Semester I						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CH 102	Fundamental concepts and applications of chemistry	3	0	0	6
2	MA 109	Calculus I (1st Half)	3	1	0	4
3	MA 121	Calculus II (2nd Half)	3	1	0	4
4	PH 101	Quantum Physics and Applications	2	1	0	6
5	BB 103	Introduction to Modern Biology	2	1	0	6
6	CS 103	Introduction to Programming - 1 (Using C) (1st Half)	3	0	2	4
7	EE 103	Introduction to Programming - 2 (Using Python) (2nd Half)	3	0	2	4
8	PH 113	Hands on Science Laboratory - I	0	0	3	3
9	HS 103	Introduction to Fine Arts				PP/NP
10	HS 106	Design Thinking and Creativity				PP/NP
11	NO 101/ NO 103	National Sports Organization (NSO)/National Service Scheme (NSS)				PP/NP
		Total Credits				**37**

1	**Title of the course** (L-T-P-C)	**Fundamental Concepts &Applications of Chemistry** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Organic and Inorganic (Inorganic): a. Harness the power of periodic table** Periodic properties: trends in size, electron affinity, ionization potential and electronegativity • Role of chemical elements in water contamination • Hardness of water • Desalination of brackish and sea water • Role of silicon in semiconducting applications • metal atom (Cu, Au, Pt, Pd etc.) based nanoparticles **b. Coordination complexes** Transition metal chemistry: inorganic complexes, bonding theories, magnetism, bonding aspects and structural distortion **(Organic): a. M.O. theory and π-conjugated compounds** Molecular orbitals of common functional groups, Qualitative Huckel MOs of conjugated polyenes and benzene. Aromaticity. Configuration, molecular chirality and isomerism, Conformation of alkanes and cycloalkanes **b. Polymers** Types and classification of polymers • polymerization techniques • Structure-property relationships of polymers • Conducting polymers **Physical Chemistry:** **a. Quantum chemistry** Schrodinger equation, Origin of quantization, Born interpretation of wave function, Hydrogen atom: solution to □-part, Atomic orbitals, many electron atoms and spin orbitals. Chemical bonding: MO theory: LCAO molecular orbitals, Structure, bonding and energy levels of diatomic molecules. Concept of sp, sp^2 and sp^3 hybridization; Bonding and shape of many atom molecules; Intermolecular Forces; Potential energy Surfaces-Rates of reactions; Steady state approximation and its applications; Concept of pre-equilibrium; Equilibrium and related thermodynamic quantities **b. Electrochemistry** Electrochemical cells and Galvanic cells • EMF of a cell Single electrode potential • Nernst equation • Electrochemical series • Types of electrodes • Reference electrodes • Batteries • Modern batteries • Fuel cells • corrosion
4	**Texts/References**	1. J. D. Lee, "Concise Inorganic chemistry" 5th Edition. Wiley India. Ed. 2. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, "Inorganic Chemistry: Principles of structure and reactivity" 4th Edition, Person. 3. P. Atkins, J. de Paula, "physical chemistry" 5th Edition, Oxford. 4. J. Clayden, N. Greeves, S. Warren, "Organic chemistry" 2th Edition, Oxford. 5. George Odian, Principles of polymerization, 4th edition, Wiley student edition, Wiley India Pvt Ltd. 6. F. W. Billmeyer, Text book of Polymer Science, 3rd edition, Wiley student edition, Wiley India Pvt Ltd. 7. A. K. De, Environmental Chemistry, 8th edition, New Age International publishers. 8. B. K. Sharma, Environmental Chemistry, 16th edition, Krishna Prakashan Media Pvt Ltd. 9. A. R. West, Solid State Chemistry and Its Applications, Wiley student edition, Wiley India Pvt Ltd. 10. T. Pradeep, Nano: The essentials, McGraw-Hill Education publishers. 11. Geoffrey A Ozin and André Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, 2nd edition, RSC publishing.

1	**Title of the course** (L-T-P-C)	**Calculus I** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Review of limits, continuity, differentiability. Mean value theorem, Taylor's Theorem, Maxima and Minima. Riemann integrals, Fundamental theorem of Calculus, Improper integrals, applications to area, volume. Convergence of sequences and series, power series.
4	**Texts/References**	1. B. V. Limaye and S. Ghorpade, A Course in Calculus and Real Analysis, Springer International Publishing (2004) 2. James Stewart, Calculus (5th Edition), Thomson Brooks/Cole (2003) 3. T. M. Apostol, Calculus, Volume 1, Wiley Eastern (1980)

1	**Title of the course** (L-T-P-C)	**Calculus II** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Calculus I
3	**Course content**	Partial Derivatives, gradient and directional derivatives, Chain rule, Maxima and Minima, Lagrange multipliers. Double and Triple integration, Jacobians and change of variables formula. Parametrization of Curves and Surfaces, Vector fields, Line and Surface integrals. Divergence and Curl, Theorems of Green, Gauss, and Stokes.
4	**Texts/References**	1. B.V. Limaye and S. Ghorpade, A Course in Multivariable Calculus and Real Analysis, Springer International Publishing (2010) 2. James Stewart, Calculus (5th Edition), Thomson Brooks/Cole (2003) 3. T. M. Apostol, Calculus, Volume 2, Wiley Eastern (1980) 4. Marsden and Tromba, Vector calculus (First Indian Edition), Springer (2012)

1	**Title of the course** (L-T-P-C)	**Quantum Physics and Applications** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	• Quantum nature of light: Photoelectric Effect and Compton Effect. • Stability of atoms and Bohr`s rules. • Wave particle duality: De Broglie wavelength, Group and Phase velocity, Uncertainty Principle, Double Slit Experiment. • Schrödinger Equation. • Physical interpretation of Wave Function, Elementary Idea of Operators, Eigen-value Problem. • Solution of Schrödinger equation for simple boundary value problems. • Reflection and Transmission Coefficients. Tunneling. • Particle in a three dimensional box, Degenerate states. • Exposure to Harmonic Oscillator and Hydrogen Atom without deriving the general solution. • Quantum Statistics: Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics by detailed balance arguments. • Density of states. • Applications of B-E statistics: Lasers. Bose-Einstein Condensation. • Applications of F-D statistics: Free electron model of electrons in metals. Concept of Fermi Energy. • Elementary Ideas of Band Theory of Solids. • Exposure to Semiconductors, Superconductors, Quantum Communication and Quantum Computing.
4	**Texts/References**	1. Quantum Physics: R. Eisberg and R. Resnick, John Wiley 2002, 2nd Edition. 2. Introduction to Modern Physics: F. K. Richtmyer, E. H. Kennard and J.N. Cooper, Tata Mac Graw Hill 1976, 6th Edition. 3. Modern Physics: K. S. Krane, John Wiley 1998, 2nd Edition. 4. Introduction to Modern Physics: Mani and Mehta, East-West Press Pvt. Ltd. New Delhi 2000. 5. Elements of Modern Physics: S. H. Patil, Tata McGraw Hill, 1984. 6. Concepts of Modern Physics, A Beiser, Tata McGraw Hill, 2009.

1	**Title of the course** (L-T-P-C)	**Introduction to Modern Biology** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Quantitative views of modern biology. Importance of illustrations and building quantitative/qualitative models. Role of estimates. Cell size and shape. Temporal scales. Relative time in Biology. Key model systems – a glimpse. Management and transformation of energy in cells. Mathematical view – binding, gene expression and osmotic pressure as examples. Metabolism. Cell communication. Genetics. Eukaryotic genomes. Genetic basis of development. Evolution and diversity. Systems biology and illustrative examples of applications of Engineering in Biology.
4	**Texts/References**	Campbell Biology 12th edition, Pearson publication by Lisa Urry,Michael Cain,Steven Wassserman

1	**Title of the course** (L-T-P-C)	**Introduction to Programming – 1** **(3-0-2-4)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	This course provides an introduction to problem solving with computers using C Topics covered will include: **Utilization**:Developer fundamentals such as editor, integrated programming environment, Unix shell, modules, libraries. **Programming features**: Machine representation, data types, arrays and records, objects, expressions, control statements, iteration, procedures, functions and recursion, Pointers, Structures and basic I/O. **Applications**: Sample problems in engineering, science, text processing, and numerical methods.
4	**Texts/References**	The C Programming Language Brian W Kernighan, Dennis M Ritchie, Prentice Hall India , 2nd edition, 1988 Programming with C (Second Edition) Byron Gottfried, Schaum's Outlines Series, Tata-Mcgraw Hill, 2011 How to Solve It by Computer, by G. Dromey, Prentice- Hall, Inc., Upper Saddle River, NJ, 1982. How to Solve _It (2nd ed.), by Polya, G., Doubleday and co, 1957. Let Us C, by Yashwant Kanetkar, Allied Publishers, 1998.

1	**Title of the course** (L-T-P-C)	**Introduction to Programming-2** **(3-0-2-4)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	This is a continuation of the CS101 (first half semester) course. In the first half semester, the students are introduced to basic programming. This course (second half semester) provides an introduction to problem solving with computers using python language. Topics covered will include: Basic python programming: variables, expression and statements, Functions, conditional and recursions, iterations, strings, lists/NumPy and dictionaries. Other topics: Introduction to object oriented programming, classes and objects in python, polymorphisms, introduction to different libraries in python. Applications: Sample problems in engineering, data pre- processing, and plotting tools.
4	**Texts/References**	1.Python Programming: An Introduction to Computer Science, 3rd edition by John M. Zelle, Franklin, Beedle and Associates. 2.Think Python: How to Think Like a Computer Scientist, 2nd edition, by Allen B. Downey, O'Reilly, 2015.

1	**Title of the course** (L-T-P-C)	**Introduction to Fine Arts: Urban Dance in India: A Brief & Partial Introduction in Theory & Practice**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Body and Movement, Classical Dance in India, Contemporaneity: Modern & Postmodern Forms & Modes of Sustenance for a Dancer, Experimenting, Making Your Own Dance Work (Dance-pieces)
4	**Texts/References**	--

1	**Title of the course** (L-T-P-C)	**Design thinking and Creativity** **(1-0-0-0)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	1.Problem Exploration- Students move around and find problems that need solutions. 2.They analyse the problem (not solution) and evolve a problem space. The problem space is converted into a story boar and presented in a poster session. 3.Feedback at the poster session is used to refine the problem definition(s). 4.Solution Exploration: Creative solutions (solution space) are now explored and presented using story boards. 5.The solutions are converted into "embodiments"
4	**Texts/References**	1."Stuff Matters" Prof. Mark Miodownik, Penguin 2. "Design and Technology" by James Garratt, Cambridge University Press. 3. How it works in the home: Walt Disney :9780894340482- Amazon.com. 4.How it works in the City (Walt Disney available on Amazon.com) 5.Change by design – Tim Brown There are some additional books in this "How it Works" series.

Semester II						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MA 102	Linear Algebra (1st Half)	3	1	0	4
2	MA 103	Differential Equations - I (2nd Half)	3	1	0	4
3	ME 111	Engineering Graphics Laboratory	1	0	3	5
4	EE 101	Introduction to Electrical Systems and Electronics	3	0	0	6
5	CS 106	Data Structures and Algorithms	3	0	0	6
6	CS 111	Data Structures and Algorithms Laboratory	0	0	3	3
7	ME 113	Hands on Engineering Laboratory	0	0	3	3
8	ME 202	Engineering Materials	2	1	0	6
9	NO 102/ NO 104	National Sports Organization (NSO)/National Service Scheme (NSS)				PP/NP
		Total Credits				**37**

1	**Title of the course** (L-T-P-C)	**Linear Algebra** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Vectors in R^n, notion of linear independence and dependence, linear span of a set of vectors, vector subspaces of R^n, basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants. Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product spaces, Gram-Schmidt process, orthonormal bases, projections and least squares approximation. Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, hermitian, symmetric, skew-symmetric, normal). Algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to quadratic forms.
4	**Texts/References**	1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995). 2. G. Strang, Linear algebra and its applications (4th Edition), Thomson (2006) 3. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000) 4. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999)

1	**Title of the course** (L-T-P-C)	**Differential Equations -I** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Exact equations, integrating factors and Bernoulli equations. Orthogonal trajectories. Lipschitz condition, Picard's theorem, examples on non-uniqueness. Linear differential equations generalities. Linear dependence and Wronskians. Dimensionality of space of solutions, Abel-Liouville formula. Linear ODE's with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters. Laplace transform generalities. Shifting theorems. Convolution theorem.
4	**Texts/References**	1. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999) 2. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)

1	**Title of the course** (L-T-P-C)	**Engineering Graphics Lab** **(1-0-3-5)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Engineering Graphics with mini-drafter: Around half a semester and bit more with following topics to be covered. • Introduction to Engineering Graphics • Curves • Projections of Points • Projection of Lines • Projection of Planes • Projections on Auxiliary Planes • Projections of Solids • Sections of Solids • Intersections of Solids Engineering Graphics with 2D Drafting Software: 5 weekly computer laboratory sessions covering above using AutoCAD® as a drafting software, 5th session on Isometric Projections.
4	**Texts/References**	1. N. D. Bhatt, revised and enlarged by V. M. Panchal and P. R. Ingle, Engineering Drawing, 53rd Edition, 2014, Charotar Publishers, Anand. 2. Warren J. Luzadder and Jon M. Duff, Fundamentals of Engineering Drawing, Prentice-Hall of India. 3. Gopalakrishna K. R., Engineering Drawing Vol. I & II Combined., Subhas Stores, 25th Edition, 2017. 4. Narayana. K. L., and Kannaiah, P. E., Text Book on Engineering Drawing, 2nd Edition, 2013, Scitech Publications, Chennai. 5. Venugopal K. and Prabhu Raja V., Engineering Drawing + AutoCAD, New Age International Publishers, 5th Edition, 2011.

1	**Title of the course** (L-T-P-C)	**Introduction to Electrical Systems and Electronics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Calculus
3	**Course content**	**From Physics to Electrical Engineering** (a) Lumped matter discipline (b) Batteries, resistors, current sources and basic laws (c) I-V characteristics and modeling physical systems **Basic Circuit Analysis Methods** (a) KCL and KVL, voltage and current dividers (b) Parallel and serial resistive circuits (c) More complicated circuits (d) Dependent sources, and the node method (e) Superposition principle (f) Thevenin and Norton method of solving linear circuits (g) Circuits involving diode. **Analysis of Non-linear Circuits** (a) Toy example of non-linear circuit and its analysis (b) Incremental analysis (c) Introduction to MOSFET Amplifiers (d) Large and small signal analysis of MOSFETs (e) MOSFET as a switch **Introduction to the Digital World** (a) Voltage level and static discipline (b) Boolean logic and combinational gates (c) MOSFET devices and the S Model (d) MOSFET as a switch; revisited (e) The SR model of MOSFETs (f) Non-linearities: A snapshot **Capacitors and Inductors** (a) Behavior of capacitors, inductors and its linearity (b) Basic RC and RLC circuits (c) Modeling MOSFET anomalies using capacitors (d) RLC circuit and its analysis (e) Sinusoidal steady state analysis (f) Introduction to passive filters **Operational Amplifier Abstraction** (a) Introduction to Operational Amplifier (b) Analysis of Operational amplifier circuits (c) Op-Amp as active filters (d) Introduction to active filter design **Transformers and Motors** (a) AC Power circuit analysis (b) Polyphase circuits (c) Introduction to transformers (d) Introduction to motors
4	**Texts/References**	1. Anant Agarwal and Jefferey H. Lang, “Foundations of Analog and Digital Electronics Circuits,” Morgan Kaufmann publishers, 2005 2. Wlilliam H. Hayt, Jr., Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuit Analysis,” Tata McGraw-Hill 3. Theodore Wildi, “Electrical Machines, Drives and Power Systems,” Pearson, 6-th edition. 4. V. Del. Toro, “Electrical Engineering Fundamentals,” Pearson publications, 2nd edition.

1	**Title of the course** (L-T-P-C)	**Data Structures and Algorithms** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Computer Programming
3	**Course content**	Introduction: data structures, abstract data types,analysis of algorithms. Creation and manipulation of data structures: arrays,lists, stacks, queues, trees, heaps, hash tables, balanced trees, tries, graphs. Algorithms for sorting and searching, order statistics, depth-first and breadth-first search, shortest paths and minimum spanning tree.
4	**Texts/References**	1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Pressand McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T. Goodrich, Roberto Tamassia, and David M. Mount,Wiley, 2004.

1	**Title of the course** (L-T-P-C)	**Data Structures and Algorithms Laboratory** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Exposure to Computer Programming (CS 102)
3	**Course content**	Laboratory course for CS 211 is based on creatingand manipulating various data structures and implementation of algorithms.
4	**Texts/References**	1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Press and McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T.Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004.

1	**Title of the course** (L-T-P-C)	**Engineering Materials** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Economic, Environmental and Societal Issues in Materials Science & Engineering • Basic Materials Science: Crystallography, phase diagrams, • grain boundaries, dislocation movements and their effects on • Properties • Material properties: Stress-strain relationships, Tensile • strength, Toughness, Impact Strength, Ductility, Malleability, • Stress intensity, Fatigue • Failure: by Oxidation, Corrosion (Types, impact on material • Strengthening mechanisms: Solute Hardening, chemical hardening, dispersion hardening, Aluminium alloys: Properties, phase diagrams and uses • Copper alloys: Properties phase diagrams and uses • Ferrous Alloys (Steels): Types, properties, iron-carbon • phase diagrams • Material Selection: Ashby Charts • Ceramics: Structure and Properties, Mechanical Properties • of Ceramics, Types and Application of Ceramics, Fabrication • and Processing of Ceramics • Polymers: Molecules, Structures and Shapes, Thermosetting • & Thermoplastic, Polymer Crystals, Polymer Characteristics • and Applications, Synthesis, Processing and Degradation. • Composites: Processing of Fiber Reinforced Composites, • Structural Composites, Application of Compositescold working, strain Hardening
4	**Texts/References**	TEXTBOOKS 1.W.D. Callister, Jr. & D.G. Rethwisch: 'Materials science and Engineering: An Introduction', 9th Ed., John Wiley (2014) 2.W.F.Smith and J.Hashemi: 'Foundations of Materials Science and Engineering', 5th Ed., McGraw-Hill(2009). REFERENCES 1.D.R.Askeland, P.P.Phule& W.J. Wright: 'The Science and Engineering of Materials' 7th Ed., Cengage Learning(2014). 2.V.Raghavan: Materials Science and Engineering: A First Course' 6th Ed. PHI(2015). 3.J.F. Shackeford: 'An Introduction to Materials Science for engineers' 8th Ed., Pearson (2016). 4.R.A.Higgins: 'Properties of Engineering Materials' 2nd Ed., Industrial Press (1994). 5. T.Fishcher: 'Materials Science for Engineering Students', Academics Press (2009). 6. V.Raghavan: 'Physical Metallurgy: Principles and Practice' 3rd Ed., PHI (2015)

Semester III						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME 207	Thermodynamics	2	1	0	6
2	ME 203	Fluid Mechanics	3	0	0	6
3	ME 201	Engineering Mechanics	2	1	0	6
4	ME 204	Manufacturing Processes - I	3	0	0	6
5	ME 205	Machine Drawing and 3D Modelling Laboratory	1	0	2	3
6	EE 221	Introduction to Probability (1st Half)	3	0	0	3
7	ME 212	Manufacturing processes and Metrology Laboratory	0	0	3	3
8	HS 201	Economics	3	0	0	6
		Total Credits				**39**

1	**Title of the course** (L-T-P-C)	**Thermodynamics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Thermodynamic Systems, properties & state, process &cycle **Heat & Work**: Definition of work and its identification, work done at the moving boundary, Zeroth law, **Properties of pure substance**: Phase equilibrium, independent properties, and equations of state, compressibility factor, Tables of thermodynamic properties & their use, Mollier Diagram **First law**: First law for control mass & control volume for a cycle as well as for a change of state, internal energy & enthalpy, Specific heats; internal energy, enthalpy & specific heat of ideal gases. SS process, Transient processes. **Second Law of Thermodynamics**: Reversible process; heat engine, heat pump, refrigerator; Kelvin-Planck & Clausius statements ,Carnot cycle for pure substance & ideal gas, Concept of entropy; the Need of entropy definition of entropy; entropy of a pure substance; entropy change of a reversible & irreversible processes; principle of increase of entropy, thermodynamic property relation, corollaries of second law, Second law for control volume; SS & Transient processes; Reversible SSSF process; principle of increase of entropy, Understanding efficiency. **Irreversibility and availability**: Available energy, reversible work & irreversibility for control mass and control volume processes; second law efficiency. **Thermodynamic relations**: Clapeyron equation, Maxwell relations, Thermodynamic relation for enthalpy, internal energy, and entropy, expansively and compressibility factor, equation of state, generalizedchart for enthalpy. **Thermodynamic Cycles**: Otto, Diesel, Duel and Joule Third Law of Thermodynamics
4	**Texts/References**	1. Sonntag R., Claus B. & V. Wylen G, Fundamentals of Thermodynamics, John Wiley, 2000. 2. G Rogers, YR Mayhew, Engineering Thermodynamics Work and Heat Transfer, Pearson 2003 3. J.P Howell, P.O. Bulkins, Fundamentals of Engineering Thermodynamics, McGraw Hill,1987 4. Y Cengal, M A Boles, Thermodynamics: An Engineering Approach, Tata McGraw Hill, 2003. 5. Michael J. & H.N. Shapiro, Fundaments of Engineering Thermodynamics, John Wiley, 2004.

1	**Title of the course** (L-T-P-C)	**Fluid Mechanics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction :Scope, definition of fluid as continuum, fluid properties.(2hr) Fluid Statics: Pressure at a point, basic equation for pressure field, pressure variation(fluid at rest):standard atmosphere, Measurement of pressure manometer,Hydrostatics force on a plane and curve surface, Buoyancy, flotation and stability, pressure variation in a fluid with rigid body motion linear motion, rigid body rotation(4hr) Elementary Fluid Dynamics: Statics, stagnation pressure, Bernoulli Equation assumptions(4hr) Fluid Kinematics The velocity filed : Eulerian and Largrangian flow descriptions, steady and deformation, Acceleration field: material derivative, unsteady and convective effects. Control volume and system representation : Reynolds' Transport Theorem, physical interpretation, steady, unsteady effects, moving control volume, potential function(6Hr) Integral approach Conservation of mass derivation of continuity, fixed, non-deforming control volume, moving non-deforming control volume, deforming control volume. Conservation of momentum: linear momentum and moment of momentum equation and their application., comparison of energy equation with Bernoulli's equation(6hr) Differential approach : linear motion and angular motion with deformation, Conservation of mass: differential form of continuity equation, stream function, Conservation of linear momentum, Inviscid flows, Irrotational flow(6hr) Viscous flow : Stress relationships,NS Equations, Simple solutions for viscous flows(4hr) Dimensional analysis Buckingham's II-theorem,Dimensionless groups & their importance (3hr) Viscous Flow in Pipes : General characteristics of pipe flow, fully developed laminar and turbulent flow, turbulent shear stress, turbulent velocity profile, Pipe Flow rate measurement.(4hr) Boundary layer: Boundary layer characteristics boundary layer structure and thickness on a plate, Blasius boundary layer, momentum integral boundary layer equation for a flat plate(4hr)
4	**Texts/References**	1.Yunus A. Cengel, John M. Cimbala, Fluid Mechanics, Tata McGraw Hill Education,2011 2.F.M.White Fluid Mechanics, Seventh Edition, Tata McGraw Hill Education,2011, 3.Kundu,Pijush K., and Ira M.Cohen.Fluid Mechanic, Elsevier,2001

1	**Title of the course** (L-T-P-C)	**Engineering Mechanics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Module 1:** Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy **Module 2:** Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; **Module 3:** Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines; **Module 4:** Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia-Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook; **Module 5:** Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. Module 6: Particles dynamics- Kinematics of Particles: Rectilinear motion, Plane curvilinear motion - rectangular coordinates, normal and tangential coordinates, polar coordinates, Space curvilinear - cylindrical, spherical (coordinates), Relative and Constrained motion. Kinetics of Particles: Force, mass and acceleration – rectilinear and curvilinear motion, work and energy, impulse and momentum – linear and angular; Impact – Direct and Oblique. Kinetics of System of Particles: Generalized Newton's Second Law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum Module 7: Introduction to Rigid body dynamics Kinematics of Planar Rigid Bodies: Equations for rotation of a rigid body about a fixed axis, General plane motion, Instantaneous Center of Rotation in Plane Motion Plane Motion of a Particle Relative to a Rotating Frame. Coriolis Acceleration Kinetics of Planar Rigid Bodies: Equations of Motion for a Rigid Body, Angular Momentum of a Rigid Body in Plane Motion, Plane Motion of a Rigid Body and D'Alembert's Principle, Systems of Rigid Bodies, Constrained Plane Motion; Energy and Work of Forces Acting on a Rigid Body, Kinetic Energy of a Rigid Body in Plane Motion, Systems of Rigid Bodies, Conservation of Energy, Plane Motion of a Rigid Body - Impulse and Momentum, Systems of Rigid Bodies, Conservation of Angular Momentum. Module 8: Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums
4	**Texts/References**	**Textbooks:** 1. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 6th Ed, John Wiley, 2008. 2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, 9th Ed, Tata McGraw Hill, 2011. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 2006.

		References: 1. S. P. Timoshenko and D. H. Young, Engineering Mechanics. Fourth Edition. McGraw-Hill, New York, 1956. 2. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002. 3. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Dynamics – Computational Edition, 1st Ed., Cengage Learning, 2007 4. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Statics-Computational Edition, 1st Ed., ,Cengage Learning, 2007

1	**Title of the course** (L-T-P-C)	**Manufacturing Process I** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Exposure to Mechanical Measurements
3	**Course content**	**Casting processes**: dispensable and permanent mould processes; analysis of melting, pouring and solidification phenomena; design of pattern, core, feeder and gating system; casting defects and inspection. **Joining processes**: fusion and solid-state welding; brazing and soldering; weld joint design, cooling rate, and joint properties; welding defects and inspection. **Bulk and Sheet Forming processes**: rolling, forging, extrusion and drawing; sheet metal working; forming limit diagram; loads, friction and lubrication; forming defects and inspection. **Powder processing**: Powder manufacture, characterization, compaction and sintering; metal injection moulding; hot and cold iso-static pressing. Polymers and Composites: Thermoplastics, thermosets, elastomers and composites; related processes; injection mould design; moulding defects and inspection. Advanced processes: Free form fabrication (rapid prototyping), and net shape manufacturing processes.
4	**Texts/References**	1. Ghosh A. and Mallick A.K., Manufacturing Science, Affiliated East West Press, 2001. 2. Rao P.N., Manufacturing Technology- Foundry, Forming and Welding, TMG Hill, 1987. Schey J., Introduction to Manufacturing Processes, Tata McGraw Hill, 2000. 3. DeGarmo E.P., Black J.T., Kohser R.A., Materials and Processes in Manufacturing, PHI, 1997. 4. Pye R.G.W., Injection Mold Design, Longman Scientific & Technical, Essex, 1989.

1	**Title of the course** (L-T-P-C)	**Machine Drawing and 3D Modelling** **(1-0-2-3)**
2	**Pre-requisite courses(s)**	Exposure to Engineering Graphics Laboratory (ME 111)
3	**Course content**	**Introduction**: Engineering design process and drawings. Drawing standards. Computer aided drafting and use of software packages for engineering drawings **Detachable Fasteners**: Screw threads: conventional representations and specifications; Threaded fasteners:Types, forms, standard, and specifications; Drawing of connections; Foundation bolts; Locking Devices: Classification, principles of operation, standard types andtheir proportions; Shaft Couplings: Common types, standard proportions for some couplings; Pipe Joints, common pipe connections **Permanent Fastenings**: Rivets: Standard forms andproportions; Riveted Joints: Common types of joints,terminology, proportions and representation; Welds:Types of welds and welded joints, edge preparation, specifications, and representation of welds on drawings **Assembly Drawings**: with sectioning and bill of materials. Assemblies involving machine elements like shafts, couplings, bearing, pulleys, gears, belts, brackets. Engine mechanisms-assembly. Detailed part drawings from assembly drawings **Tool Drawings**: Jigs and fixtures **Production Drawings**: Limits, fits, and tolerances of size and form; Types and grade, use of tolerance tables and specification of tolerances, form and cumulative tolerances, tolerance dimensioning; Surface quality symbols, terminology and representation on drawings, correlation of tolerances and surface quality with manufacturing techniques 3D Modelling exercise: use of Reverse Engineering to disassemble and measure components
4	**Texts/References**	1. D K Cheng, "Fundamentals of Electromagnetics", Addison Wesley, MA 1993. 2. R K Shevgaonkar, "Electromagnetic Waves", McGraw- Hill Education (India) Pvt Limited, 2005 3. Hayt, William H., Jr., and John A. Buck, "Engineering Electromagnetics", 7th ed. McGraw-Hill, 2006.

1	**Title of the course** (L-T-P-C)	**Introduction to Probability** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Basic calculus
3	**Course content**	**Introduction**: Motivation for studying the course, revision of basic math required, connection between probability and length on subsets of the real line, probability-formal definition, events and σ-algebra, independence of events, and conditional probability, sequence of events, and *Borel-Cantell* Lemma. **Random Variables**: Definition of random variables, and types of random variables, CDF, PDF and its properties, random vectors and independence, brief introduction to transformation of random variables, introduction to Gaussian random vectors. **Mathematical Expectations**: Importance of averages through examples, definition of expectation, moments and conditional expectation, use of MGF, PGF and characteristic functions, variance and k-th moment, MMSE estimation. **Inequalities and Notions of convergence**: Markov, Chebychev, Chernoff and Mcdiarmid inequalities, convergence in probability, mean, and almost sure, law of large numbers and central limit theorem. **A short introduction to Random Process:** Example and formal definition, stationarity, autocorrelation, and cross correlation function, definition of ergodicity.
4	**Texts/References**	**1. Robert B. Ash**, ``Basic Probability Theory," Reprint of the John Wiley & Sons, Inc., New York, 1970 edition. **2. Sheldon Ross**, ``A first course in probability," Pearson Education India, 2002. **3. Bruce Hayek**, ``An Exploration of Random Processes for Engineers," Lecture notes, 2012. 4. D. P. Bertsekas and J. Tsitisklis, "Introduction to Probability" MIT Lecture notes, 2000 (*link*: https://www.vfu.bg/en/e-Learning/Math--Bertsekas_Tsitsiklis_Introduction_to_probability.pdf)

1	**Title of the course** (L-T-P-C)	**Manufacturing processes and Metrology laboratory** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Introduction to Communication Systems
3	**Course content**	List of experiments: Angle measurement using Sine bar Chip Thickness measurement using microscope Calibration of measuring instruments Three Wire Method Of Measuring Pitch Diameter Surface Roughness testing Manual Milling Manual Turning Welding of Al, etc. Shaping Green Sand moulding.
4	**Texts/References**	• Jerzy A. Slade Coordinate Metrology: Accuracy of Systems and Measurements ISSN2195-9862, Springer publisher • Val Marinov Manufacturing Process Design Laboratory Manual, Kendall/Hunt PublishingCompany, ISBN 1465275312, 9781465275318 • R. K. Rajput A Textbook of Manufacturing Technology: Manufacturing Processes • Ghosh and A. K. Mallik, Manufacturing Science, Affiliated East West Press, 1985. HMT,Production Technology, Tata McGraw Hill, 1980. • J. Mcgeough, Advanced Methods of Machining, Chapman and Hall, 1988.

1	**Title of the course** (L-T-P-C)	**Economics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Basic economic problems. resource constraints and Welfare maximizations. Nature of Economics: Positive and normative economics; Micro and macroeconomics, Basic concepts in economics. The role of the State in economic activity; market and government failures; New Economic Policy in India. Theory of utility and consumer's choice. Theories of demand, supply and market equilibrium. Theories of firm, production and costs. Market structures. Perfect and imperfect competition, oligopoly, monopoly. An overview of macroeconomics, measurement and determination of national income. Consumption, savings, and investments. Commercial and central banking. Relationship between money, output and prices. Inflation - causes, consequences and remedies. International trade, foreign exchange and balance payments, stabilization policies : Monetary, Fiscal and Exchange rate policies.
4	**Texts/References**	. 1. P. A. Samuelson & W. D. Nordhaus, Economics, McGraw Hill, NY, 1995. . 2. A. Koutsoyiannis, Modern Microeconomics, Macmillan, 1975. R. Pindyck and D. L. Rubinfeld, Microeconomics, Macmillan publishing company, NY, 1989. 6. R. J. Gordon, Macroeconomics 4th edition, Little Brown and Co., Boston, 1987. . 4. William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. . 5. R.S. Pindyck and D.L. Rubinfeld. Microeconomics Th (7 Edition), Pearson Prentice Hall, New Jersey, 2009. . 6. R. Dornbusch, S. Fischer, and R. Startz. Macroeconomics (9th Edition), McGraw-Hill Inc. New York, 2004.

Semester IV						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME 208	Mechanical Measurements	3	0	0	6
2	ME 206	Mechanics of Materials	2	1	0	6
3	ME 309	Theory of Machines	2	1	0	6
4	ME 220	Heat Transfer	3	0	0	6
5	MA 407	Introduction to Numerical Linear Algebra (1st Half)	3	1	0	4
6	ME 224	Fluid Mechanics Laboratory	0	0	3	3
7	EE 226	Control Systems and Laboratory	2	0	2	6
		Total Credits				**37**

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

1	**Title of the course** (L-T-P-C)	**Mechanics of Materials** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Module 1:** Basics: Fundamentals of mechanics of deformable solids. Concepts of stress and strain and their relationships. Axially loaded members - Normal stress and strain, Simple (direct) shear stress and strain, Hooke's law, Stresses on inclined planes under axial loading, thermal stresses and strains, statically indeterminate problems. Elastic strain energy under axial loads. **Module 2:** Torsion: torsion of circular cross-section shafts (Solid and hollow sections): Deformation field, Torsion formulae for stresses and angular deflection, Elastic strain energy under torsion, Closely-wound helical springs – stresses and deflections. **Module 3**: Bending: Euler – Bernoulli model: normal and shear stresses, deflections for symmetric bending. Statically indeterminate problems, Elastic strain energy under flexure. **Module 4:** Combined stresses: State of stress and strain at a point , transformation laws , Mohr's circle diagram for stress and principal stresses, thin walled structures : thin cylinders and spheres. Theories of failure: Maximum Normal-Stress theory, Maximum shear-stress theory and Maximum Distortional-energy theory. **Module 5:** Energy methods – Castigliano's theorem and its applications, fictitious-load method. Stability of structures – Buckling of idealized and elastic columns
4	**Texts/References**	**TEXTBOOKS:** 1) S.H Crandall, N.C Dahl and S.J Lardner, An Introduction to Mechanics of Solids, Tata McGraw Hill, Third Edition, 2012. 2) E.P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, 2nd edition, 2012. **REFERENCES:** 1. J. M. Gere and Goodno, Mechanics of Materials, 7th ed, Cengage Learning India, 2012. 2. J.P Den Hartog, Strength of Materials, Dover, 1949. 3. J.M Gere and S.P Timoshenko, Mechanics of Materials, CBS Publishers, 1986 4. R. C. Hibbeler, Mechanics of Materials, Pearson, 10th edition, 2016 . 5. S.P Timoshenko and D.H Young, Elements of strength of Materials, 5th ed, Affiliated East West Press, 1976. 6. F. P. Beer, E. R. Johnston Jr., John T. DeWolf , D. F. Mazurek, Mechanics of Materials, McGraw-Hill Education; 7th edition, 2014 7. M. Salvadori and R. Heller, Structure in Architecture, Prentice Hall Inc, 1963. 8. S.P Timoshenko, History of Strength of Materials, Dover, 1983. 9. M. H. Sadd, Elasticity: Theory, Applications, and Numerics, 1st ed, Elsevier India, 2006.

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

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

1	**Title of the course** (L-T-P-C)	**Introduction to Numerical Linear Algebra** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Calculus, MA 101 & Linear Algebra, MA 106
3	**Course content**	Floating point number system, Big O notation Matrix and vector norms, ill conditioned problems Solution of a system of linear equations, Gauss elimination, LU factorization, Cholesky method, Classical iterative methods: Jacobi and Gauss-Seidel Eigenvalue problems, Power method, QR method, Gershgorin theorem. Exposure to MATLAB
4	**Texts/References**	S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980

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

1	**Title of the course** (L-T-P-C)	**Control Systems and Laboratory** **(2-0-2-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• **Basic concepts:** Notion of feedback, open- and closed-loop systems. • **Modeling and representations of control systems:** Transfer function models of for suitable mechanical, electrical, thermal and pneumatic systems, Ordinary differential equations, Transfer functions, Block diagrams, Signal flow graphs, State-space representations. • **Performance and stability:** Time-domain analysis, Second-order systems, Characteristic-equation and roots, Routh-Hurwitz criteria. • **Basic modes of feedback control:** Proportional, Integral, Derivative. • **Root locus** method of design. • **Frequency-domain techniques:** Root-locus methods, Frequency responses, Bode-plots, Gain-margin and phase-margin, Nyquist plots. • **Compensator design:** Proportional, PI and PID controllers, Lead-lag compensators. • **State-space concepts:** Controllability, Observability, pole placement result, Minimal representations. Laboratory involves set of experiments following the theory component covered in the class
4	**Texts/References**	1. Norman Nise, Control System Engineering, Wiley, 6th Edition, 2011 2. K. Ogata, Modern Control Engineering, Pearson, 5th edition, 2010. 3. Gene franklin et. al., "Feedback Control of Dynamic Systems", 7th Edition, Pearson 4. B. Kuo, Automatic Control System, Wiley, 9th Edition, 2014

Semester V						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME 223	Manufacturing Processes - II	3	0	0	6
2	ME 324	Design of Machine Elements	2	1	0	6
3	ME 302	Applied Thermodynamics	3	0	0	6
4	ME 314	Heat Transfer Laboratory	0	0	3	3
5	ME 218	Solid Mechanics Laboratory	0	0	3	3
6	ME 311	Mechanical Measurements Laboratory	0	0	3	3
7	EE 227	Data Analysis (2nd Half)	3	0	0	3
8		Elective 1	3	0	0	6
		Total Credits				**36**

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

1	**Title of the course** (L-T-P-C)	**Design of Machine Elements** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Fundamentals of Mechanical Engineering Design**: Mechanical engineering design, Phases of design process, Design considerations, Engineering Materials and their Mechanical properties, Standards and Codes, Factor of safety, Material selection, Static Stresses: Static loads. Normal, Bending, Shear and Combined stresses, Stress concentration factor **Design for Impact and Fatigue Loads**: Impact stress, Fatigue failure: Endurance limit, S-N Diagram, Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman & Soderberg relationship, cumulative fatigue damage.Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links **Threaded Fasteners & Power Screws:** Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static loads, eccentrically loaded bolted joints, types of power screws, efficiency & self-locking, design of power screw, screw jack: (complete design) **Riveted Joints & Weld Joints:** Rivet types, rivet materials, failures of riveted joints, efficiency, boiler joints, Lozanze joints, riveted brackets, eccentrically loaded joints, types of welded joints, strength of butt, fillet welds, Welded brackets with transverse & parallel fillet welds, eccentrically loaded welded joints **Design of Shafts, Joints, Couplings and Keys:** Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads. Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling, Design of Cotter and Knuckle joints, Design of keys- square, saddle, flat and feather **Mechanical Springs & Flexible mechanical Elements:** Types of springs, spring materials, stresses in helical coil springs of circular & non-circular cross sections. Tension & compression springs, concentric springs; springs under fluctuating loads Belts: Materials of construction of flat & V belts, power rating of belts,concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition, Selection of flat & V belts, length & cross section from manufacturers' catalogues. Construction & application of timing belts, Wire ropes: Construction of wire ropes, stresses, selection of wire ropes. Chain drive: Types of power transmission chains, modes of failure for chain, & lubrication of chains **Gear drives, Clutches & Brakes:** Classification of gears, materials for gears, standard systems of gear tooth, gear tooth failure modes and lubrication of gears, Spur Gears, Design of Clutches, Design of Brakes **Bearing Design:** Lubricants, their properties, bearing materials, properties; mechanisms of lubrication, hydrodynamic lubrication, Numerical examples on hydrodynamic journal & thrust bearing design, static, dynamic load carrying capacities, equivalent bearing load, load life relationship; probability of survival
4	**Texts/References**	**TEXTBOOKS:** 1. **Mechanical Engineering Design**, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition, 2009. 1. **REFERENCES: Machine Design, Robert L. Norton, Pearson Education Asia, 2001.** **DATA HANDBOOK: Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Ed.

1	**Title of the course** (L-T-P-C)	**Applied Thermodynamics** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction to the Course, General Scheme of things, Energy Resources, Heat Engines. Recap of I law for Closed and Open Systems. Classification of cycles as Open/Closed, Refrigeration/Power, Multi-component/ Single- component, Internal combustion/ external combustion, etc. Performance parameters: Network, thermal efficiency, heat rate, specific fuel consumption, work ratio, specific output, mean effective pressure, volumetric efficiency, COP, refrigeration effect. Carnot vs. other cycles. General stoichiometry and definition of terms (rich mixture, lean mixtures). Heat of formation, Heat of reaction, Calorific Value of fuel, Estimation methods for Calorific values, Exhaust Gas Analysis, Orsat Apparatus. Otto Cycles, Diesel Cycles, Air-standard cycles and Actual cycles, Dual cycle, p-theta diagram. Combustion and knocking in SI engine. Combustion and knocking in CI engine. Carburetion. Brayton cycle with explanation of various terms Modifications of Brayton cycle. Rankine cycle. Modifications to Rankine cycle. Feed Water Heaters and analysis. Moisture separators/ application of Rankine to Nuclear power plants. Vapour Compression and Reverse Brayton Cycles Vapour Absorption Cycles. Psychrometry. Reciprocating, rotary and centrifugal Compressors. Gas Power Cycles: Simple gas turbine cycle - single and twin shaft arrangements, intercooling, reheating, regeneration, closed cycles, optimal performance of various cycles, Ideal vs Real cycles; Jet Propulsion: turbojet, turboprop, turbofan, ramjet, thrust and propulsive efficiency; Rocket Propulsion; Direct Energy Conversion: thermionic and thermoelectric converters, photovoltaic generators, MHD generators, fuel cells.
4	**Texts/References**	1. Moran M. J. and H. N. Shapiro., Fundamentals of Engineering Thermodynamics, Third Edition, Wiley, New York, 1995. 2. Cengel Y. A. and Boles M. A., Thermodynamics: An Engineering Approach, McGraw Hill, 3rd Ed., 1998 3. Dossat R. J. and Horan T. J., Principles of Refrigeration, Pearson Education, 4th Indian Reprint, 2004. 4. Arora C. P., Refrigeration and Air-conditioning, Tata McGraw Hill, 2nd Ed., 2003. 5. H I H Saravana muttoo, G F C Rogers and H. Cohen, Gas Turbine Theory 4e, Pearson, 2003

1	**Title of the course** (L-T-P-C)	**Heat Transfer lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	1. Measurement of thermal conductivity of a composite material 2. Measurement of convective heat transfer coefficient 3. Transient heat conduction 4. Heat transfer through fins 5. Jet impinging 6. Boiling and Condensation 7. Critical heat flux measurement 8. Emissivity measurement 9. Heat flux meter calibration 10. Heat transfer in the tubular heat exchanger 11. Heat transfer by radiation
4	**Texts/References**	1. Incropera F. P. and Dewitt D. P., Fundamentals of Heat and Mass Transfer, 5th Ed., Wiley and Sons, New York, 2002. 2. Gayler J. F. W. and C. R Shotbolt, Metrology for Engineers, ELBS, 1990.

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

1	**Title of the course** (L-T-P-C)	**Mechanical Measurements Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Exposure to Mechanical Measurements
3	**Course content**	**List of experiments:** • Study of the output characteristics of RC circuit for various inputs (Sine wave, square wave and step input) • Study of the output characteristics of LRC circuit for various inputs (Sine wave, square wave and step input) • Study of the working of orificemeter, venturimenter and rotameter • Steady state and transient calibration of temperature sensors (thermocouple and RTD) • Steady state and transient calibration of pressure sensors • Measurement of rotational speed by encoder, infrared sensor and stroboscope • Measurement of stress/strain through strain gage rosettes • Utility of operational amplifiers for generation of square wave, differentiator and integrator Study of Analog to digital converter and digital to analog converter
4	**Texts/References**	1. E.O. Doebelin, Measurement systems: Application and Design, Fourth Ed., 1990, McGrawHill. 2. Richard S. Figliola, Donald E. Beasley, Theory and Design for Mechanical Measurements, John Wiley and Sons.

1	**Title of the course** (L-T-P-C)	**Data Analysis** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	The role of statistics. Graphical and numerical methods for describing and summarising data. Probability. Population distributions. Sampling variability and sampling distributions. Estimation using a single sample. Hypothesis testing a single sample. Comparing two populations or treatments. Simple linear regression and correlation. Case studies.
4	**Texts/References**	1. Introduction to Probability and Statistics for Engineers and Scientists by Sheldon M. Ross, Elsevier, New Delhi, 3rd edition (Indian), 2014. 2. Probability, Random Variables and Stochastic processes by Papoulis and Pillai, 4th Edition, Tata McGraw Hill, 2002. 3. An Introduction to Probability Theory and Its Applications, Vol. 1, William Feller, 3rd edition, Wiley International, 1968.

Semester VI						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CE 301	Environmental Studies	3	0	0	6
2	ME 313	Kinematics and Dynamics of Machinery Laboratory	0	0	3	3
3	ME 411	Manufacturing processes Laboratory	0	0	3	3
4	ME 328	Applied Thermodynamics Laboratory	0	0	3	3
5	MA 406	Introduction to Numerical Methods (1st Half)	3	1	0	4
6		Elective Course from Physics Department	3	0	0	6
7		Elective 2	3	0	0	6
8		Elective 3	3	0	0	6
		Total Credits				**37**

1	**Title of the course** (L-T-P-C)	**Environmental studies** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Module A: Natural Resources, Ecosystems, Biodiversity and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity Module B: Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems. Module C: Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes. Module D: Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes. Module E: Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues Module F: Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development and the Environment Module G: Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution. Module H: Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues.
4	**Texts/References**	1) Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi. 2) Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi. 3) Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers. 4) Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi. 5) Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology. 6)Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana. 7) Review articles from literature

1	**Title of the course** (L-T-P-C)	**Kinematics and Dynamics of Machinery lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Fabrication or model demonstration of ● Lower and Upper joins ● Multi-degree of freedom linkages with verification of Kutzback's Equation ● Inversions of 4R, 3R-P and 2R-2P four-link linkages ● Grashof Criterion ● Approximate and Exact Straight line generating mechanisms ● Pantograph Linkages ● Ackerman's steering linkage ● Geneva Mechanism ● Simple, Compound and Planetary Gear trains –Verification of velocity analysis, velocity ratio, instantaneous centers –Demonstration of inversion in synthesis of Cam profiles –Examination of geometry of involute gears in mesh –Passive Vibration Analysis; Damped response –Active Vibration Analysis; Frequency Response; Resonance –Vibration of two degree of freedom systems –Balancing of rotating masses –Balancing of reciprocating masses –Critical speed of shafts
4	**Texts/References**	1. Kinematics, Dynamics, and Design of Machinery: Edition 3 2. Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, 10 May 2016 John Wiley & Sons

1	**Title of the course** (L-T-P-C)	**Manufacturing processes laboratory** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Manufacturing processes
3	**Course content**	**List of experiments:** CNC milling programming CNC turning programming Surface Roughness testing Eccentric Turning Angle measurement using Sine bar Chip Thickness measurement using microscope Different type of drilling Shaping Green Sand moulding Casting process Solidification Study Digital Fabrication (3D printing)
4	**Texts/References**	• Val Marinov Manufacturing Process Design Laboratory Manual, Kendall/Hunt Publishing Company, ISBN 1465275312, 9781465275318 • R. K. Rajput A Textbook of Manufacturing Technology: Manufacturing Processes • Ghosh and A. K. Mallik, Manufacturing Science, Affiliated East West Press, 1985. HMT, Production Technology, Tata McGraw Hill, 1980. • J. Mcgeough, Advanced Methods of Machining, Chapman and Hall, 1988.

1	**Title of the course** (L-T-P-C)	**Introduction to Numerical Methods** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Calculus, MA101 & Linear Algebra, MA 106
3	**Course content**	Interpolation by polynomials, divided differences, error of the interpolating polynomial, piecewise linear and cubic spline interpolation. Numerical integration, composite rules, error formulae. Solution of a nonlinear equation, bisection and secant methods. Newton's method, rate of convergence, solution of a system of nonlinear equations, Numerical solution of ordinary differential equations, Euler and Runge-Kutta methods, multi-step methods, predictor-corrector methods, order of convergence, Finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations. Exposure to MATLAB
4	**Texts/References**	S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980

Semester VII						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1		Elective Course 4	3	0	0	6
2		Elective Course 5	3	0	0	6
3		Elective Course 6/ BTP	3	0	0	6
		Total Credits				**18**

Semester VIII						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1		Elective Course 7	3	0	0	6
2		Elective Course 8 / BTP	3	0	0	6
		Total Credits				**12**