp specifications, inverting amplifier, non-inverting amplifier, integrator, differentiator, summing amplifier etc., concept of active filters; Power electronics: Half wave and full wave rectification, filtering, regulation with zener diode and linear regulators, switched mode power supply; Digital electronics: Review of Boolean algebra and signed number representation schemes in binary, implementation of Boolean functions using various logic gates, concept of combinatorial and sequential circuits, registers and counters from functional viewpoint, concept of programmable processors and microcontrollers.

Text/Reference Books:

1. A. Malvino and D. J Bates "*Electronic Principles,*" Tata McGraw - Hill Education, 2006.
2. D. A. Neamen, "*Electronic Circuits,*" Tata McGraw - Hill Education, 2006.
3. Malvino and Brown, "*Digital Computer Electronics,*" Tata McGraw - Hill Education, 2001.
4. Samuel C. Lee, "*Digital Circuits and Logic Design,*" PHI Learning, 2009.
5. R. A. Gayakwad, "*Op-Amps and Linear Integrated Circuits,*" PHI Learning, 2009.

Subject Code: MA2L005	**Name:** Transform Calculus ***(Mathematics – V)***	**L-T-P: 3-0-0**	**Credit: 3**

Pre-Requisite: MA1L001

Laplace Transform: Definition of Laplace Transform, linearity property, conditions for existence of Laplace Transform. First and second shifting properties, Laplace Transform of derivatives and integrals, unit step functions, Dirac delta-function, error function. Differentiation and integration of transforms, convolution theorem, inversion, periodic functions. Evaluation of integrals by Laplace Transform. Solution of initial and boundary value problems.

Fourier Series: Periodic functions, Fourier series representation of a function, half range series, sine and cosine series, Fourier integral formula, Parseval's identity.

Fourier Transform: Fourier Transform, Fourier sine and cosine transforms. Linearity, scaling, frequency shifting and time shifting properties. Self reciprocity of Fourier Transform, convolution theorem. **Other Transforms:** Brief Introduction of Z-Transform, Mellin transform and Wavelet Transform, Hilbert Transform, Radon Transform.

Text Books:

1. Jain R. K. and Iyengar S. R. K. *Advanced Engineering Mathematics*, Narosa
2. Dyke P. P. G. *Introduction to Laplace Transform and Fourier Series*, Springer

Reference Books:

1. Watson E. J. *Laplace Transforms and Applications*
2. Pinkus A. & Zafrany S. *Fourier Series and Integral Transforms*, Cambridge University Press
3. Rao K. S. *Introduction to Partial Differential Equations*, Prentice Hall of India Private Ltd

Subject Code: ID2L001	**Name:** Introduction to Material Science and Engineering	**L-T-P: 2-0-0**	**Credit: 2**

Pre-Requisite: Nil

Atomic structure and Bonding: Electrons in atoms, Bonding forces and energies, Ionic bonding, Covalent Bonding, Metallic Bonding, Secondary bonding.

Structure of Crystalline Solids: Crystalline and noncrystalline materials, Crystal structures in metals and ceramics, Miller indices

Imperfections in Solids: Point defects, Line defects and dislocations, Interfacial defects, Bulk or volume defects, significance of defects in materials

Diffusion in materials: Diffusion mechanisms, Steady and non-steady state diffusion, Factors that influence diffusion

Phase Diagrams: Definitions and basic concepts, Types of phase transformations, Gibbs Phase Rule, Interpretation of phase diagrams

Mechanical Properties of Materials: Elastic deformation, Plastic deformation, Interpretation of tensile stress-strain curves, Measurement of hardness in materials

Electrical Properties of Materials: Electrical conduction, Semiconductivity, Dielectric Behaviour, Ferroelectric and Piezoelectric Behaviour

Thermal Properties: Heat capacity, Thermal expansion, Thermal conductivity, Thermal stresses ***Magnetic Properties:*** Basic concepts, Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Influence of temperature, Domains and Hysteresis

Optical Properties: Interaction of light with solids, Optical properties of metals and non-metals

Text Books:

1. *Materials Science and Engineering*, William D. Callister, Jr. Wiley India (P) Ltd.
2. *Introduction to Physical Metallurgy*, Sidney H. Avner, Tata McGraw-Hil.

Reference Books:

1. *Materials Science and Engineering*, William D. Callister, Jr. Wiley India (P) Ltd.
2. *Introduction to Physical Metallurgy*, Sidney H. Avner, Tata McGraw-Hil.

Subject Code: ID2L002	**Name:** Introduction to Bioscience and Technology	**L-T-P: 2-0-0**	**Credit: 2**

Pre-Requisite: Nil

Cell: The Unit of Life: The concept of cell in the perspective of a whole living body; Concept of cell, tissue system, organ and whole organism. Brief overview of plant and animal cell.

Genes are DNA & Bioinformatics: DNA is the genetic material; Structural aspects–components of DNA and RNA, Nucleosides & Nucleotides (introduction, structure & bonding), Double helical structure of DNA (Watson and Crick model). Mutations change the sequence of DNA, a gene codes for a single polypeptide, recombination occurs by physical exchange DNA, genetic code is triplet. NCBI, protein primary sequence analysis, DNA sequence analysis, sequence alignment, BLAST, multiple sequence alignment; CLUSTALW.

***Expression of genetic information*:** Central dogma: The Relationship between genes and protein, Visualization of protein structure using PyMol, The Central dogma; The basic processes of DNA replication, RNA Transcription and Protein translation; Protein function: Enzymes as a case study.

Mutation and Disease: Occurrence, kinds of Mutation, spontaneous & induced Mutation, Mutagens, detection of Mutation, Lethal Mutations, Biochemical Mutations, Phenotypic effects of Mutation, Molecular basis of Mutation, Significance & Practical applications of Mutation.

Immune system: An overview of immune system.

Genetic Engineering: Recombinant DNA technology and basic genetic engineering techniques; some case studies: Cholera Toxin, Bt toxins, GM food, transgenic plants.

Text/Reference Books:

1. Nelson D. L. and Cox M. M. Lehninger *Principles of Biochemistry*, W. H. Freeman & Company.
2. Lodish H.; Berk A. and Kaiser C. A. Molecular *Cell Biology & eBook*, W. H. Freeman & Company.
3. Voet and Voet. *Biochemistry*, 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:

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

Subject Code: ME2L003	Name: Thermodynamics	L-T-P: 3-0-0	Credit: 3
Pre-Requisite: None			

Introduction, Thermodynamic equilibrium; Qasi-static process; Zeroth law and reference points in thermometry; Work and heat transfer; First law for a closed system; Steady flow energy equation; 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; Quality of energy; Energy principle; Guoy-Stodale theorem; 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; Maxwell's equations; Joule-Kelvin effect; Clausius-Clapeyron equation; Brayton cycle; Jet propulson; Turboprop, turbojet and ramjet engines.

Text/Reference Books:

1. Michael A.B., and Cengel Y.A., *Thermodynamics: An Engineering Approach*, Tata McGraw - Hill Education.
2. Van Wylen G.J., and Sonntag R.E., *Fundamentals of Classical Thermodynamics*, John Wiley & Sons Inc.
3. Nag P.K., *Engineering Thermodynamics*, Tata McGraw – Hill.
4. Kumar D.S., *Thermal Science and Engineering*, S. K. Kataria & Sons.

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

Pre-Requisite: None

Review of Elementary Mechanics of Materials, Methods of Analysis, Stress – Strain Relations, Failure and Limits on Design. 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, and Other Properties, Differential Equations of Motion of a Deformable Body, Deformation of a Deformable body, Strain Theory, Transformation of Strain, and Principal Strains, Small – Displacement Theory, Strain Measurements and Strain Rosettes. Theories of Failure or Yield Criteria: General Concepts. Applications of Energy Methods. Bending of Straight Beams, Shear Center for Thin – Wall Beam Cross Sections, Curved Beams, Axisymmetric Problems, Torsion and Elastic Stability.
Introduction to Fatigue, Creep and Fracture.

Text/Reference Books:

1. Boresi A.P., and Schmidt R.J., *Advanced Mechanics of Solids*, Willey.
2. Srinath L.S., *Advanced Mechanics of Solids*, Tata McGraw – Hill.
3. Timoshenko S.P., *Strength of Materials - (Part 1 & 2)*, CBS Publishers.
4. Timoshenko S.P., and Goodier J.N., Theory of Elasticity, Tata McGraw – Hill.
5. Johnston E.R., Beer F.P., Dewolf J.T., and Mazurek D.F., *Mechanics of Materials (In SI units)* –Tata McGraw – Hill.
6. Hibbeler R.C., *Mechanics of Materials (In SI* units), Pearson Education.
7. Popov E.P., *Engineering Mechanics of Solids*, Prentice-Hall.

Subject Code: ID2L003	Name: Environmental Science, Technology and Management	L-T-P: 2-0-0	Credit: 2

Pre-Requisite: Nil

Module-I: Introduction to Environmental System (10-12 Lectures)
Components of Earth System: Lithosphere, Cryosphere, Atmosphere, Hydrosphere, Biosphere and Outer space, Science of Weather and Climate systems and their variabilities, Energy, Water, Carbon and Nitrogen Cycles in the Atmosphere, Environmental Pollution (Air, Water, Noise, Soil and Marine), Natural Hazards, Climate Change and Global Warming, Green energy and adaptation to Climate change, Observations-modeling-prediction of environmental systems. Role of ocean on earth's climate system

Module-II: Green and Sustainable Technology (6-8 Lectures)
Pollution issues in Industries, Introduction to Green Technology, Emerging and sustainable practices in Electronics, Chemical, Petroleum and Mineral Processing Industries, 12 Principles of Green Chemistry and 12 Principles of Green Engineering.

Module-III: Environmental Economics and Policies (8-10 Lectures)
Components of Earth System: Sustainable development, economics of renewable and non-renewable natural resources, Green growth, Environmental valuation, accounting and audit, Carbon Trading, Command and control approach and market based instruments for reducing pollutions, Environmental policies and acts (Air, Noise, Water, Forest, E-waste, Hazardous waste acts).

Subject Code: ME2L005	Name: Theory of Machines - II	L-T-P: 3-1-0	Credit: 4
Pre-Requisite: None			

Kinematics of Particles: Representation of motion of particles in various coordinate systems, relative motion in translating frames, constrained motion; **Kinetics of particles:** Newtons second law, equations of motion for unconstrained and constrained motion, work-energy relation, conservation of energy, conservative and non-conservative forces, potential energy, impulse-momentum relation, angular momentum, conservation of momentum, d'Alemberts principle. Applications: central force motion, impact. **Kinetics of a system of particles**: Newtons second law, work-energy relation, impulse-momentum relations, conservation laws, steady and variable mass flow systems; **Plane kinematics of rigid bodies**: Kinematics of rigid bodies, instantaneous center of rotation, kinematics in rotating frames and relative motion; **Plane kinetics of rigid bodies**: Linear and angular momentum, equations of motion, work-energy relation, impulse-momentum relation, conservation laws; **Introduction to spatial dynamics of rigid bodies**: Kinematics in rotating frames and relative motion, angular momentum, kinetic energy, equations of motion, special cases of parallel-plane motion, and gyroscopic motion.

Dynamics of Machinery: Balancing- Static unbalance, Dynamic unbalance, Dynamic balancing, Field balancing, Balancing of single cylinder and multicylinder Engines, analytical technique for balancing multicylinder reciprocating engines. **Governors**- Classification, Centrifugal and inertia governors, Terminology used in Governors- Height, equilibrium speed, Hunting, isochronism, stability, sensitiveness. **Gyroscopes**- Gyroscopic Action in Machines: Angular velocity and acceleration, gyroscopic torque and couple, gyroscopic effect on naval ships **Vibration**- Free Vibration of SDOF Systems: Basic concepts; undamped translational system; Rayleigh's energy method; free vibration with viscous damping. Harmonically Excited Vibration: Equation of motion; undamped response; magnification factor; damped response; energy dissipation.

Text/Reference Books:

1. Beer F.P., and Johnston Jr. E.R., *Vector Mechanics for Engineers: Dynamics*, McGraw-Hill Book Company Inc.
2. Kraige L.G., and Meriam J.L., *Engineering Mechanics - Dynamics*, Wiley.
3. Hibbeler R.C., *Engineering Mechanics - Dynamics*, New Jersey: Pearson Prentice Hall.
4. Norton R.L., *Design of Machinery*, McGraw-Hill.
5. Myszka D.H., *Machines and Mechanisms : Applied Kinematic Analysis*, Prentice Hall.
6. Bevan T., *Theory of Machines*, CBS Publishers & Distributors, Delhi.
7. Shigley J.E., and Uicker J.J., *Theory of Machines and Mechanisms*, McGraw Hill, Inc.
8. Ghosh A., and Malik A.K., *Theory of Machines and Mechanism*, East-West Press.
9. Wilson C.E., and Sandler J.P., *Kinematics and Dynamics of Machinery*, Pearson Education.

Subject Code: ME3L001	Name: Heat Transfer	L-T-P: 3-1-0	Credit: 4
Pre-Requisite: None			

Modes of heat transfer, thermal conductivity, combined modes of heat transfer, concept of thermal contact resistance. Derivation of heat conduction equation, steady state one-dimensional heat conduction with and without generation of heat in simple geometries: plane wall, cylindrical and spherical walls, critical thickness of insulation, heat transfer from extended surfaces, 2D steady state heat conduction Unsteady conduction: lumped heat-capacity system, transient heat conduction in infinite and semi-infinite walls, concept of Heisler chart and Schmidt plot, heat conduction from a moving heat source. Forced convection: Derivation of energy equation, concept of thermal boundary layer and derivation of thermal boundary layer equation, flat plate in parallel flow (solution by energy integral method), cylinder in cross flow, internal flows: concept of thermally fully developed flow and its corollaries, fully developed pipe flow, fully developed channel flow with constant wall heat flux and viscous dissipation, turbulent flow in pipes, Reynolds analogy. Free convection: Vertical plate at constant temperature: derivation of governing equation, recognition of dimensionless terms, and solution by integral method, free convection in vertical channel. Condensation and Boiling: laminar film condensation over a vertical plate and horizontal circular tube. regimes of boiling heat transfer, correlations for heat flux in boiling. Heat exchangers: classification of heat exchangers, overall heat transfer coefficient, concept of fouling factor, LMTD and NTU methods of analysis for a double pipe heat exchanger, applications to multi-tube, multi-pass heat exchangers. Thermal radiation: Radiation properties, blackbody radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, radiation exchange between black surfaces, concept of view factor, radiation exchange between non-black surfaces, two-surface enclosure, three surface enclosure, concept of radiation shield.

Text/Reference Books:

1. Incropera, Bergman and DeWitt, *Fundamentals of Heat and Mass Transfer*, John Wiley & Sons Inc.
2. Cengel Y., *Heat Transfer: A Practical Approach*, McGraw-Hill Professional.
3. Ozisik M.N., *Heat Transfer: A Basic Approach*, McGraw-Hill Companies.
4. Holman J.P., *Heat Transfer*, McGraw-Hill.
5. Bejan A., *Convection Heat Transfer*, Wiley.

Subject Code: ME3L002	Name: Design of Machine Elements	L-T-P: 3-0-0	Credit: 3
Pre-Requisite: None			

Introduction to Mechanical Engineering Design; Failure Preventions; Materials; Factor of Safety; Fits and Tolerances; Welding, Bonding, and the Design of Permanent Joints; Screws, Fasteners, and the Design of Non-Permanent Joints; Shafts; Clutch, Brakes, Couplings, and Flywheel; Mechanical Springs; Lubrication and Bearings; Gears - General; Flexible Mechanical Elements.

Text/Reference Books:

1. Shigley J.E., *Shigley's Mechanical Engineering Design*, McGraw Hill.
2. Norton R.L., *Machine Design 'An Integrated Approach'* , Pearson.
3. Spotts M.F., *Design of Machine Elements*, Pearson.
4. Bhandari V.B., *Design of Machine Elements*, McGraw Hill.
5. Khurmi R.S., and Gupta J.K., *Machine Design,* S Chand.
6. Lingaiah K., *Machine Design Data Book*, Tata McGraw – Hill.

Subject Code: ME3L003	Name: Casting, Welding and Forming (CWF)	L-T-P: 3-0-0	Credit: 3
Pre-Requisite: None			

Casting: Types of foundries, steps in making a casting; cast metals; types, materials and allowances of patterns; moulding processes and their characteristics; moulding materials; gating and risering; melting furnaces; casting defects. Welding: Welding processes; welding energy sources and their characteristics; fluxes and coatings; weldability and welding of various metals and alloys; metallurgical characteristics of welded joints; weld testing and inspection. Forming: Classification of metal forming processes; basic metal working concepts and plasticity; yield criterion; slip line fields; estimation of force and energy requirements; technology of bulk and sheet metal forming processes; precision forming processes; various features of different types of metal forming dies; principles of powder forming.

Text/Reference Books:

1. Kalpakjin S, *Manufacturing Engineering and Technology*, Pearson Education.
2. Rao P.N., *Manufacturing Technology*, Tata McGraw – Hill.
3. Jain R.K., *Production Technology*, Khanna Publishers.
4. Lindberg, *Process and materials of manufacturing*, Pearson Education.
5. Heine R. W., Loper C. R. and Rosenthal P. C., *Principles of Metal Castings*, Tata McGraw – Hill.
6. Parmar R. S., *Welding Process and Technology*, Khanna Publishers.
7. Sharma P. C., *A Textbook of Production Technology*, S Chand.
8. Dalela S., and Shankar R., *Production Engineering*, Galgotia Publications Pvt. Ltd.

Subject Code: ME3L004	Name: Systems & Controls	L-T-P: 3-0-0	Credit: 3
Pre-Requisite: None			

Introduction to generalized coordinates, derivation of Lagrange's equation from D' Alembert's principle.Small oscillations, matrix formulation, Eigen value problem and numerical solutions. Introduction to MAPLE® and MATLAB®, computer generation and solution of equations of motion. Introduction to complex analytic functions, Laplace and Fourier transform. Transfer function and block diagrams, tiMEnd frequency domain system behavior. Root-locus, Bode and Nyquist plots; stability and sensitivity; PID controllers, Phase lag and Phase lead compensation. Analysis of Control systems in state space, pole placement, computer simulation through MATLAB - SIMULINK®.

Text/Reference Books:

1. *System Dynamics* - Katsuhiko Ogata - Pearson Education India.
2. *Modern Control Theory - William L. Brogan - Prentice Hall.*
3. *Modern Control Engineering - Katsuhiko Ogata - Prentice Hall.*
4. *Control Systems Engineering - Norman S. Nise – Wiley.*
5. *Control System Design: An Introduction to State-Space Methods – B. Friedland – Dover.*
6. *Feedback and Control for Everyone - P. Albertos Pérez, Pedro Albertos – Springer.*
7. *Automatic Control Systems - Benjamin C. Kuo, FaridGolnaraghi – Wiley.*
8. *A Mathematical Introduction to Control Theory - ShlomoEngelberg - World Scientific Publishing Company.*
9. *Computational Methods in Multibody Dynamics - Farid M. L. Amirouche - Prentice Hall.*
10. *MATLAB® for Control Engineers - Katsuhiko Ogata - Prentice Hall.*
11. *Dynamical Systems with Applications using Maple® - Stephen Lynch - Birkhäuser Boston.*

Subject Code: ME3L005	Name: IC Engines	L-T-P: 3-0-0	Credit: 3
Pre-Requisite: None			

Engine Classification, Components, Carnot Cycle, Stirling Cycle, Ericsson Cycle, Lenoir Cycle, Atkinson Cycle, Air standard Cycles: Otto, Diesel and Dual cycles, Fuel-Air and Actual cycles' comparison**.** Working principles and comparison of 2-stroke and 4-stroke SI & CI engines, Valve Timing Diagram. Important Qualities and Ratings of SI & CI Engine Fuels, Dopes, Gas Turbine Fuels. Magneto Ignition System, Battery Ignition System and Modern Ignition System for S.I. Engines, Ignition Timing. Combustion in SI & CI Engines : Stages of combustion, Ignition lag and factors affecting the lag, Flame propagation and factors affecting the propagation in SI engine, Abnormal combustion, Detonation or Knocking, Factors affecting knocking, Effects of knocking, Control of Knocking, Combustion Chambers. Simple Carburetor, Drawbacks, Complete Carburetor, Compensation. Fuel Injection of CI and SI Engines: Introduction, Requirement and Types of Injection System, MPFI System in SI engine. Engine Heat Transfer, Engine cooling and lubrication: Principle and description. Supercharging of SI and CI engines, Effect of supercharging, Limitation of supercharging, Superchargers. Performance Parameters, Measurements & Testing of I C Engines, Engine Indicator and its use, Heat balance. Pollutant Formation & its Control.

Text/Reference Books:

1. Taylor C.F., *Internal-combustion engine in theory and practice*, Cabridge University Press.
2. Ferguson C.R., and Kirkpatrick A.T., *Internal combustion engines : Applied Thermosciences*, John Wiley & Sons.
3. Heywood J.B., *Internal combustion engine fundamentals*, McGraw-Hill.
4. Ganesan V., *Internal combustion engines*, McGraw-Hill.
5. Rogowski A.R., *Elements of internal-combustion engines*, McGraw-Hill.

Subject Code: ME3L006	Name: Refrigeration & Air Conditioning	L-T-P: 3-0-0	Credit: 3
Pre-Requisite: Thermodynamics			

Refrigeration Cycles; Thermodynamic analysis of vapour-compression, aircraft refrigeration systems; Application and optimization of multistage and cascade refrigeration systems; Fan, pump, evaporator and condenser selection; Vapour absorption refrigeration systems; Refrigerants; multistage refrigeration; Load calculations; Design of various elements of a refrigeration unit.

Brief history of airconditioning; Principles of psychrometry, psychrometry of airconditioning processes, comfort chart, indoor and outdoor design conditions, comfort air conditioning.

Text/Reference Books:

1. Ameen A., *Refrigeration and Air Conditioning*, Prentice Hall India Learning.
2. Stocker W.F. and Jones J.W., *Refrigeration and Air Conditioning*, McGraw-Hill Publishing Company.
3. Dossat R.J., *Principle of Refrigeration*, Wiley.
4. Arora C.P., *Refrigeration and Air Conditioning*, McGraw-Hill.
5. Rajput R.K., *Refrigeration and Air Conditioning*, S. K. Kataria & Sons.

Subject Code: ME3L007	Name: Machine Tools & Machining	L-T-P: 3-0-0	Credit: 3

Pre-Requisite: None

Machine tools:- Concept and definition of machining and machine tools. History of developments of machine tools. Kinematic schemes of machine tools, Concept of producing geometrical surfaces by generatrix and directrix. Kinematic systems and structures of conventional machine tools. Electromechanical and hydraulic drives and control of machine tools. Machine tool automation. Classification and specification of machine tools. Construction, working principle and application of various semi-automatic and automatic lathes. Flexible automation: need, principle and advantages.

Machining:- Tool geometry, mechanism of chip formation. Mechanics of machining. Cutting temperature: causes, effects, estimation, measurement and control. Cutting fluid applications. Failure modes, wear and life of cutting tools. Cutting tool materials. Role of geometrical and process parameters and cutting fluid on machinability. Mechanics of grinding. Economy of machining and grinding. Special techniques and advanced technology of machining and grinding.

Text/Reference Books:

1. Rao P.N., *Manufacturing Technology, metal cutting & Machine tools*, Tata McGraw-Hill.
2. Boothroyd G., *Fundamentals of metal machining and machine tools*, Taylor & Francis.
3. Jain R.K., and Gupta S.C., *Production Technology*, Hindustan Machine Tools.
4. Hazra Chowdary S.K., *Elements of Workshop Technology –Vol II*, Media Promoters.
5. Ghosh A., and Mallik A.K., *Manufacturing science*, East-West Press.

Subject Code: ME3L008	Name: Power Plant Engineering	L-T-P: 3-0-0	Credit: 3

Pre-Requisite: None

Introduction to Power Plant, Analysis of steam cycles, optimization of reheat pressure and degree of regeneration, coupled cycles and combined plants, process heat and power. Boilers: Different types of boilers, boiler mountings & accessories, feed water treatment, boiler energy balance & draft system. Nozzles; convergent and convergent-divergent nozzles - theory and design. Steam Turbines: Impulse and reaction turbines, compounding of turbines, optimum velocity ratio, reheat factor and condition line, parallel exhaust, losses in steam turbines, steam turbine governing. Theory and design of condensers, air ejector and cooling tower. Fluid Power & Machinery: Similarity, Euler equation for Turbo-machines, Centrifugal pump, Hydraulic turbines, Cavitation.

Text/Reference Books:

1. El-Wakil M.M., *Power Plant Technology*, McGraw-Hill Science/Engineering/Math.
2. Nag P.K., *Power Plant Engineering*, Tata McGraw Hill Publishing Company Limited.
3. Veatch B., Drbal L.F., Boston P.G., Westra K.L., Erickson R.B., *Power Plant Engineering*, CBS Publishers.
4. Rajput R.K., *A Textbook of Power Plant Engineering*, Laxmi Publication.
5. Som S.K., and Biswas G., *Introduction to Fluid Mechanics and Fluid Machines*, Tata McGraw Hill Publishing Company Limited.

Subject Code: ME 6L001	Name: Vibrations	L-T-P: 3-1-0	Credit: 4

Pre-Requisite: None

Fundamental concepts in vibration and modeling: Introduction to modeling and analysis Introduction to mechanical vibration

Free vibration of single degree of freedom systems: Undamped vibration; Simple harmonic motion; Damped vibration; Modeling: Energy and Newton's methods; Measurement of vibrational components; Design Consideration; Stability

Forced harmonic excitation of single degree of freedom systems: Undamped vibration; Damped vibration; Base excitation; Rotating unbalance; Coulomb damping

Vibration of single degree of freedom systems under general forcing conditions: Impulsive inputs; Arbitrary non-periodic inputs; Arbitrary periodic inputs; Stability

Vibration of multi degree of freedom systems: Modeling, Free undamped vibration; Eigenvalue

problem; Modal analysis; Free damped vibration; Forced vibration Dynamic vibration absorbers; Isolators for shock and harmonic loading.

Recommended Books:

1. *Theory of Vibrations with Applications* - William T. Thomson and Marie Dillon Dahleh (Pearson Education)
2. *Mechanical Vibration* - William J. Palm (Wiley)
3. *Principles of Vibration* – B. H. Tongue (Oxford University Press)
4. *Fundamentals of Vibrations* - Leonard Meirovitch (Mcgraw-Hill)
5. *Mechanical Vibrations*: Theory and Applications - S. Graham Kelly (CL-Engineering)
6. *Mechanical Vibration* – S. S. Rao (Prentice Hall)
7. *Advanced Theory of Vibration* - J. S. Rao (New Age International)
8. *Structural Dynamics*: *Vibrations and Systems* – Madhujit Mukhopadhyay (ANE Books)
9. *Vibration Testing: Theory and Practice* - Kenneth G. McConnell and Paulo S. Varoto (Wiley)
10. *Vibration problems in engineering*- Stephen Timoshenko (Oxford)

Subject Code: ME 6L002	**Name: Advanced Solid Mechanics**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-Requisite: None

Analysis of stress and strain, Stress-strain relations for linearly elastic solids, Theories of failure or yield criteria and introduction to ideally plastic solids, Applications of energy methods, Bending of straight beams, Shear center for thin-wall beam sections, Curved beams, Thick and thin wall cylinders, Elastic and inelastic stability of columns, Torsion, Analysis of plates, Stress concentration, Basic concepts of fatigue, creep and fracture.

Recommended Reference Books:

1. *Advanced Mechanics of Materials* – A. P. Boresi and R. J. Schmidt (Wiley)
2. *Advanced Mechanics of Solids* – L. S. Srinath (Tata McGraw-Hill)
3. *Fracture Mechanics: Fundamentals and Application* – T. L. Anderson (Taylor & Francis Group)
4. *Advanced Mechanics of Materials* – R. Solecki (Oxford University Press)
5. *Strength of Materials and Structures* – J. Case, L. Chilver and Carl T. F. Ross (Butterworth-Heinemann)
6. *Advanced Mechanics of Solids* – Bruhns Otto T. (Springer)
7. *Advanced Mechanics of Materials* – R. D. Cook, W. C. Young (Prentice Hall)
8. *Elements of Fracture Mechanics* – Prashant Kumar (Tata Mcgraw Hill)
9. *Fundamentals of Fracture Mechanics* – TribikramKundu (CRC Press)

Subject Code: ME 6L051	**Name: Dynamics and Control of Mechanical Systems**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-Requisite: None

Revisit to the history of development of mechanics from Galileo to Newton. Kinematics of rigid bodies - coordinate transformation, angular velocity vector, description of velocity and acceleration in relatively moving frames. Euler angles, Review of methods of momentum and angular momentum of system of particles, inertia tensor of rigid body. Dynamics of rigid bodies - Euler's equation, application to motion of symmetric tops and gyroscopes and problems of system of bodies.Kinetic energy of a rigid body, virtual displacement and classification of constraints. D' Alembert's principle. Introduction to generalized coordinates, derivation of Lagrange's equation from D' Alembert's principle.Small oscillations, matrix formulation, Eigen value problem and numerical solutions.

Introduction to MAPLE® and MATLAB®, computer generation and solution of equations of motion. Introduction to complex analytic functions, Laplace and Fourier transform. Transfer function and block diagrams, tiMEnd frequency domain system behavior. Root-locus, Bode and Nyquist plots; stability and sensitivity; PID controllers, Phase lag and Phase lead compensation. Analysis of Control systems in state space, pole placement, computer simulation through MATLAB - SIMULINK®.

Recommended Reference Books:

1. *Methods of Analytical Dynamics* - Leonard Meirovitch – Dover.
2. *Classical Dynamics* - Donald T. Greenwood – Dover.
3. *Advanced Dynamics* - Donald T. Greenwood – Cambridge University Press.
4. *Analytical Mechanics* - Herbert Goldstein - Addison Wesley.
5. *Engineering Mechanics:* Dynamics – I. H. Shames, Prentice-Hall of India.
6. *Dynamics: Theory and Applications* - T.R. Kane, David A. Levinson - McGraw-Hill.
7. *System Dynamics* - Katsuhiko Ogata - Pearson Education India.
8. *Modern Control Theory* - William L. Brogan - Prentice Hall.
9. *Modern Control Engineering* - Katsuhiko Ogata - Prentice Hall.
10. *Control Systems Engineering* - Norman S. Nise – Wiley.
11. *Control System Design:* An Introduction to State-Space Methods – B. Friedland – Dover.
12. >*Feedback and Control for Everyone* - P. Albertos Pérez, Pedro Albertos – Springer.
13. *Automatic Control Systems* - Benjamin C. Kuo, FaridGolnaraghi – Wiley.
14. *A Mathematical Introduction to Control Theory* - ShlomoEngelberg - World Scientific Publishing Company.
15. *Computational Methods in Multibody Dynamics* - Farid M. L. Amirouche - Prentice Hall.
16. *MATLAB® for Control Engineers* - Katsuhiko Ogata - Prentice Hall.
17. *Dynamical Systems with Applications using Maple®* - Stephen Lynch - Birkhäuser Boston.

Subject Code: **ME 6L052**	**Name:** Applied Elasticity	**L-T-P:** 3-1-0	**Credit: 4**

Pre-Requisite: None

Concepts of states of stress and strain. Analysis of three dimensional stresses and strains, equations of equilibrium, generalized Hookes law, Plane elastic problems in cartesian and polar coordinates, axisymmetric problems, torsion, solutions of problems using elasticity theory, anisotropic elasticity, thermoelasticity, contact problems, energy and variational principles and elastic stability.

Recommended Books:

1. *Theory of Elasticity*- S. Timoshenko and J.N. Goodier (McGraw Hill)
2. *Elasticity in engineering mechanics*- Arthur Peter Boresi, Ken Pin Chong (Wiley)

Elective - I

Subject Code: ME3L012	Subject Name: Operations Research	L-T-P: 3-0-0	Credit: 3

Pre-requisite(s): None

Introduction of Operations Research, Applications of OR, Linear Programming: Formulation Linear Programming, Graphical method, Simplex method, Duality, Sensitivity Analysis, Transportation problem: Initial basic feasible solution, Optimality test, Special cases of Assignment Problem, Integer Linear Programming, Branch and Bound Method, Sequencing Problem, Game Theory: two person zero sum game problem, Games with mixed strategy, Project scheduling: CPM, PERT, Project Crashing, Multi Criteria Decision Making Tools, Queuing Theory: multiple server models, Simulation.

Text/Reference Books:

1. Hillier F.S., and Lieberman G.J., Introduction to Operations Research, Tata McGraw Hill, New York.
2. Taha H.A., Operations Research: An Introduction, Prentice-Hall, New York.
3. Winston W.L., Operations Research: Applications and Algorithms, Duxbury Press, Belmont.
4. Ravindran and Phillip, Operations Research, Wiley publication.

Subject Code: ME3L013	Subject Name: Computational Fluid Dynamics	L-T-P: 3-0-0	Credit: 3

Pre-Requisite(s): Fluid Mechanics

Basic conservation equations for fluid flow and heat transfer, classification of partial differential equations and pertinent physical behavior, parabolic, elliptic and hyperbolic equations, role of characteristics; Common methods of discretisation: an overview of finite difference and finite volume methods; Numerical solution of parabolic partial differential equations using finite-difference and finite-volume methods: explicit and implicit schemes; Consistency, stability and convergence; Numerical solution of systems of linear algebraic equations: iterative methods, tridiagonal matrix algorithm, Jacobi and Gauss-Seidel iterations, necessary and sufficient conditions for convergence of iterative schemes; The finite volume method of discretisation for diffusion problems; Convection-diffusion problems; Numerical solution of the Navier-Stokes system for incompressible flows.

Text/Reference Books:

1. Patankar S.V., *Numerical Heat Transfer and Fluid Flow*, Taylor and Francis.
2. Versteeg H.K., and Malalasekera W., *Introduction to Computational Fluid Dynamics: The Finite Volume Method*, Pearson Publisher.
3. Tannehill J.C., Anderson D.A., and Pletcher R.H., *Computational Fluid Mechanics and Heat Transfer*, Taylor and Francis Group.
4. Anderson Jr. D.A., *Computational Fluid Dynamics*, McGraw-Hill Publisher.
5. Smith G.D., *Numerical Solution of Partial Differential Equations: Finite Difference Methods*, Oxford University Press.

Subject Code: ME3L014	Subject Name: Robotics	L-T-P: 3-0-0	Credit: 3

Pre-Requisite(s): None

Introduction, brief history, components, types and classification of robots, Homogeneous transformations, representation of joints and links using D-H parameters, direct and inverse kinematics of manipulators, examples of kinematics of some common manipulator configurations, Jacobian and dynamics of manipulators, trajectory planning; Purpose and types of sensors, Internal and external sensors, common sensors–displacement sensors, velocity sensors, force sensors and vision, necessity of actuators, different kinds of actuators – stepper motors, DC servo

and brushless motors, programming of robots.

Text/Reference Books:

1. Ghosal A., *Robotics: Fundamental concepts and analysis*, Oxford university press.
2. Groover M.P., *Industrial Robotics*, Pearson Education.
3. Mittal R.K., and Nagrath I.J., *Robotics and Control,* Tata Mc-Graw Hill.
4. Fu K., Gonzalez R., and Lee C. S. G., *Robotics: Control, sensing, vision and intelligence*, McGraw Hill.
5. Klafter R.D., *Robotic Engineering*, Prentice Hall.
6. Craig J.J., *Introduction to Robotics*, Pearson Education.
7. Spong M.W., and Vidyasagar M., *Robot Dynamics & Control,* John Wiley & Sons (ASIA) Pte Ltd.
8. Saha S.K., *Introduction to robotics*, Tata Mc-Graw Hill.
9. Jazar R.N., *Theory of applied robotics, kinematics, dynamics and control*, Springer.

Subject Code: ME3L015	**Subject Name: Intermediate Fluid Mechanics**	**L-T-P: 3-0-0**	**Credit: 3**

Pre-Requisite(s): Fluid Mechanics

Review: Differential form of Conservation Equations of Mass, Momentum & Energy, N-S Equations for Incompressible Flows; Velocity Potential, Stream-function; Vorticity & Circulation; Potential Flows – Elementary plane flows, superposition, plane flow past closed body shapes, flow past cylinder (Lifting & Non-lifting) – lift & drag, Complex Potential & Conformal mapping, Image & Reflections, Applications to plane flows; Vortex Lines, Kelvin-Helmhotz Theorems, Biot-Savart Law & Induced Velocity; Airfoil theory – Kutta conditions, lifting-line theory; Boundary Layer – Equations, Approximate & Exact solutions; Introduction to Stability, Transition & Turbulence.

Text/Reference Books:

1. White F.M., *Fluid Mechanics*, Tata McGraw Hill Publishing Company Limited.
2. Anderson J.D., *Fundamentals of Aerodynamics*, McGraw Hill.
3. Fox R.W., and McDonald A.T., *Introduction to Fluid Mechanics*, John Wiley & Sons, Inc.
4. Panton R.L., *Incompressible Flow*, Wiley.
5. White F.M., *Viscous Fluid Flow,* McGraw-Hill.
6. Schlichting H., and Gersten K., *Boundary Layer Theory,* Springer.
7. Kundu P.K., and Cohen I.M., *Fluid Mechanics with Multimedia DVD*, AP / Elsevier.
8. Munson B.R., Young D.F., Okiishi T.H., and Huebsch W.W., *Fundamentals of Fluid Mechanics,* Wiley.