Curriculum for Dual Degree Programme
B. Tech. (Mechanical Engineering) - M. Tech. (Mechanical Systems Design)

Subject Name	Subject Code	L-T-P	Credit	Contact Hour
SEMESTER - I				
Mathematics – I	**MA1L001**	3-1-0	4	4
Physics / Chemistry	**PH1L001 / CY1L001**	3-1-0	4	4
Mechanics / English for Communications or Learning English	**ME1L001 / HS1L001 or HS1L002**	3-1-0/3-0-2 or 3-1-0	4	4/5 or 4
Electrical Technology / Introduction to Programing and Data Structures	**EE1L001 / CS1L001**	3-1-0	4	4
Introduction to Manufacturing Processes / Engineering Drawing and Graphics	**ME1P001 / CE1P001**	0-0-3/1-0-3	2/3	3/4
Physics Laboratory / Chemistry Laboratory	**PH1P001 / CY1P001**	0-0-3	2	3
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory	**EE1P001 / CS1P001**	0-0-3	2	3
EAA - 1	**ID1T001**	0-0-3	1	3
		Total	**22/23+1**	**25/27 or 26+3**
SEMESTER – II				
Mathematics – II	**MA1L002**	3-1-0	4	4
Chemistry / Physics	**CY1L001 / PH1L001**	3-1-0	4	4
English for Communication or Learning English / Mechanics	**HS1L001 or HS1L002 / ME1L001**	3-0-2 or 3-1-0/3-1-0	4	5 or 4/4
Introduction to Programing and Data Structures / Electrical Technology	**CS1L001 / EE1L001**	3-1-0	4	4
Chemistry Laboratory / Physics Laboratory	**CY1P001 / PH1P001**	0-0-3	2	3
Introduction to Programing and Data Structures Laboratory / Electrical Technology Laboratory	**CS1P001 / EE1P001**	0-0-3	2	3
Engineering Drawing and Graphics / Introduction to Manufacturing Processes	**CE1P001 / ME1P001**	1-0-3/0-0-3	3/2	4/3
EAA – 2	**ID1T002**	0-0-3	1	3
		Total	**23/22+1**	**27 or 26/25 +3**
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

Subject Name	Subject Code	L-T-P	Credit	Contact Hour
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	3
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**	**25**

SEMESTER - VI				
Lateral Theory-3	**ME3LXXX**		3	3
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**	**24**
INDUSTRIAL SUMMER TRAINING				

Curriculum for Dual Degree Programme
B. Tech. (Mechanical Engineering) - M. Tech. (Mechanical Systems Design) – 4th and 5th year

Subject Name	Subject Code	L-T-P	Credit	Contact Hour
SEMESTER - VII				
Vibrations	**ME 6L001**	3-1-0	4	4
Advanced Solid Mechanics	**ME 6L002**	3-1-0	4	4
Elective – 2	**ME4LXXX/ ME6LXXX**	3-0-3	5	6
Breadth - 2		3-0-0	3	3
Industrial Training Defense	**ME4T001**	0-0-0	2	3
Project – Part 1	**ME4D001**	0-0-0	4	0
Experimental Techniques for Mechanical Engineers	**ME6P002**	0-0-3	2	3
		Total	**24**	**23**
SEMESTER - VIII				
Dynamics and Control of Mechanical Systems	**ME 6L051**	3-1-0	4	4
Elective - 3	**ME6LXXX**	3-0/1-0	3/4	3/4
Breadth – 3		3-0-0	3	3
Breadth – 4		3-0-0	3	3
Project – Part 2	**ME4D002**	0-0-0	6	0
Mechanical System Simulations Lab –II	**ME6P003**	0-0-3	2	3
		Total	**21/22**	**16/17**
SEMESTER – IX				
Elective – 4	**ME6LXXX**	3-0/1-0	3/4	3/4
Seminar	**ME6S101**	0-0-0	2	0
Thesis– Part 1	**ME4D001**	0-0-0	12	0
		Total	**17/18**	**3/4**
SEMESTER – X				
Elective – 5	**ME4LXXX/ ME6LXXX**	3-0/1-0	3/4	3/4
Thesis– Part 2	**ME4D002**	0-0-0	13	0
		Total	**16/17**	**3**
		G. Total	**222/226**	**201/207**

Elective Courses B. Tech. – M. Tech Dual Degree (Mechanical Systems Design) – 4th & 5th Years

Subject Name	Code	L-T-P	Credit	Contact Hour
Elective – II (Semester VII)				
Computer Aided Design & Manufacturing	ME4L002	3-0-3	5	6
Advanced Manufacturing Processes	ME4L004	3-0-3	5	6
Elective – III & V (Semester IX)				
Applied Elasticity	ME6L152	3-1-0	4	4
Tribology	ME6L005	3-0-0	3	3
Engineering Design Optimization	ME6L007	3-0-0	3	3
Sensing and Actuation	ME6L008	3-0-0	3	3
Engineering Measurements	ME6L009	3-1-0	4	4
Operations Management	ME6L010	3-0-0	3	3
Finite Element Methods in Engineering	ME6L011	3-1-0	4	4
Acoustics	ME6L012	3-0-0	3	3
Robotics and Automation	ME6L013	3-0-0	3	3
Introduction to Nonlinear Dynamics	ME6L014	3-0-0	3	3
Computational Methods in Thermal & Fluid Engineering	ME6L102	3-1-0	4	4
Spectral Methods for Engineering & Scientific Computing Applications	ME6L113	3-0-0	3	3
Solar Energy	ME6L114	3-0-0	3	3
Computational Intelligence	CS6L001	3-0-0	3	3
Data Analytics	ID6LXXX	3-0-0	3	3
Applications of Linear Algebra in Mechanical Engineering	ME6L120	3-0-0	3	3
Structural Health Monitoring	ME6L121	3-0-0	3	3
Artificial Intelligence & Neuro-fuzzy systems	ME6L060	3-1-0	4	4
Elective – IV (Semester X)				
Industrial Noise Control	ME6L053	3-0-0	3	3
Experimental Stress Analysis	ME6L056	3-0-0	3	3
Theory of Composite Materials	ME6L057	3-0-0	3	3
Experimental Modal Analysis	ME6L058	3-0-0	3	3
MEMS & Microsystems Technology	ME6L062	3-0-0	3	3
Reverse Engineering	ME6L063	3-0-0	3	3
Design and Analysis of Experiments	ID6LXXX	3-0-0	3	3
Mathematical Methods for Mechanical Engineers	ME6L171	3-0-0	3	3

Syllabus

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

Pre-requisite(s): None

Formulation Linear Programming, Graphical method, Simplex method, Duality, Transportation problem: Optimality test, Special cases of Assignment Problem, Sequencing Problem, Game Theory, Project scheduling, Queuing Theory.

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: 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.

Subject Code: PH1P001	Subject Name: Physics Laboratory	L-T-P: 0-0-3	Credit: 2

Pre-Requisite(s): None

1. To determine the damping constant of the pendulum for different eddy damping current.
2. To verify Malus's Law of polarization of light.
3. To determine the wave length of the prominent lines of mercury source by a plane transmission diffraction grating and to calculate the resolving power and dispersive power of the grating.
4. To study the intensity distribution of Fraunhofer diffraction pattern by a single slit and measure the width of the slit for a given wavelength of laser light.
5. To determine the wavelength of the given source using the Michelson interferometer.
6. To determine the wave length of the given source using Fresnel's biprism.
7. To find out the resonance and beat time period of the coupled pendulum and find out the spring constant.
8. To study the interference pattern and determine the radius of curvature of the plano convex lens using Newton's rings apparatus.

Text/Reference Books:

1. Ghatak *A. Optics*, McGraw-Hill.
2. Pain H. J. *The Physics of Vibrations and Waves*, Wiley.

Subject Code: CY1P001	Subject Name: Chemistry Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

Experiment-1: Determination of the surface tension and parachor of a homologous series.
Experiment -2: Measurement of the coefficient of viscosity of ethanol & ethanol -water system.
Experiment -3: Studies on acid-base conductometric titration.
Experiment- 4: Studies on PH metric titration of strong base with strong acid.
Experiment -5: Estimation of sulphate ion in tap water by nepheloturbidimetric analysis.
Experiment - 6: Spectrophotometric determination of acid dissociation constant (pka) of methyl red (MR) an acid base indicator.
Experiment -7: Determination of solubility and solubility product of a sparingly soluble salt at room temperature by conductometric method.
Experiment- 8: Potentiometric titration of a given sodium carbonate solution with aquesous hydrochloric acid solution.
Experiment -9: kinetics of ester hydrolysis.
Experiment -10: Detection of functional groups in an organic compound for solid sample.
Experiment-11: Detection of functional groups in an organic compound for liquid sample.
Experiment -12: Thin layer chromatography (TLC).

Text/Reference Books:

1. Nad, A. K.; Mahapatra, B. and Ghoshal A. *An advanced course in practical chemistry*, New Central Book Agency (P) Ltd.
2. Elias A. J. *A collection of general chemistry experiments*, University Press.

Maity S. and Ghosh N. *Physical Chemistry Practical*, New Central Book Agency (P) Ltd.

Subject Code: EE1P001	Subject Name: Electrical Technology Laboratory	L-T-P: 0-0-3	Credits: 2

Prerequisite(s): Electrical Technology

Experiments as per the topics in the syllabus for the course `Electrical Technology' (EE1L001) will be conducted in the laboratory class.

Text Books:

1. E. Hughes, "*Electrical Technology,*" Pearson Education, 2010.
2. V. Del Toro, "Electrical Engg Fundamentals," PHI Learning, 2009.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, '*Basic Electrical Engineering'* TATA McGraw Hill Education, 2009.
2. D. A. Bell, "*Electric Circuits,*" 7th Ed., Oxford Higher Education, 2009.

Subject Code: CS1P001	Subject Name: Introduction to Programming and Data Structures Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): Introduction to Programing and Data Structures

Familiarization of a computer and the environment; Execution of sample programs related to Expression evaluation, Conditionals and branching, Iteration, Functions, Recursion, Tail-recursion, Arrays, String manipulation, Structures, Linked lists, Doubly-linked lists and Binary Trees. Execution of programs involving abstract data types like Stacks and Queues.

Subject Code: CE1P001	Subject Name: Engineering Drawing	L-T-P: 1-0-3	Credit: 3
Pre-requisite(s): None			

Introduction to IS code of drawing; Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute; Projection of lines – traces, true length; Projection of planes and solids; sold objects – cube, prism, pyramid, cylinder, cone and sphere; Projection on Auxiliary planes; Isometric projection, isometric scale; Section of solids – true shape of section; Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

Text/Reference Books:

1. Bhatt N.D.*Elementary Engineering Drawing*, Charotar Publishing House.
2. Gill P.S.*Engineering Drawing & Engg. Graphics*, S. K. Kataria & Sons.
3. Lakshminarayan L.V. and Vaish R.S.*Engineering Graphics*, Jain Brothers.

Subject Code: ME1P001	Name: Introduction to Manufacturing Processes	L-T-P: 0-0-3	Credit: 2
Pre-requisite(s): None			

Machining:

- Introducing to various machine tools and demonstration on machining
- Making a steel pin as per drawing by machining in centre lathe
- External screw thread on lathe
- Making a cast iron Vee block by shaping
- Making a regular polygon prism (MS)/ hexagon by milling machine
- Slot fitting by milling machine
- Study of machining in machining in machining centre (CNC)
- Study of Electro discharge machining (EDM)

Foundry Practice:

- Orientation, demonstration and practice on metal casting
- Practicing sand moulding using split and uneven parting line pattern
- Practice on CO2 moulding and machine moulding
- Mechanised sand preparation and melting practice

Welding Practice:

- Practice on electric arc welding
- Practice on oxy-acetylene gas welding
- Introduction and demonstration on submerged arc welding

Metal Forming:

Demonstration of deep drawing and other forming process

Text/Reference Books:

1. Chapman W.A.J., *Workshop Technology - Part I*, CBS Publishers.
2. Chapman W.A.J., *Workshop Technology - Part II*, CBS Publishers.
3. Hajra Choudhury S.K., *Elements of workshop Technology Vol. I*, Media Promoters.
4. Hajra Choudhury S.K., *Elements of workshop Technology Vol. II*, Media Promoters.

Subject Code: ME2P001	Name: Workshop Processes	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

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: ME2P002	Name: Fluid Mechanics Lab	L-T-P:0-0-3	Credit: 2

Prerequisite(s): None

Hydrostatic Pressure & Measurement of Pressure; Center of Pressure on a Submerged Plane Surface; Impact of a Jet of Water; Laminar & Turbulent Flow in Pipes; Minor & Major Losses in Pipe Flow; Measurement of Flow Rates; Pressure Distribution About a Circular Cylinder, Drag Force Determination; External Laminar Flows Over Immersed Bodies; Laminar & Turbulent Boundary Layer.

Subject Code: ME2P003	Name: Machines & Mechanisms Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

Four Bar Link Mechanism, Single Stage Helical Gear, Oldham's Coupling, Single Stage Spur Gear with Intermediate gear, Differential Gear, Universal Joint-Single and Double joint, Epicyclic Gear with Three Gears, Reciprocating Engine Mechanism, Oscillating Cylinder Mechanism, Sun-Planet Annular gear, Three Stage Spur Gear, Whitworth Quick Return Mechanism, ScotchYoke Mechanism, Worm Gear, Single Stage Spur Gear(Parallel Axis), Bevel Gear(Single).

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

Prerequisite(s): None

Tests using UTM (Tensile test, Three point bend test, compression test etc.; Hardness tests; Impact test; Fatigue test (Rotary and Axial); Torsion test; Cupping test; Spring compression test; Stresses in pressure vessels; Introduction to Photoelasticity; Strain measurements using strain gauges.

Subject Code: ME3P001	Name: Thermo-Fluid Lab - 1	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

Linear and radial heat conduction, Heat transfer through extended surfaces, Determination of heat transfer coefficient in free and forced convection, Experiments to verify various radiation heat transfer laws, Parallel and counter flow heat exchangers: LMTD and temperature distribution, Radiation error in temperature measurement.

Subject Code: ME3P002	Name: Casting, Welding and Forming Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

Casting: Practice on CAD of gating and riser, Experiment to determine the effect of moulding variables in sand moulds, To determine the effect of mould additive on the properties of castings, To determine the characteristics of base sands. **Welding**: Study of arc characteristics in simulated MMA welding; arc gap-arc voltage relationship; recording of voltage oscillograms and its study. Study of heat flow and temperature distribution in welding, Study of characteristics of TIG/MIG

welding, Ultrasonic/dye penetrant inspection or computer simulation of welding heat flow/analysis of arc-voltage pattern. **Forming**: Experiments on formability test, powder compaction; strip layout for progressive die design.

Subject Code: ME3P003	**Name: Machine Design Practice**	**L-T-P: 0-0-3**	**Credit: 2**
Prerequisite(s): None			
Design and Drawing of Simple Machine Elements; Assembly Drawings; Use of CAD softwares that allows development of three-dimensional (3-D) designs; Introduction and Application of Engineering based softwares for Mechanical Engineering Applications.			
Subject Code: ME3P004	**Name: Thermo-Fluid Lab - 2**	**L-T-P: 0-0-3**	**Credit: 2**
Prerequisite(s): None			
Study of I.C. Engine models, Load test on a Petrol engine, Load test on a Diesel engine and Morse test on a multi-cylinder engine. Studies on refrigerant compressors. Experimental observations on a refrigeration test-rig. Performance evaluation of a vapour compression refrigeration system. Performance evaluation of an air conditioning system Pressure distribution for flow over a cylinder, measurement of velocity profile in the boundary layer, characteristics of a convergent-divergent nozzle and characteristics of a centrifugal fan.			
Subject Code: ME3P005	**Name: MTM Laboratory**	**L-T-P: 0-0-3**	**Credit: 2**
Prerequisite(s): None			
Machine tools: 1. Acceptance test of machine tool (radial drilling machine) 2. System compliance of machine tool (center lathe). **Machining**: 3. Resharpening of turning tool to specific geometry 4. Measurement of cutting forces and surface finish in turning, drilling and milling 5. Measurement of cutting temperature and tool life in turning 6. Measurement of grinding forces and surface finish in grinding 7. Machine setting and operation for helical gear teeth cutting**. Metrology**: 8. Inspection of straightness and flatness of surfaces Measurement of angles 9. Measurement of external and internal taper 10. Inspection of screw threads 11. Inspection of gear teeth 12. Measurement of roundness by Telerond Calibration of measuring instruments.			

Core Courses B. Tech. – M. Tech Dual Degree (Mechanical Systems Design) – 4th & 5th Years

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: The state of stress at a point, principal stresses, stress invariants, octahedral stresses, decomposition into Hydrostatic and Pure Shear States, Mohr's circles for three dimensional state of stress, Plane state of stress, Differential Equations of Equilibrium, Boundary Conditions, The state of strain at a point, Cubical dilatation, Principal State of Strain, Plane state of strain, Compatibility conditions; Stress –strain relations for linearly elastic solids; Theories of failure or yield Criteria and introduction to ideally plastic solid; Energy methods; Bending of straight beams: Euler Bernoulli Hypothesis, Shear Center or Flexure, Curved beams (Winkler-Bach Formula), Deflection of thick curved Bars; Axi-symmetric Problems: Thick walled cylinders (Lame's problem), Composite tubes – shrink fits, Rotating discs, shafts and cylinders etc; Shear center for thin-wall beam sections; Elastic and inelastic stability of columns; Torsion; Analysis of plates; Stress concentration; Introduction to 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 – Tribikram Kundu (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: ME4L002	Subject Name: Computer Aided Design & Manufacturing	L-T-P: 3-0-3	Credit: 5

Pre-Requisite(s): Engineering Drawing & Graphics

Overview of CAD, Software and hardware requirements of CAD, CAD applications, solid modeling, wire frame modeling, B-rep, CSG approaches, Transformations and projections, Mathematical representation of curves and surfaces, Cubic, Bezier and B-spline curves and properties; Introduction to NC, components, advantages and limitations of NC, CNC, DNC, part programming, adaptive control, group technology, computer aided process planning, FMS and CIM.

Laboratory

Generation of various 3D models through protrusion, revolve and shell sweep and their assembly modelling using any of the CAD modelling software. Determination of deflection and stresses in 2D and 3D trusses and beams. Determination of principal and von-mises stresses in plane stress, plane strain and axi-symmetric components. Determination of stresses in 3D and shell structures. Estimation of natural frequencies and mode shapes in beams using analysis package. Generation of part programs on CNC turning and milling machines to produce free form and sculptured surfaces using CAM package.

Text/Reference Books:

1. Zimmers & Groover P., *CAD/CAM*, PE/PHI Publishers.
2. Zeid I., *CAD / CAM Theory and Practice,* Tata McGraw – Hill.
3. Rao P.N., *CAD/CAM principles and applications*, Tata McGraw – Hill.
4. Korean Y., *Computer control of Machine Tools and Processes*.
5. Groover, *Automation , Production systems & Computer integrated Manufacturing*, Pearson Education.
6. Amirouche F., *Principles of Computer Aided Design and Manufacturing*, Pearson Education.
7. Seames W.S., *Computer Numerical Control Concepts and programming*, Thomson Learning.

Subject Code: ME4L004	Subject Name: Advanced Manufacturing Processes	L-T-P: 3-0-3	Credit: 5

Pre-Requisite(s): Introduction to Manufacturing Process

Industrial needs and problems in manufacturing. Probable principles in achieving the solutions through non-conventional energy sources. Classifications and sources for hybridization of processes. Erosion theories and principles of their uses through different Mechanical processes, e.g. Ultrasonic, Abrasive-jet and fluid flow. Principles and analyses of crack & stress free processes, e.g. Chemical processing and Electrochemical processing of materials. Principles and analyses of thermal processing materials and their uses through Electrical Discharges (EDM/WEDM), Laser, Electron and Ion Beam, Plasma processing. Processing of materials through hybridization to achieve desired surface integrity and surface quality. Emerging trends in Material processing: introduction to RPT and macro-micro-nano manufacturing.

Laboratory

Orientation to Non-conventional machine; Exposure to EDM/WEDM/EB, quantifications of process parameters and their effects; Exposure to Laser with relevant experiments to quantities its effect on materials for different operations. Hybridization of processes, solid/liquid (US/AJ/WJ) impact erosion studies. Manufacturing using CHM/PCM for manufacturing of micro components. Exposure to high precision measuring instruments, e.g. Roughness: contact/noncontact type, Sample preparation for micro structural and hardness studies etc., Promoting innovations through hands on experimentations & Audio-video studies.

Text/Reference Books:

1. Mishra P.K., *Nonconventional Machining*, Narosa Publishers.
2. Ghosh A., and Mallik A.K., *Manufacturing Science*, East-West Press.
3. Benedict G.F., *Nontraditional Manufacturing Processes*, CRC Press.
4. Jain V.K., *Advanced Machining Processes*, Tata Mc-Graw Hill.
5. McGeough J., *Micromachining of Engineering Materials*, Marcel Dekker, Inc.

Subject Code: ME 6L152	**Name: Applied Elasticity**	**L-T-P: 3-1-0**	**Credit: 4**

Pre-Requisite: None

Introduction: Elasticity, Stress, Components of stress and strain, Hook's Law, Index notation.
Plane Stress and Plane Strain: Stress and strain at a point, Differential equations of equilibrium, Boundary conditions, Stress function.

Two-dimensional problems in Rectangular Coordinates: Solution by Polynomials; End effects. Saint Venant's Principle; Determination of Displacements; Bending of Cantilever Loaded at the End; Bending of Beam by Uniform Load; Other cases of Continuously Loaded Beams.

Two-dimensional problems in Polar Coordinates: General Equations, Stress Distribution Symmetrical about an Axis, Pure Bending of Curved Bars, Strain Components, Rotating Disks etc.

General Theorems, Torsion, Bending of Bars, Axisymmetric Stress and Deformation in a Solid of Revolution

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)

Subject Code: ME6L005	**Subject: Tribology**	**L-T-P: 3-0-0**	**Credit: 3**

Prerequisite(s): None

Introduction: Economic aspects, lubrication of bearings, friction control and wear prevention. Properties and testing of lubricants. Mechanics of fluid flow - Reynolds equation and its limitations.
Idealized bearings : Infinitely long plane pivoted shoe and fixed shoe sliders, Infinitely long journal bearings, Infinitely short (narrow) bearings, Lightly loaded infinitely long journal bearing (Petroffs' solution).
Finite bearings: Approximate analytical solution, Numerical solution and Electrical analogy method. Hydrostatic oil bearing: Thrust and journal bearings, Squeeze film bearings, Gas-lubricated bearings: Hydrodynamic bearings, Hydrostatic bearings, Porous bearings, Elasto-hydrodynamic lubrication, Fluid inertia and turbulence and hydrodynamic instability, Friction and wear of metals.

Recommended Books:

1. *Tribology* – Hutchings (Asterix)
2. *Tribology: Lubrication, Friction and Wear* - I. V. Kragelsky and V. V. Alisin (John Wiley & Sons)
3. *Fundamentals of Tribology* - R. Gohar and H. Rahnejat (World Scientific Publishing Co.pvt Ltd)
4. *A Tribology Casebook* -J. D. Summers-smith (John Wiley & Sons)
5. *Tribology of Interface Layers* - HooshangHeshmat (CRC Press)
6. *Principles of Tribology* - Shizhu Wen and Ping Huang(John Wiley & Sons)

Subject Code: ME6L007	Subject: Engineering Design Optimization	L-T-P: 3-0-0	Credit: 3

Prerequisite(s): None

Basic concepts: Unconstrained and constrained problems. The Kuln-Tucker conditions; Function of one variable; Polynomial approximations, Golden section method. Finding the bounds on the solution, a general strategy for minimizing functions of one variable; Unconstrained functions of n variables : Zero-order, first-order and second order methods, convergence criteria; constrained functions of n variables: linear programming, Sequential unconstrained minimization techniques, Direct methods; Approximation techniques; Duality; General design applications.

Recommended Books:

1. *Optimization for Engineering Design*: Algorithms and Examples- Deb Kalyanmoy (PHI)
2. *Introduction to Engineering Design Optimization*- ChinyereOkechiOnwubiko (Prentice Hall)
3. *Engineering Optimization*: Theory and Practice- S. S. Rao (Wiley)
4. *Optimization Concepts and Applications in Engineering*-Ashok D. Belegundu and Tirupathi R. Chandrupatla(Cambridge Univ)
5. *Engineering Optimization*: methods and applications- A. Ravindran , K. M. Ragsdell, G. V. Reklaitis (Wiley)

Subject Code: ME6L008	Subject: Sensing and Actuation	L-T-P: 3-0-0	Credit: 3

Prerequisite(s): None

Sensing Principle: Introduction to Sensing Static and Dynamics Characteristics of Sensors; Motion and Dimensional Sensors; Force, Torque, and Power Sensors; Pressure and Sound Sensors; Fluid Flow Sensors; Temperature Sensors.

Electrical Actuators: Introduction to Electro-Magnetic Principle; Classification of Electrical Actuators; DC Motors and Modeling; DC Motor Drivers; AC Motors and Modeling; AC Motor Drivers; Stepper Motors and Modeling; Stepper Motor Drivers.

Hydraulic and Pneumatic Actuators: Description of Fluid Behavior; Hydraulic Actuator and System; Pneumatic Actuator and System, Sensors and Actuators Design

Recommended Books:

1. *Theory and Design for Mechanical Measurements* - Richard S. Figliola, Donald E. Beasley (John Wiley & Sons)

Subject Code: ME6L009	Subject Name: Engineering Measurements	L-T-P: 3-1-0	Credit: 4

Pre-Requisite(s): None

Principles of Measurement: Static characteristics and accuracy in the steady state, Generalized model, Measurement errors and error reduction techniques, Dynamic characteristics, Loading effects and noise, Transfer function, TiMEnd frequency responses, Dynamic errors and compensation, Random signals and effects of noise and interference, Noise sources and reduction methods, Economics of measurement systems: Reliability, Selection of measurement systems, Operating cost; Measurement System Design: Sensing elements: resistive, capacitive, inductive,

electromagnetic and other sensing elements, Signal conditioning and processing elements: deflection bridges, amplifiers, AC carrier systems, current transmitters, oscillators and resonators, A/D conversion, sampling, quantization and encoding, Data Acquisition, Multiplexing, Data acquisition system, digital signal analysis; Specialized Measurement Systems: Principles of flow, optical and ultrasonic measurement systems, Heat transfer effects and particle size analysis.

Text/Reference Books:

1. Figliola R.S., and Beasley D.E., *Theory and Design for Mechanical Measurements*, John Wiley & Sons.
2. Beckwith T.G., Marangoni R.D., and Lienhard J.H., *Mechanical Measurements*, Pearson.
3. Nakra B.C., and Chaudhry K.K., *Instrumentation: Measurement and Analysis*, Tata Mcgraw-hill Education Private Ltd.

Subject Code: ME6L010	**Subject: Operations Management**	**L-T-P: 3-0-0**	**Credit: 3**
Prerequisite(s):	**None**		

Productivity, Competitiveness, Operations strategy, Production system, Facility Location, Facility layout, product and services, Process planning, Process Capability, Statistical Process control, Quality control tools, Acceptance Sampling Plans and selection, Taguchi Techniques, Product Reliability, ISO 9000, ISO 14000, Inventory control, Project Management, Decision Analysis, Work measurement, Resource Planning.

Recommended Books:

1. *Operations management* -Russel& Taylor (Wiley India)
2. *Operations management* - Krajewski, Ritzman, Malhotra (Pearson Prenctice Hall)
3. *Operations management* - Heizer, Render (Pearson Education)
4. *Operations Management* – Stevenson (McGraw Hill)
5. *Operations Management* - Chase and Aquilano (Tata McGraw Hill)

Subject Code: ME6L011	**Subject: Finite Element Methods in Engineering**	**L–T–P : 3–1–0**	**Credits: 4**
Prerequisites: None			

Introduction. Integral Formulations and Variational Methods.

FE Analysis of One-dimensional problems. Second-Ordesr boundary value problems; Bending of Beams; FE Error Analysis; Eigenvalue and Time-Dependent Problems; Numerical Integration and Computer Implementation.

FE Analysis of Two-Dimensional Problems. Single-Variable Problems; Interpolation Functions, Numerical Integration and Modeling; Plane Elasticity; Flows of Viscous Incompressible Fluids; Bending of Elastic Plates; Computer Implementation.

FE Analysis of Three-Dimensional and Nonlinear Problems.

Text/Reference Books:

1. Reddy J.N., *An Introduction to the Finite Element Method*, McGraw Hill.
2. Reddy J.N., *An Introduction to Nonlinear Finite Element Method*, Oxford University Press.
3. Cook R.D., *Concepts and Applications of Finite Element Analysis,* Willey.
4. Zienkiewicz O.C., *The Finite Element Method: Its Basis & Fundamental,* Elsevier.
5. Rao, *The Finite Element Method in Engineering*, Elsevier.
6. Dixit U.S., *Finite Element Methods for Engineers*, Cengage Publications.
7. Chandrupatla T.R., *Introduction to Finite Elements in Engineering*, PHI.

Subject Code: ME6L012	Subject: Acoustics	L-T-P: 3-0-0	Credit: 3
Prerequisite(s): None			

Fundamentals of vibration, vibrations of continuous systems (strings, rods, beams and membranes), one dimensional wave equation, initial values and boundary conditions, acoustic wave equation, concept of impedance, sound radiation from simple sources, near field and far field, directivity of sources, sound waves in pipes standing waves and travelling waves, resonances, wave guides, lumped parameter modeling of acoustic systems, transmission of sound through partitions, dynamics of microphones and speakers, room acoustics, sound in enclosures (cylinders).

Recommended Books:

1. *Fundamentals of Acoustics* - Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens, James V. Sanders, Wiley, 1999.
2. *Fundamentals of Physical Acoustics* - David T. Blackstock, Wiley; 4th edition (December 30, 1999)
3. *Sound and Structural Vibration* - Frank J. Fahy, Elsevier India Pvt. Ltd, New Delhi, 2010.
4. *Sound And Structural Vibration*: Radiation, Transmission And Response - Frank J. Fahy, Paolo Gardonio, Academic Press, 2007.
5. *Handbook of Acoustics* - Malcolm J. Crocker, Wiley-Interscience, 1998.

Subject Code: ME6L013	Subject: Robotics and Automation	L-T-P: 3-0-0	Credit: 3
Prerequisite(s): None			

Introduction to robots, Internal and external sensors, actuators: hydraulic, pneumatic and electric actuators, programming of robots. Homogeneous transformations, D-H parameter notation, direct & inverse kinematics of manipulators: examples of kinematics of some common manipulator configurations. Jacobian, dynamics of manipulators: L-E formulation, N-E formulation, trajectory planning. Automation, types of automation, analysis of automated assembly systems, line balancing problems, analysis of automated material handling systems, automated storage and retrieval systems

Recommended Books:

1. *Robotics: Fundamental concepts and analysis*, A. Ghosal, Oxford university press
2. *Industrial Robotics* / Groover M P /Pearson Edu.
3. *Robotics and Control* / Mittal R K &Nagrath I J / TMH.
4. *Robotics: Control, sensing, vision and intelligence*, Fu, K., Gonzalez, R. and Lee, C. S. G McGraw Hill.
5. *Robotic Engineering* / Richard D. Klafter,
6. *Introduction to Robotics* / John J Craig / Pearson Edu. Prentice Hall
7. *Robot Dynamics & Control* – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd.
8. *Automation, Production systems and Computer Intigrated Manufacturing* – M P Groover, Prentice Hall India.

Subject Code: ME6L014	Subject Name: Introduction to Nonlinear Dynamics	L-T-P: 3-0-0	Credit: 3
Pre-Requisite(s): None			

A brief introduction to modelling

One dimensional flows: Flows on the line : Geometrical intuition, Fixed points and stability, Local stability analysis, Existence and uniqueness, Impossibility of oscillations, Potentials Solving equations on the computer, Bifurcations: Saddle-node, Normal forms, Transcritical, Pitchfork Imperfect bifurcations, Numerics (XPP-Auto), Flows on the circle: Uniform oscillator, Non-uniform oscillator

Two dimensional flows: Linear systems: Definitions and examples, Classification of linear systems, Dynamics of love affairs, Phase plane: Phase portraits, Existence, uniqueness and topological consequences, Fixed points and linearization, Example: population dynamics, Limit cycles: Ruling out closed orbits, Poincare-Bendixson theorem, Lienard systems, Weakly nonlinear oscillators, Bifurcations: Saddle-node, Transcritical and Pitchfork, Choice of bifurcation parameter, Hopf Poincare maps

Final comments: Higher-order systems, and the existence of chaos, Importance of time delays and noise

Text/Reference Books:

1. Steven Strogatz, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering by Perseus Books.
2. M Lakshmanan, Nonlinear Dynamics: Integrability, Chaos and Patterns, Springer (India) Pvt. Ltd.
3. Marco Thiel, Jürgen Kurths , M. Carmen Romano , György Károlyi , Alessandro Moura, Nonlinear Dynamics and Chaos: Advances and Perspectives (Understanding Complex Systems), Springer.

Subject Code: ME6L102	Subject Name: Computational Methods in Thermal & Fluid Engineering	L-T-P: 3-1-0	Credit: 4
Pre-Requisite(s):	**None**		

A brief overview of the basic conservation equations for fluid flow and heat transfer, classification of partial differential equations and pertinent physical behaviour, parabolic, elliptic and hyperbolic equations, role of characteristics. Common methods of discretization: an overview of finite difference, finite element 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: general concepts of elimination and iterative methods, Gaussian elimination, LU decomposition, tri-diagonal matrix algorithm, Jacobi and Gauss-Seidel iterations, necessary and sufficient conditions for convergence of iterative schemes.The finite volume method of discretization for diffusion problems: one-dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization. Discretization of transient one-dimensional diffusion problems. Discretization for multi-dimensional diffusion problems. Solution of discretized equations using point and line iterations, strongly implicit methods and pre-conditioned conjugate gradient methods.
Convection-diffusion problems: Central difference, upwind, exponential, hybrid and power-law schemes, concept of false diffusion.Numerical solution of the Navier-Stokes system for

incompressible flows: stream-function vorticity and artificial compressibility methods, requirement of a staggered grid. SIMPLE, SIMPLEC and SIMPLER algorithms.Special topics: phase-change problems, interface/free-surface tracking methods.

Recommended Books:

1. Numerical Heat Transfer and Fluid Flow1ed, 2004 - Suhas V. Patankar, - Taylor and Francis
2. Introduction to Computational Fluid Dynamics: The Finite Volume Method 2ed, 2008 - H. K. Versteeg and W. Malalasekera – Pearson
3. Computational Fluid Dynamics1ed, 1995 - D. A. Anderson Jr - McGraw-Hill
4. Computational Fluid Mechanics and Heat Transfer - John C. Tannehill, Dale A. Anderson and Richrad H. Pletcher - Taylor and Francis Group, 1997
5. Introduction to Computational Fluid Dynamics 2005 - Anil W. Date, Cambridge University Press
6. Computational Fluid Flow and Heat Transfer2ed, 2009 - K. Muralidhar and T. Sundararajan - Narosa
7. Numerical Solution of Partial Differential Equations: Finite Difference Methods3ed, 1986 - G. D. Smith - Oxford University Press

Subject Code: ME6L113	**Name: Spectral Methods for Engineering & Scientific Computing Applications**	**L-T-P: 3-0-0**	**Credit: 3**
Pre-Requisite(s):			

Introduction: What are Spectral methods? Basic ideas, survey of applications. Fundamentals: Projection, Fourier Galerkin, and Spectral Convergence. Interpolation, Fourier Collocation. Approximation of Derivatives. Aliasing error, convergence of interpolation and collocation. Variable coefficients and nonlinear problems (mode coupling, aliasing, aliasing removal, filtering). Sturm-Liouville problems, polynomial truncation and interpolation. Spectral approximations: CG, Collocation, tau, Penalty, DG. Elliptic problems, Laplacian Solver, Poisson solver. Advection-diffusion problems, CG approximation. Solving Laplace/Poisson Equation on a Square using Spectral Approximations: Fourier, CG etc. Hyperbolic conservation laws, DG approximation, Euler gas dynamics equations. Solutions for Advection-Diffusion Problems using CG Approximation. Advection-Diffusion and Compressible Navier-Stokes, DG approximation. Solution of Advection-Diffusion Equation using DG Approximation. Introduction to Spectral Element Method: CG and DG Spectral elements in 1D. CG and DG in 2/3D on structured meshes. Spectral Element Methods on unstructured meshes. Issues and approaches for solution of general problems.

Text/Reference Books:

1. D.A. Kopriva, *Implementing Spectral Methods: Algorithms for Scientists and Engineers*, Springer, 2009.
2. C. Canuto, M.Y. Hussaini, A. Quarteroni and T.A. Zang, *Spectral Methods: Fundamentals in Single Domains*, Springer 2007.
3. C. Canuto, M.Y. Hussaini, A. Quarteroni and T.A. Zang, *Spectral Methods: Evolution to Complex Geometries and Applications to Fluid Dynamics*, Springer 2010.

Subject Code: ME6L114	**Subject: Solar Energy**	**L – T – P : 3 –0 – 0**	**Credits: 3**
Prerequisites: Fluid Mechanics, Heat Transfer			

Introduction to energy systems, Review of renewable energy sources, Solar Hot Water system – construction of a solar hot water system, Fundamentals of solar – solar radiation, structure of the

Sun PV panels, modules, arrays and characteristics – physics of the solar cell, types of solar cells, PV solar panel, Solar modules, Solar arrays, Photovoltaic system construction and MPP tracking – standalone system, grid – tied system, sizing a solar system, Inverters – true sine wave, modified sine wave, Battery types – characteristics, limitation, installation, sizing.

Text/Reference Books:

1. S P Sukhatme and J K Nayak, *Solar Energy*, McGraw Hill Education (India) Private Limited, 3rd edition.
2. G N Tiwari, *Solar Energy: Fundamentals*, Design, Modelling and Application (Revised Edition), Narosa Publishing House Pvt. Ltd.

Subject Code: CS6L001	**Subject: Computational Intelligence**	**L-T-P: 3-0-0**	**Credit: 3**
Prerequisite(s):	**Introduction to Programing and Data Structures**		

Soft Computing: Artificial Neural Network: Artificial neuron, single layer and multilayer architecture, nonlinear function like sigmoid function, back propagation learning algorithm. Functional link artificial neural network, trigonometric, Chebyshev and Legendre polynomial. Readial basis function neural network, its learning algorithm, recurrent neural network and its learning algorithm; Fuzzy Logic: Types of fuzzy logic, membership functions, fuzzification and defuzzification, rule-based fuzzy inference engine, Type-1 and Type-2 fuzzy logic, typical applications; Evolutionary Computing and Swarm Intelligence: Derivative based and derivative free optimization, multivariable and multiconstraint optimization. Genetic algorithm and its variants, Differential evolution and its variants, particle swarm optimization and its variants, Cat swarm optimization, bacterial foraging optimization, Artificial immune system, multiobjective optimization like NSGA-II.

Recommended Books:

1. S. Haykin, *'Neural Networks and Learning Machines', Prentice Hall, 2009.*
2. Y.H. Pao, *'Adaptive pattern recognition and neural networks', Addison-Wesley, 1989.*
3. Jang, J.S.R., Sun, C.T. and Mizutani, E., *'Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence', Prentice Hall, 2009.*
4. Hagan, M., *'Neural Network Design', Nelson Candad, 2008.*
5. K.A.D. Jong*, 'Evolutionary Computation – A Unified Approach', PHI Learning, 2009.*
6. *Research publications that will be suggested during the course.*

Subject Code: ID6LXXX	Subject: Data Analytics	L – T – P : 3 –0 – 0	Credits: 3
Prerequisites: None			

The syllabus spans the development of data analytics in the fields of statistics, management science, data mining, and machine learning. The subject will involve hands-on experience with statistical software packages, Sources, modes of availability, inaccuracies, and uses of data, Descriptive Statistics; Visualization; and Data Similarity and Dissimilarity, Cleaning for Missing and Noisy Data; Data Reduction – Discrete Wavelet Transform, Principal Component Analysis, Partial Least Square Method, Attribute Subset Selection; and Data Transformation and Discretization, Probability Density Functions; Inferential Statistics through Hypothesis Tests, Predictive Analysis (Regression and Correlation, Logistic Regression, In-Sample and Out-of-Sample Predictions), Prescriptive Analytics (Optimization and Simulation with Multiple Objectives); Concepts of Support and Confidence; Frequent Itemset Mining Methods; Pattern Evaluation, Decision Trees – Attribute Selection Measures and Tree Pruning; Bayesian and Rule-based Classification; Model Evaluation and Selection; Cross-Validation; Classification Accuracy; Bayesian Belief Networks; Classification by Backpropagation; and Support Vector Machine, Partitioning Methods – k-means Hierarchical Methods and Hierarchical Clustering Using Feature Trees; Probabilistic Hierarchical Clustering; Introduction to Density-, Grid-, and Fuzzy and Probabilistic Model-based Clustering Methods; and Evaluation of Clustering Methods., Ridge Regression; Lasso Regression; and k-Nearest Neighbours, Regression and Classification, Bias-Variance Dichotomy, Linear and Quadratic Discriminant Analysis, Classification and Regression Trees, Ensemble Methods: Random Forest, Neural Networks, Deep Learning.

Text/Reference Books:

1. Han, J., M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, Elsevier, Amsterdam. Textbook.
2. James, G., D. Witten, T. Hastie, and R. Tibshirani, An Introduction to Statistical learning with Application to R, Springer, New York.
3. Jank, W., Business Analytics for Managers, Springer, New York.
4. Williams, G., Data mining with Rattle and R: The Art of Excavating Data for Knowledge Discovery, Springer, New York.
5. Witten, I. H., E. Frank, and M. A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann.
6. Wolfgang, J., Business Analytics for Managers, Springer.
7. Montgomery, D. C., and G. C. Runger, Applied Statistics and Probability for Engineers. John Wiley & Sons.
8. Samueli G., N. R. Patel, and P. C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, New York.
9. Hastie, T., R. T. Jerome, and H. Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer.
10. Bishop C., Pattern Recognition and Machine Learning, Springer.
11. Tan, P., M. Steinbach, and V. Kumar, Introduction to Data Mining, Addison-Wesley.

Subject Code: ME6L120	Name: Applications of Linear Algebra in Mechanical Engineering	L-T-P: 3-0-0	Credit: 3
Pre-Requisite(s):			

Key Ideas of Linear Algebra, Differential Eqns. and Difference Eqns., Solving a Linear System, Eigenvalues and Positive Definite matrix, Springs and Masses, Oscillation, Finite Differences in Time, Least Squares, Graphs and Networks, Kirchhoff's Current Law, Trusses, Finite Elements in 1D, Quadratic/Cubic Elements, Element Matrices; 4th Order Bending Equations, Boundary Conditions, Splines, Gradient, Divergence, Gradient and Divergence, Laplace's Equation, Finite Elements in 2D, Fast Poisson Solver, Fourier Series, Discrete Fourier Series, Fast Fourier Transform, Convolution, Filtering, Fourier Integral Transform, Convolution Equations: Deconvolution, Sampling Theorem.

Text/Reference Books:

1. G. Strang, *Introduction to Linear Algebra*. 4th ed. Wellesley, MA: Wellesley-Cambridge Press.
2. Michael Woolfson & Malcolm S. Woolfson, *Mathematics for Physics,* Oxford Univ. Press.

Subject Code: ME6L121	Name: Structural Health Monitoring	L-T-P: 3-0-0	Credit: 3
Pre-requisite: None			

Introduction to Structural Health Monitoring (SHM), Types of Sensor System and its application. Data acquisition system. Various Techniques for SHM. Global and local techniques. Computational and Experimental aspect of global dynamic technique. Smart Material and its application for SHM. Piezo-electric material and its application as sensor, actuator and transducer. Electro-mechanical Impedance (EMI) Technique for SHM, its basic principle, application and limitation. Low cost adaptations of EMI technique. Fatigue life assessment using EMI Technique. Integration of global technique and EMI Technique and their validations.

Reference:

1. C.K. Soh, Y.W. Yang and S. Bhalla (eds.), Smart Material in Structural Health Monitoring, Control and Bio-Mechanics, Springer.
2. D.J. Ewins, Modal Testing: Theory, Practices and Applications, Wiley-Blackwell.

Subject Code: ME6L060	Name: Artificial Intelligence & Neuro-Fuzzy Systems	L-T-P: 3-1-0	Credit: 4
Pre-requisite: None			

Machine Intelligence Technologies: Neural Networks ; Introduction to Neural Networks; Perception Learning Rule; Hebbian Learning; Widrow-Hoff Learning; Backpropagation; Associative Learning; Competitive Networks; Grossberg Networks and Adaptive Resonance Theory; Hopfield Networks, Fuzzy Set Theory: Introduction to Fuzzy Set with Properties; Fuzzy Relations; Fuzzy Arithmetic; Fuzzy Logic; Applications and Fuzzy Control Genetic Algorithm: Introduction to Genetic Algorithm; GA Operations; Standard Method; Rank Method; Rank Space Method Simulated Annealing: Introduction to Annealing Process; Simulated Annealing Optimization Particle Swarm Optimization: Introduction to Swarm Behavior; Particle Swarm Optimization Artificial Intelligence: Introduction to Artificial Intelligence; Semantic Nets

and Description Matching ;Generate and Test, Means-Ends Analysis, and Problem Reduction; Nets, Basic Search, and Optimal Search; Trees and Adversarial Search; Rules and Rule Chaining; Planning.

Recommended Books:

1. Artificial Intelligence: A Modern Approach by Stuart Russell, Peter Norvig (Prentice Hall)
2. Probabilistic Robotics (Intelligent Robotics & Autonomous Agents Series) - Sebastian Thrun (MIT Press)

Subject Code: ME6L053	**Subject: Industrial Noise Control**	**L-T-P: 3-0-0**	**Credit: 3**
Prerequisite(s): None			

Nature of air borne and structure-borne sound; source path receiver concept; various mechanisms of the generation of radiation of sound; propagation of sound; noise reduction by sound absorption or dissipation, isolation and damping of structure borne sound; general methods of noise control; applications to specific machines; principles of flow acoustics and application thereof to I.C. engines, fans and compressors.

Recommended Books:

1. *Noise Control: From Concept to Application* - Colin Hansen, CRC Press, 2005.
2. *Noise and Vibration Control Engineering: Principles and Applications* - Leo L. Beranek, István L. Vér, Wiley-Interscience, 1992.
3. *Handbook of Acoustic*s, Malcolm J. Crocker, Wiley-Interscience, 1998.
4. *Industrial Noise Control: Fundamentals and Applications* - L. H. Bell, D. H. Bell, CRC Press, 1993.
5. *Industrial noise and vibration control* - J. David Irwin, Edward R. Graf, Prentice-Hall, 1979.

Subject Code: ME6L056	**Subject: Experimental Stress Analysis**	**L-T-P: 3-0-0**	**Credit: 3**
Prerequisite(s): None			

Basic elasticity theory. Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits, transducer applications, recording instruments for static and dynamic applications. Photoelasticity: Theory of photoelasticity, Analysis techniques, Three dimensional photoelasticity, Reflection Palanscope and application. Brittle coating methods of strain indication. Moire Method of strain analysis. Grid method of strain analysis. Computer interfacing and on-line monitoring of strain and stress fields.

Recommended Books:

1. *Modern Experimental Stress Analysis: Completing The Solution Of Partially Specified Problems* - James F. Doyle (Willey)
2. *Experimental Stress Analysis* - James W. Dally, William F. Riley (College House Enterprises)
3. *Experimental Stress Analysis* - U C Jindal (Pearson)
4. *Advanced strength and applied stress analysis*- Richard Gordon Budynas (McGraw Hill)

Subject Code: ME6L057	Subject: Theory of Composite Materials	L-T-P: 3-0-0	Credit: 3
Prerequisite(s): None			

Basic concepts of three dimensional stresses and strains, Introduction to composite materials, Processes and characteristics, Macromechanical and micromechanical behavior of a lamina, Macromechanical and micromechanical behavior of a laminate, Hygrothermal effects, Bending, buckling and vibration of laminated plates, shells and panels, Experimental methods for characterization and testing of composite materials.

Recommended Books:

1. *Mechanics of Composite Materials* – R. M. Jones (Taylor & Francis)
2. *Engineering Mechanics of Composite Materials* – I. M. Daniel and O. Ishai (Oxford University Press)
3. *Practical Analysis of Composite laminates* – J. N. Reddy and A. Miravete (CRC Press)
4. *Mechanics of laminated plates and shells* – J. N. Reddy (CRC Press)
5. *Introduction to Composite Materials Design*- Ever J. Barbero(CRC Press)
6. *Composite Materials: Science and Engineering* - Krishan K. Chawla (Springer)

Subject Code: ME6L058	Subject: Experimental Modal Analysis	L-T-P: 3-0-0	Credit: 3
Prerequisite(s): None			

Overview of vibration, Modal testing, Experimental Modal theory, Excitation techniques (Shaker and Hammer) Transducer and calibration, Digital signal processing for experimental modal analysis Modal parameter extraction, Validation of extracted modal parameters, Model updating, Structural Dynamic modification, Practical discussion and case studies.

Recommended Books:

1. *Modal Testing, Theory, Practice, and Application* - D.J. Ewins(Mechanical Engineering Research Studies: Engineering Dynamics Series)
2. *Theoretical and Experimental Modal Analysis* - Maia N M M(Mechanical Engineering Research Studies. Engineering Control Series, 9)
3. Modal Analysis - Zhi-Fang Fu , Jimin He (Butterworth-Heinemann, publisher)

Subject Code: ME6L062	Subject: MEMS & Microsystems Technology	L-T-P: 3-0-0	Credit: 3
Prerequisite(s): None			

Introduction to MEMS & MST. Scaling Laws and demand in miniaturization. Working principles of Micro Sensors, Actuators and applications in real systems. Microsystems mechanisms & precision using flexures, design considerations, modeling and innovations. Materials selection, Micro Fabrication. Microfluidics, Chemical Sensors, Biomedical & Bio-MEMS, and Lab-on-a-chip.

System Integration and Packaging.

Recommended Books:

1. Tai-Ran Hsu, "*MEMS & MICROSYSTEMS Design and Manufacture*", *Tata McGraw Hill Education Pvt. Ltd.*
2. Marc Madou, "*Fundamentals of Microfabrication: The Science of Miniaturization*", *Vol. I, II, & III, CRC Press. 2012*
3. Stephen D. Senturia, "*Microsystems Design*", *Springer, 2006.*

Subject Code: ME6L063	**Subject: Reverse Engineering**	**L – T – P : 3 –0 – 0**	**Credits: 3**
Prerequisites: None			

Forward Engineering Design, Design Thought and Process, Design Steps, System RE, RE Methodology, RE Steps, System level Design, and Examples, Product Development, Product Functions, Engineering Specifications, Product Architecture, Mechanical RE, Computer-Aided RE, Electronic RE, Identify electronic components, PCB RE, Schematic Drawings and Analysis, S/W RE, Reverse Engineering in Computer Applications, Re-engineering of PLC programs etc.

Course references:

1. Product Design: Techniques in Reverse Engineering and New Product Development by K. Otto and K. Wood Prentice Hall, 2001.

2. Reverse Engineering: An Industrial Perspective by Raja and Fernandes. Springer-Verlag 2008

3. Reverse Engineering in Computer Applications. MIT Lecture Notes 2001

4. RE as necessary phase by rapid product development by Sokovic and Kopac. Journal of Materials Processing Technology 2005

5. A Rapid Prototyping Methodology for Reverse Engineering of Legacy Electronic Systems by Deno, Landis, Hulina, and Sanjay IEEE International Workshop on Rapid System Prototyping, 1999.

Subject Code: ID6LXXX	**Subject: Design and Analysis of Experiments**	**L-T-P: 3-0-0**	**Credit: 3**
Prerequisite(s): None			

Introduction to Designed Experiments: Strategy of experimentation, Typical applications, Basic principles and guidelines for designing experiments, Basic statistical concepts: Descriptive Statistics, Sampling and Sampling Distributions, Tests of Hypotheses, Single factor experiments with Fixed Effects: ANOVA, Model Adequacy Tests, Orthogonal Contrasts, Experiments with Blocking Factors: Randomised Complete and Incomplete Block Designs, Latin Squares Design , Factorial Experiments: 22,, 32, and 2k Designs, Blocking and Confounding, and Fractional Factorial Designs , Linear Regression Models: Estimation of Parameters, Tests of Hypothesis, Regression Model Diagnostics, Response Surface Design: Method of Steepest Ascent, Second-Order Response Surface, Experimental Designs, Computer Models, Mixture Experiments, Evolutionary Operations, Advanced Design of Experiments: Random Effects Models, Analysis of Covariance, Non-Normal

Response, and Taguchi Methods.

Recommended Books:

1. Design and Analysis of Experiments, D. C. Montgomery, John Wiley & Sons, Wiley Student Edition, International Student Version, 7th Edition.
2. Experimental Design: From User Studies to Psychophysics, D. W. Cunningham and C. Wallraven, CRC Press.
3. Design of Experiments: An Introduction Based on Linear Models, M. Morris, Chapman & Hall/CRC Texts in Statistical Science, First Edition.
4. Experiments: Planning, Analysis, and Optimization C. F. J. Wu and M. S. Hamada, Wiley Series in Probability and Statistics, Wiley.
5. Statistics for Experimenters: Design, Innovation, and Discovery, G. E. P. Box, J. S. Hunter, and W. G. Hunter, Wiley, 2nd Edition.
6. Practical Guide to Designed Experiments: A Unified Approach, P. D. Funkenbusch, CRC Press.
7. Statistical Design and Analysis of Experiments, with Applications to Engineering and Science, R. L. Mason, R. F. Gunst, and J. L. Hess, Wiley Interscience, Second Edition.
8. Design and Analysis of Experiments A. M. Dean and D. Voss, Springer Texts in Statistics, Second Edition.
9. The Theory of the Design of Experiments, D. R. Cox and N. Reid, Chapman and Hall/CRC.
10. Statistical Design and Analysis of Experiments, P. W. M. John, (Classics in Applied Mathematics No 22), Society for Industrial and Applied Mathematics.

Subject Code: ME6L171	**Name: Mathematical methods for Mechanical Engineers**	**L-T-P: 3-0-0**	**Credit: 3**
Pre-Requisite(s):			

Initial Value Problems, Wave Equation, Heat Equation, Convection Equation, Conservation Laws, Navier-Stokes Equation, Finite Difference Methods: Accuracy and Stability, Lax Equivalence Theorem: CFL and Von Neumann Conditions, Fourier Analysis: Diffusion, Dissipation, Dispersion, Separation of Variables and Spectral Methods.

Solution of Large Linear Systems , Finite Differences, Finite Elements, Optimization, Direct Methods: Reordering by Minimum Degree, Iterative Methods and Preconditioning , Simple Iteration (Jacobi, Gauss-Seidel, Incomplete LU), Krylov Methods: Arnoldi Orthogonalization, Conjugate Gradients and GMRES, Multigrid Methods, Inverse Problems and Regularization

Text/Reference Books:

1. G. Strang, *Introduction to Linear Algebra*. 4th ed. Wellesley, MA: Wellesley-Cambridge Press.
2. Michael Woolfson & Malcolm S. Woolfson, *Mathematics for Physics,* Oxford Univ. Press.

Subject Code: ME6P002	Name: Experimental Techniques for Mechanical Engineers	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

- Determination of Impact strength of different material by using Charpy & Izod test.
- Hardness measurement in Rockwell, Vicker's and Brinell hardness testing machine.
- Finding shear modulus, angle of twist of material in Torsion testing machine.
- Determination of Endurance limit or fatigue strength of material by using rotary bending machine.
- Evaluation of spring stiffness by using spring compression testing machine.
- Study of buckling behaviour of different columns.
- To perform the pick and place operation by using Five-Axis robotic manipulator.
- To analyse the gait generation of a hexapod robot.
- To perform the path following on a wheeled robot.
- Machining of a profile /contour using CNC router and part programing.
- Welding of two MS sheet using fibre Laser.
- Study of stress field pattern using Photo-elastic demonstration unit
- To compare theoretical value and experimental values of gyroscopic couple and to determine the relation between gyroscopic couple, angle of precession, angular velocity and MI.
- To determine Whirling speed of shaft theoretically and experimentally.
- Find out different sand characteristics used for sand casting (GFN, permeability no etc.)
- Use of Pressure, Temperature, Strain, Vibration and Sound sensors, the respective data acquisition and processing

Subject Code: ME6P003	Name: Mechanical Systems Simulation Laboratory-II	L-T-P: 0-0-3	Credit: 2

Prerequisite(s): None

Application of various numerical methods in engineering using MATLAB/Mathematica/Simulink. Methods include writing solvers for systems of linear and nonlinear algebraic equations, ordinary and partial differential equations, finding roots of polynomials, finding eigenvalues, introduction to engineering software like SOLIDWORKS, ADAMS, ANSYS, FLUENT using both GUI and script like languages.