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| **KERALA TECHNOLOGICAL UNIVERSITY**  http://ktu.edu.in/images/logo_final.png  **SCHEME AND SYLLABUS**  **FOR**  **M. Tech. DEGREE PROGRAMME**  **IN**  **MECHANICAL ENGINEERING**  **WITH SPECIALIZATION**  **MACHINE DESIGN**  **CLUSTER 05 (ERNAKULAM II)**  **KERALA TECHNOLOGICAL UNIVERSITY CET Campus, Thiruvananthapuram Kerala, India -695016**  **(2015 ADMISSION ONWARDS)** |

**KERALA TECHNOLOGICAL UNIVERSITY**

**SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME**

**Branch: MECHANICAL ENGINEERING**

**Specialization: MACHINE DESIGN**

**Semester 1** (Credits: 21)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
| A | 05ME 6201 | Advanced Engineering Mathematics | 3-1-0 | 40 | 60 | 3 | 4 |
| B | 05ME 6203 | Theory of Vibration | 3-1-0 | 40 | 60 | 3 | 4 |
| C | 05ME 6205 | Advanced mechanics of solids | 3-1-0 | 40 | 60 | 3 | 4 |
| D | 05ME 6207 | Finite Element Analysis | 3-0-0 | 40 | 60 | 3 | 3 |
| E | 05ME 621X | Elective-I | 3-0-0 | 40 | 60 | 3 | 3 |
|  | 05ME 6277 | Research Methodology | 0-2-0 | 100 | 0 | 0 | 2 |
|  | 05ME 6291 | Design Engineering Lab | 0-0-2 | 100 | 0 | 0 | 1 |

21

**Elective I**

|  |  |
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| 05ME 6211 | Design of power transmission elements |
| 05ME 6213 | Mechanics of Composite materials |
| 05ME 6215 | Industrial Tribology |

**Semester 2** (Credits: 21)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
| A | 05ME 6202 | Advanced Machine Design | 3-1-0 | 40 | 60 | 3 | 4 |
| B | 05ME 6204 | Optimization methods in design | 3-0-0 | 40 | 60 | 3 | 3 |
| C | 05ME 6206 | Advanced Theory of Machines | 3-0-0 | 40 | 60 | 3 | 3 |
| D | 05ME 622X | Elective-II | 3-0-0 | 40 | 60 | 3 | 3 |
| E | 05ME 623X | Elective-III | 3-0-0 | 40 | 60 | 3 | 3 |
|  | 05ME 6266 | Seminar - I | 0-0-2 | 100 | 0 | 0 | 2 |
|  | 05ME 6288 | Mini Project | 0-0-4 | 100 | 0 | 0 | 2 |
|  | 05ME 6292 | Design and Analysis Lab | 0-0-2 | 100 | 0 | 0 | 1 |

21

**Elective II**

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| 05ME 6222 | Theory of plates and shells |
| 05ME 6224 | Fracture Mechanics and design |
| 05ME 6226 | Rotor Dynamics |

**Elective III**

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| 05ME 6232 | Computer Applications in design |
| 05ME 6234 | Oil hydraulics and pneumatics |
| 05ME 6236 | Acoustics and noise control |

**Semester 3** (Credits: 14)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
| A | 05ME 724X | Elective-IV | 3-0-0 | 40 | 60 | 3 | 3 |
| B | 05ME 725X | Elective-V | 3-0-0 | 40 | 60 | 3 | 3 |
|  | 05ME 7267 | Seminar - II | 0-0-2 | 100 | 0 | 0 | 2 |
|  | 05ME 7287 | Project (Phase 1) | 0-0-12 | 50 | 0 | 0 | 6 |

14

**Elective IV**

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| 05ME7241 | Design of pressure vessels and piping |
| 05ME7243 | Experimental stress analysis |
| 05ME7245 | Continuum Mechanics |

**Elective V**

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| 05ME 7251 | Mechatronics system design |
| 05ME 7253 | Design for manufacture |
| 05ME 7255 | Vibration control and condition monitoring |

**Semester 4** (Credits: 12)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
|  | 05ME 7288 | Project (Phase 2) | 0-0-21 | 70 | 30 | 0 | 12 |

12

Total: 68

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6201 | | ADVANCED ENGINEERING MATHEMATICS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   * To equip with the different methods of numerical solution of partial differential equations and its applications * To familiarize with integral equations, its formation and application. * To familiarize with methods of solution of special functions and its application to Engineering problems. * To introduce basic concepts of tensors and its applications to Continuum Mechanics  COURSE OUTCOMES: By the end of the course, the student will be able to:   * Apply the concepts of tensors to solve engineering problems. * Acquire skill to associate and develop numerical procedures to solve Design problems in terms of methods of Partial Differential Equations. * Get an exposure to advanced developments in applications of special functions, tensor calculus, methods of solution of Partial differential equations. * Acquire an ability to solve interdisciplinary level problems in Engineering | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Applications partial differential equations: Linear partial differential equation of second order – elliptic, parabolic, hyperbolic equations – solution of Laplace, one-dimensional heat & wave equations. Numerical solution of partial differential equation: Finite difference method – solution of Laplace equation – solution of one-dimensional heat equation – Crank Nicholson method, Schmidt method, Durfort – Fankel method, implicit method. | | | | 9 |
| **INTERNAL TEST 1(Module 1)** | | | | | |
| **II** | Integral equations: – solution of integral equations by (i) transform method (ii) method of successive approximations, Integro - differential equations. Partial differential equations: – The Pfaffian differential equations, parabolic, elliptic and hyperbolic equations. D‘Alembert‘s method. Canonical form, Characteristics, Green functions, Laplace equation in polar co-ordinates - solution and application | | | | 9 |
| **INTERNAL TEST 2(Module 2)** | | | | | |
| **III** | Special functions: - Beta, Gamma functions, Bessel functions-recurrence relation, generating functions, Legendre‘s equations and Legendre‘s Polynomials – recurrence relation and orthogonality property | | | | 10 |
| **IV** | Tensors:- An introduction to vector calculus (gradient, divergence, curl and Green‘s theorem, Divergence theorem, Stokes theorem) Dyads- Polyads, Nonions, forms of a Dyadic, dual vectors and tensors,Fundamental operations with Tensors – Christopher’s symbols. Tensor Calculus, Eigen values and Eigen vectors of Tensors. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Integral equations – Santhi Swarrop, Krishna Prakasan Media. 2. Higher Engineering Mathematics - Dr. B. S. Grewal – Khanna Publishers. 3. Higher Engineering Mathematics – N. V. Bali – Lekshmi Publications – New Delhi. 4. Higher Engineering Mathematics – M. K. Venkataraman – National Publishers Co. 5. Higher Engineering Mathematics- B.V. Ramana – Tata Mcgraw hill edn pvt ltd. 6. Vector, Tensors and Basic Equations of Fluid Mechanics – Rutherford Aris (Dover Publications) 7. Intro. to Tensor Calculus and Continuum Mechanics – John Henry Heinbockel, Trafford Publishing 2001 8. Advanced Engineering Mathematics – Erwin Kreyzig 9. Partial Differential Equations – Ian Sneddon 10. Introduction to Partial Differential Equations – K. Sankara Rao – Prentice Hall of India. 11. Introductory Methods of Numerical Analysis – S. S. Sastry- Prentice Hall of India. 12. Introduction to PDE – K. Sankara Rao Prentice Hall of India. 13. Schaum‘s outline of Tensor Calculus – David Kay (Schaum‘s outline series) 14. Applications of Tensor Analysis – A. J. McConnell (Dover Books on Mathematics, 2011) | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6203 | | THEORY OF VIBRATIONS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Understand the causes and effects of vibration in mechanical systems and their classification. 2. Develop schematic models for physical systems and formulate governing equations of motion. 3. Understand the role of damping, stiffness and inertia in mechanical systems 4. Calculate free and forced vibration responses of multi degree freedom systems using modal analysis  COURSE OUTCOMES:  1. Student able to solve simplified model of vibratory system with and without damping. 2. Able to find solution to vibration problem by modeling mathematically and to find out the characteristics of systems with excitation using mathematical or numerical techniques 3. Determine physical and design interpretations for a multi-degree system. 4. Discuss the use of exact and approximate methods in the analysis of complex systems. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Fundamentals of Vibration**: Basic Concepts of Vibration, Classification of Vibration, Spring, inertia and damping elements, Harmonic Motion ,  **Free Vibration of Single-Degree-of-Freedom**: Undamped Translational System, Equation of motion, natural frequency, Energy Method, Rayleigh Method, Undamped Torsional System , Free Vibration with Viscous Damping, Logarithmic decrement, Energy Dissipated in Viscous Damping, Torsional Systems with Viscous Damping, Coulomb Damping, Torsional Systems with Coulomb Damping, Free Vibration with Hysteretic Damping | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Forced Vibration**: Harmonically excited vibration Forced Vibration: equation of motion, response of undamped systems under harmonic force, response of damped systems to harmonic force,Vibration Isolation, Energy Dissipated in Damping frequency response plots, harmonic motion of the base, transmissibility. Response under general periodic force, Forced Vibration with Coulomb Damping, Forced Vibration with Hysteresis Damping, Vibration measuring instruments. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Two-Degree-of-Freedom Systems**: Equations of Motion for Forced Vibration , Free Vibration Analysis of an Undamped System, Forced-Vibration Analysis, Viberation Absorber, Vibration Damper.  **Multi Degree of Freedom System**; normal mode of vibration, flexibility matrix and stiffness matrix, eigen values and vectors, orthogonal properties-modal matrix analysis, matrix inversion method, modal damping in forced vibration, numerical methods. | 10 |
| **IV** | **Transient Vibration**: The unit impulse (Dirac Delta), Impulse response, step response, ramp response, response to arbitrary excitations, Time domain method –Convolution Integral, complete response to arbitrary excitation, response spectrum, Frequency domain method –Laplace Transforms, transfer function, general response using Laplace transformsPulse excitation and rise time, Shock response spectrum, Shock isolation | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Leonard Meirovitch, “Fundamentals of Vibrations”, McGraw Hill International, 2001. 2. S. S. Rao, “Mechanical Vibrations”, Prentice Hall, 2000. 3. W. T. Thomson, M. D. Dahleh, C. Padmanabhan, “Theory of Vibration with Applications”, Pearson Education, 2008. 4. Den Hartog, “Mechanical Vibrations”, Dover Publishers, 1985 | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6205 | | ADVANCED MECHANICS OF SOLIDS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To learn the mathematical treatment of elastic continuum. 2. To apply the theory/principles to the real world problems. 3. To understand the theories of torsion in non standard cross section beams. 4. To learn the basics of plasticity and visco-elastic behavior.  COURSE OUTCOMES:  1. Acquires the knowledge of elastic equilibrium, compatibility and constitutive conditions applied to real world 2D and 3D problems. 2. Able to apply theory and application of Torsion to real engineering problems. 3. Can solve the problems of Plates and shells and design machines considering the effects of contact stresses. 4. Can understand the plastic deformation, and create and analyze visco-elastic models. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction to Three Dimensional Theory of Elasticity**: Plane stress and Plane strain problems, Differential Equations of equilibrium, strain-displacement relations in cartesian and polar co-ordinates, Boundary conditions, Compatibility conditions, Airy’s Stress function,Bi-harmonic equation, Saint Venant’s principle, applications to Polynomials in rectangular coordinates - cantilever with point load at free end, simply supported beam with UDL – Pure bending of curved, solid disc and disc with a central hole. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Shear center:** Bending axis and shear center-shear center for axi-symmetric and un symmetrical sections.  **Unsymmetrical bending:** Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending  **Torsion:** Torsion of prismatic shafts, Warping, Semi-inverse method and Stress function method - Membrane analogy, Torsion of bars with elliptical, square and rectangular cross section, Torsion of multi celled thin wall open and closed sections | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Thin rectangular plates**: Slope and curvature - Governing differential equation, Boundary conditions - Navier solution for a rectangular plate carrying a uniformly distributed load. Membrane stresses.  **Contact stresses:** Problem of determining contact stresses, Assumptions, Expressions for principal stresses, cylindrical bodies in line contact and spherical bodies in point contact. | | | | 10 |
| **IV** | **Theory of Plasticity:** Fundamental aspects of general inelastic behaviour. Stress-strain curves –plastic flow conditions - Von Mises and Tresca criteria – plastic work – simple applications –elasto-plastic analysis for bending and torsion of bars – residual stresses.  **Introduction to Viscoelasticity:** Rheological models, Maxwell model, Kelvin model and the four-element Maxwell-Kelvin model. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Den Hartog, “Advanced Strength of Materials”, McGraw Hill, 1952. 2. S.Timoshenko & J.W.Goodier, “Theory of Elasticity”, McGraw Hill, 2007. 3. S.P.Timoshenko, “Theory of Plates & Shells”, McGraw Hill, 1958. 4. Seely and Smith, “Advanced Mechanics of Materials”, John Wiley, 1952. 5. Strength of materials / Sadhu singh/ Khanna Publishers 6. Mechanics of Materials / Beer & Jhonson / McGraw Hill 7. Kachanov.L.M., “Foundations of Theory of Plasticity”, North-Holland Publishing Co., 1971. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME 6207 | | FINITE ELEMENT ANALYSIS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Understand the basics of the structural/governing equation solution and relative merits. 2. Understand the concept of finite element method for solving machine design problems.. 3. Develop algorithms and write FE code for solving simple design problems. Apply the knowledge of FEM for static analysis, to 3D structures and understand the use of commercial packages for complex problems. 4. Apply the knowledge of FEM for dynamic structural and heat transfer problems and understand the use of commercial packages for complex problems.  COURSE OUTCOMES: The end of the course,   1. Able to solve the structural problem using approximate methods. 2. Element level formulation for 1D, 2D, and 3D structural elements. 3. Develop FE formulations and solutions involving triangular, quadrilateral elements and higher order elements. 4. Solve dynamic structural and heat transfer problems using 1D and 2D elements. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Integral Formulations And Variational Methods- weighted – integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, weighted residual approach. Variational approach, different approximate methods - Galerkin approach, Rayleigh –Ritz method etc…- applied to heat transfer.  Introduction to Finite Element Method-Basic concept, Historical background, engineering applications, general Description, comparison with other methods. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | FE formulation- Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Jacobian matrix - Numerical Integration. discretisation of the domin, node – element numbering and ordering. Error norms and convergence. External and internal equilibrium equations, element relation for 1D, 2D (CST, LST) and 3D. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Static solution: Finite element modeling using truss, beam, plate/shell,(triangular and rectangular), 3D elements (Hexa, tetra, Axi-symmetric solids subjected to Axi-symmetric loading simple problems. Solution to complex real world problems. | 10 |
| **IV** | Dynamic considerations: Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.  Transient analysis- Implicit/Explicit schemes-Newmark-beta integration scheme-Stability conditions  **Application to heat transfer problem:** one-dimensional and two-dimensional steady state problems for conduction, convection and radiation, transient problems | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Reddy J N An Introduction to finite element methods. Tata McGraw Hill, third edition, 2009 2. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Fourth Edition,Volumes 1 &2, McGraw Hill International Edition, Physics Services, 1991. 3. Cook R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons Inc., Newyork, 1989. 4. Bather K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990. 5. Chandrakant S Desai, Tribikram Kundu Introductory Finite Element Method. 6. Vince Adams, Abraham Askenazi “Building Better Products With Finite Element Analysis” 7. Y K Cheung, “Finite Element Implementation” 8. Champion, J M Ensminger, Edward R Champion, “Finite Element Analysis With Personal Computers” 9. Ian M. Smith, Vaughan Griffiths, “Programming the Finite Element Method” 10. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, “The Finite Element Method for Engineers” 11. Ivo Babuska, T Strouboulis, “The Finite Element Method and Its Reliability” | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6211 | | **DESIGNOF POWER TRANSMISSION ELEMENTS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Design and analysis of power transmission elements like chain and belt drives 2. Design and analysis of freiction drives 3. Design and analysis of gear boxes 4. Design and dynamic analysis of brakes and clutches  COURSE OUTCOMES:  1. Able to design chain, belt and friction drives 2. Able to design gear boxes for industrial applications 3. Able to design and analyze automobile brakes 4. Able to design automobile clutches | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Chain and belt drives**: Analysis, design and selection of chain drives and belt drives, Tensioning Belt, Timer belts, Sprocket design. Chordal action in Chains, Chain velocity and drive ratio, Length of chain and centre distance. Failure of the chain drives and belt drives.  **Friction drives**: Classification, theory and operation of friction drives, design considerations, including thermal aspects. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Design of speed gear boxes**, standardization of spindle speeds, speed diagrams, design of housings, lubrication considerations, Step less regulation of speed, Selection of servo and stepper motors, timing belts | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Brakes**: Disc brakes-Graphical and analytical analysis and design of self actuating brakes, fixed, link and sliding anchor drum brakes. Dynamics and thermal aspects of vehicle braking, Design of brakes for applications such as machine tools, modern automobiles, cranes, railway coaches and aircrafts. | | | | 10 |
| **IV** | **Clutches**: Friction Clutches, Centrifugal Clutches, Analysis, dynamics and thermal aspects of clutches, design of automobile clutch: single plate, multi plate, cone cluth, overrunning clutches. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**  1. Newcom and Spurr, “Braking of road vehicles”, Chapman and Hall, 1967.  2. Nieman, “Design of Machine elements – Vol. II”, Springer Verlag.  3. Reshetov, “Design of Machine elements”, Mir Publication, 1978.  4. Dobrovolksy, “Design of Machine elements”, Mir Publishers, 1977.  5. Wong, “Theory of Ground Vehicles”, Wiley, 2001. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6213 | | MECHANICS OF COMPOSITE MATERIALS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To understand the fundamentals of composite material, constituents, strength and its mechanical behavior 2. Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber. 3. Understanding the macro-mechanical analysis of laminate. 4. To understand different theories for the analysis and failure prediction of composite laminate.  COURSE OUTCOMES:  1. The student will be able to instruct the fundamental characteristics and mechanical behavior of composite materials. 2. The students will be able to do the numerical problems for finding the elastic constants of composite laminates and to apply the hooks law in 2 dimensional problems for composite lamina. 3. The students will be able to use rule of mixture for experimental characterization of composite laminate. Also able to analyze the failure of composite lamina. 4. The students will be able to use different theories for the analysis of laminates and to solve numerical problems related. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction to Composite Materials:** Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs and sandwich construction. Rule of mixture – volume and mass fractions  Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.  Experimental Characterisation of Lamina- Elastic Moduli and Strengths  **Failure Criteria:** Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations. | | | | 10 |
| **IV** | **Macro Mechanical Analysis of Laminate**: Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices  (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation)  **Text Books:**   1. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998. 2. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005. 3. MadhijitMukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004. 2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984. 3. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009. 4. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012. 5. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6215 | | INDUSTRIAL TRIBOLOGY | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  Upon completion of this course one expected to   1. bring together Industrial competencies in the field of tribology through continual improvement 2. to establish an integrated, powerful tool to support the same 3. in developing a sustainable, collective growth 4. environmentally responsible economic growth  COURSE OUTCOMES: By going through the syllabus, students must be able to understand:   1. Various properties related to motion just like friction, wear etc.. 2. Must be able to design bearings with dynamic behaviour. 3. The static condition under loading of bearing. 4. The contact behaviour of bearings while in contact. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Friction**: Types of friction - dry-boundary and fluid-laws of friction and friction theories-Variables in friction – Surface cleanliness – effect of pressure, velocity, temperature, vibration etc.  **Wear**: Classification – theories of wear - stages of wear - adhesive and abrasive wear –factors affecting wear.  **Lubrication**: Role of lubrication – Lubricants - Importance of viscosity and methods for measuring viscosity - fundamentals of viscous flow - flow through capillary tubes between parallel pates - radial flow between parallel circular plates – The continuity equation and Reynold’s equation. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Hydrodynamic bearings design**: Journal bearings - eccentricity - pressure distribution – load carrying capacity – friction and power loss – leakage factors –Sommerfield number and design charts. Oil flow and heat dissipation in bearings - Analysis of hydro thrust bearings – Fixed and pivoted shoe bearings. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Hydrostatic bearings design**: Hydrostatic lubrication , linear slider bearing, Analysis of oil pads -hydrostatic step bearings - hydrostatic thrust bearing with shoes - role of restrictors – bearing materials and lubricants. Air film lubrication, Aerostatic slide ways. | | | | 10 |
| **IV** | **Rolling element bearings design**: Types - bearings theory - static and dynamic capacities - bearing life – selection of bearings –Ball and roller bearing design- lubrication and mounting of bearings. Bearing failures. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Radzimovsky, “Theory of lubrication of bearings”, Mir Publications, 1972. 2. O’Conner and Boyd, “Standard Hand Book of Lubrication Engineering”, McGraw Hill, 1968. 3. Fuller D.D., “Theory and practice of lubrication for Engineers”, John Wiley, 1973. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6277 | | RESEARCH METHODOLOGY | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To develop understanding of the basic framework of research process. 2. To develop an understanding of tools and techniques of data collection 3. Hypothesis formulation and analysis 4. Write a research report  COURSE OUTCOMES:  1. Can the basic framework of research process. 2. Can organize the tools and techniques of data collection 3. Hypothesis analysis 4. Write a research report | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction to research methodology**. Types of research, research methods Vs methodology - stages of research process. Literature review – Problem definition- Research design for exploratory, descriptive and experimental research – Brief introduction to completely randomized design, randomized block design and Latin square designs (description only). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Sampling fundamentals** -Types of sampling: probability and non-probability sampling. Sampling theory, sampling distribution and sample size determination. Tools and techniques of data collection: Questionnaire and schedule for field surveys, interview, observation, simulation, experimental and case study methods. Collection, recording, editing, coding and scaling of data. Scale classification and types. Measurement of validity, reliability and practicality. Cronbach’s Alpha | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Descriptive and inferential statistics** - Data analysis and interpretation –testing of hypothesis, testing of population mean, variance and proportion –Z test – t test – F test - chi square test. Test for correlation and regression –standard error of the estimate. Testing goodness of fit. Brief introduction to non parametric tests, factor analysis, discriminant analysis and path analysis (description only). Use of SPSS and other software. | | | | 10 |
| **IV** | **Meaning of interpretation and inference**: importance and care for interpreting results. Presentation of reports: popular reports and technical reports - structure and style. Oral and written presentations: Parts of a research report. Guidelines for writing research papers and reports – Writing different sections of a research paper – Introduction, Methodology, Results, Discussion, Conclusion, Abstract – Writing the title. Methods of giving references and appendices: referencing styles. Ethics in research. Use of computers and internet in research. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. C. R. Kothari, Research Methodology, Methods and techniques (New Age International Publishers, New Delhi, 2004). 2. R. Panneerseklvam, Research Methodology (Prentice Hall of India, New Delhi, 2011). 3. Ranjit Kumar, Research Methodology, A step by step approach (Pearson Publishers, New Delhi, 2005. 4. Management Research Methodology : K. N. Krishnaswami, Appa Iyer and M Mathirajan, Pearson Education, Delhi, 2010 5. Hand Book of Research Methodology : M N Borse, Sree Nivas Publications, Jaipur, 2004 6. Business Research Methods: William G Zikmund, South – Western Ltd, 2003 7. Research Methods in Social Science: P K Majumdar, Viva Books Pvt Ltd, New Delhi, 2005 8. Analyzing Quantitative Data: Norman Blaikie, SAGE Publications , London, 2003 9. SPSS for Windows: Pearson Education New Delhi, 2007 | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME6291 | DESIGN ENGINEERING LABORATORY | 3-1-0-4 | 2015 |
| **Experiment #1**  **Numerical Calculation and MATLAB Simulation**  Part A:Invariants, Principal stresses and strains with directions  Part A: Maximum shear stresses and strains and planes,Von-Mises stress  Part C: Calculate and Plot Stresses in Thick-Walled Cylinder  **Experiment #2**  **Stress analysis in Curved beam in 2D**  Part A : Experimental studies using Strain Gauge Instrumentation.  Part B : 2D Photo elastic Investigation.  Part C :Modelling and Numerical Analysis using FEM.  **Experiment #3**  **Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii. Shear**  Part A: Matlab simulation for Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate  Part B: Modelling of plate geometry under chosen load conditions and study the effect of plate geometry.  Part C: Numerical Analysis using FEA package.  **Experiment #4**  **Single edge notched beam in four point bending**.  Part A: Modellingof single edge notched beam in four point bending.  Part B: Numerical Studies using FEA.  Part C: Correlation Studies.  **Experimental #5**  **Torsion of Prismatic bar with Rectangular cross-section.**  Part A: Elastic solutions, MATLAB Simulation  Part B: Finite Element Analysis of any chosen geometry.  Part C: Correlation studies.  **Experiment #6**  **Vibration Characteristics of a Spring Mass Damper System.**  Part A: Analytical Solutions.  Part B: MATLAB Simulation.  Part C: Correlation Studies. | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6202 | | **ADVANCED MACHINE DESIGN** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Enables the student to identify failure modes and evolve design by analysis methodology. 2. Design considerations against fatigue failure. 3. Study crack and crack growth life 4. Study fatigue failure from variable amplitude loading  COURSE OUTCOMES:  1. Able to understand failure modes and design considerations 2. Able to do design against fatigue failure 3. Able to apply the knowledge of crack growth life in design 4. Able to understand variable amplitude loading and life estimation | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr’s theory and modified Mohr’s theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Stess-Life (S-N) Approach: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach. Strain-Life (ε-N)approach: Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress-strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber’s rule, Glinka’s rule, applications of fracture mechanics to crack growth at notches. | | | | 10 |
| **IV** | Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.  **Text Books:**  1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, “Metal Fatigue in engineering”, John wiley Newyork, Second edition. 2001.  2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, Newyork 1992.  3. Robert L. Norton, “Machine Design”, Pearson Education India, 2000 | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  1. S.Suresh , “Fatigue of Materials”, Cambridge University Press, -1998  2. Julie.A.Benantine, “Fundamentals of Metal Fatigue Analysis”, Prentice Hall,1990  3. Fatigue and Fracture, ASM Hand Book, Vol 19, 2002. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6204 | | **OPTIMIZATION METHODS IN DESIGN** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  To acquire the basics of   1. Classical Optimization Techniques 2. Non - linear Programming 3. Unconstrained Optimization Techniques 4. Integer Programming and Dynamic Programming.  COURSE OUTCOMES: The students will be able to apply   1. Classical Optimization Techniques in design 2. Non - linear Programming methods 3. Unconstrained Optimization Techniques in design 4. Integer Programming and Dynamic Programming. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non Linear Optimization.  **Optimization Theory** – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Sensitivity Analysis, Linear and Non Linear Approximations. Gradient Based Optimization Methods – Dual and Direct.  **Optimization Disciplines:** Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods. Internal and External Responses, Design Variables in each Discipline. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Manufacturability in Optimization Problems:** Design for Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems.  **Design Interpretation:** Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum. | 10 |
| **IV** | **Dynamic Programming:** Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples.  **Text Books:**  1. **S.S.Rao, Engineering** Optimization: Theory and Practice, John Wiley, 2009  2. **JasbirArora**, Introduction to Optimum Design, McGraw Hill, 2011. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCE**  1. Optimisation and Probability in System Engg - Ram, Van Nostrand.  2. Optimization methods - K. V. Mital and C. Mohan, New age International Publishers, 1999.  3. Optimization methods for Engg. Design - R.L Fox, Addison – Wesley, 1971. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6206 | | ADVANCED THEORY OF MACHINES | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Understand the basics of the mechanisms –definitions and analysis. 2. Understand the concept of Synthesis of Mechanisms – design the mechanism for an application – mechanism dimensions. 3. Expected to design and analyze a cam. 4. Analyze the mechanism for forces, lead to Design the mechanism with cross sectional dimensions.  COURSE OUTCOMES: After completion, the students can   1. Find out various kinematic properties of a mechanism, displacement, velocity and acceration. 2. Synthesis of Mechanisms with different accuracy and find the mechanism dimensions. 3. Expected to design and analyze a cam. 4. Find out various kinetic properties of a mechanism, force and motion and thus the cross sectional dimensions. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Kinematics:** Review of determination of velocity and acceleration of points and links inmechanisms- Analytical and graphical methods – Use of auxiliary points and special methods for velocity and acceleration determination. Pole, polode, Polode curvature, path curvature, Inflection circle-Euler-Savary Equation-Bobiller theorem- Collineation axis-Hartman’s construction | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Synthesis of Mechanisms**: Two position and three position synthesis of four bar linkage andslider crank mechanism. - Relative poles of four bar linkages and slider crank mechanisms - Geometric methods of synthesis with three accuracy points- Design of a function generators using Chebychev Spacing- Overlay method for conditioned crank mechanisms- Transmission angle – Angle design for optimum transmission – Coupler curves – Robert’s Law - Cognate mechanisms. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Analysis of Cams**: Basic curves, pressure, angle-Cam size determination-Cam profiledetermination-Analytical and graphical. Advanced curves-combination of curves-Polydyne cams. Cam dynamics: Cam force analysis-Dynamics of high speed cam system, source of vibration, Follower response-Phase plane method, Johnson’s Numerical Analysis – Position error-Jump and cross-over shock, Spring surge and wind up. | 10 |
| **IV** | **Static and Dynamic Force Analysis:** Forces, Couples. Conditions of equilibrium- Free bodydiagram. Analysis of 4-bar linkage, slider crank mechanisms, spur gears, cams, Helical gears. Force analysis using Coulomb friction and pin joint friction. Dynamic force analysis of spatial mechanism Linear impulse and momentum, Moment of momentum, Components of moment of momentum. Motion of a rigid body, moments and products of Inertia, Translation of axes. Rotation of axes. Measuring moment of Inertia, Euler’s equation of motion. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCE**   1. Shigley, J.E, John J. Uicker, “Theory of Machines and Mechanisms”, Oxford University press, 2004. 2. J.E.Shigley, “Kinematics analysis of Mechanisms”, McGraw Hill, 2007. 3. S S Rattan, theory 0f machines, Tata McGraw Hill Education 2012 4. R L Norton Kinematics and dynamics of machinery, Tata McGraw Hill Education 2012 5. Holowenko, A.R, “Dynamics of Machinery”, Wiley, 2007. 6. Allen S. Hall, Jr., “Kinematics and Linkage Design”, Prentice Hall, 2007. 7. Hartenberg and Denavit, “Kinematic Synthesis of Linkages”, McGraw Hill, 1964. 8. Arthur G. Erdman and George N. Sandor, “Mechanisms Design Analysis and Synthesis - Vol. I and II”, Prentice Hall of India. 9. Robert L. Norton, “Design of Machinery”, Tata McGraw Hill, 2004. 10. Rothbart H.A., “Cams”, Wiley, 1956. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6222 | | **THEORY OF PLATES AND SHELL** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Introduce students to the classical structural mechanics approximations of Membrane, Plate and Shell theories. 2. Use energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects. 3. Demonstrate the analysis tools necessary to describe static, dynamic and non-linear motions. 4. Demonstrate the approximation of the classical formulations using numerical approximation techniques  COURSE OUTCOMES: On completion of course, students can   1. Apply the structural mechanics approximations of membrane, plates and shells. 2. Derive simple modifications to the membrane plate and shell theories. 3. Use analysis to determine the static, dynamic, and non-linear motion of membrane, plate and shell structures.   Compute numerical approximations | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | CLASSICAL PLATE THEORY  Classical Plate Theory – Assumptions – Differential Equation – Boundary Conditions. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | PLATES OF VARIOUS SHADESNavier’s Method of Solution for Simply Supported Rectangular Plates – Leavy’s Method of Solution for Rectangular Plates under Different Boundary Conditions. Governing Equation – Solution for Axi-symmetric loading – Annular Plates – Plates of other shapes. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | EIGEN VALUE ANALYSIS AND APPROXIMATE METHODS  Stability and free Vibration Analysis of Rectangular Plates.  Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis. | | | | 10 |
| **IV** | SHELLS  Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**   1. Timoshenko, S.P. Winowsky. S., and Kreger, “Theory of Plates and Shells”, McGraw- Hill Book Co. 1990. 2. T. K. Varadan and K. Bhaskar, “Theory of Plates and Shells”,1999, Narosa. 3. Flugge, W. “Stresses in Shells”, Springer – Verlag, 1985. 4. Timoshenko, S.P. and Gere, J.M., “Theory of Elastic Stability”, McGraw-Hill Book Co. 1986 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6224 | | **FRACTURE MECHANICS AND DESIGN** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To understand the theories of crack formation and theories of fatigue and failure modes. 2. To understand the crack tip stresses, crack growth and crack arresting mechanisms. 3. To understand standard testing methods in fracture mechanics and to study various loading conditions. 4. To understand non linear fracture mechanics and standard test methods.  COURSE OUTCOMES:  1. Acquire basic knowledge of fracture mechanics theories and its importance in modern engineering design 2. Understand the stress concentration, crack growth, crack arrest and failure mechanisms in engineering materials. 3. Give an insight to fatigue testing methods and practices with different types of loading conditions. 4. Apply the theories of linear and non linear fracture mechanics in the engineering design field. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Fracture mechanics**: The geometry of stress and strain, elastic deformation, plastic and elastoplasticdeformation - limit analysis. Damage tolerant fracture mechanics – Fatigue testingmethods - statistical nature of fatigue data - theories of fatigue - crack initiation and growth infatigue - notches and stress concentration – Stress intensity solutions for 2-D and 3-D crackgeometries – Fractography - Structure modes and types. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Analysis of crack tip field**: Elements of elasticity - linear elastic crack tip fields. Stress intensityfactor - energy release rate - Criterion for crack growth - Crack resistance curve - Principles ofcrack arrest - Small-scale yielding (SSY) - crack growth relation in SSY - Stable crack growth inSSY. Irwin plastic zone correction- Actual shape of plastic zone - Plane stress - Plane strain. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Fatigue crack growth**: Fatigue crack growth test - stress intensity factor, factors affecting stressintensity factor - variable amplitude service loading - Dynamic energy balance – crack arrest -retardation model. | 10 |
| **IV** | **Nonlinear fracture mechanics**: J integral – Elastic – plastic stationary crack tip fields, ductilestructure criterion, J-controlled crack growth and stability – Tearing modulus – the x factor.  Engineering approach to plastic fracture - J-integral – testing single specimen testing – standardtest methods.  **Fracture design**: Selection of materials - fatigue crack growth rate curve - stress intensity factorrange - use of crack growth law. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCE**  1. Kanninen, M.F and Popelar, C.H, “Advanced fracture mechanics”, Oxford UniversityPress, 1985.  2. Knott, J.F., “Fracture in engineering materials”, Butterworth, 1973.  3. Hortezberg, R.W., “Determination of fracture mechanics of engineering materials”, Wiley,1983  4. John M. Barson and Stanely T. Rolfe, “Fracture and Fatigue Control in Structures”,Prentice Hall, Inc, USA, 1987. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6226 | | ROTOR DYNAMICS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. Understand and model the physical systems and analysis the model. 2. Understand and analysis the gyroscopic and unbalanced systems. 3. Solve some of the practical problems using transfer matrix methods. 4. Solve the rotors by assuming continuous system, study the effect of anisotropy in support and design a practical rotor system  COURSE OUTCOMES:  1. Can analyze simple rotors for various effects, like damping , unbalance etc.. 2. Can design multi-degree freedom system 3. Can analyse a multi-degree freedom system using transfer matrix methods. 4. Design the rotors by assuming continuous system with various effects like, anisotropy in support | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Linear Rotor Dynamics:** Equation of motion, Rotating systems, Complex coordinate representation, Undamped Jeffcott Rotor – Free whirling, Unbalance response, Shaft Bow Jeffcott Rotor with viscous damping – Free whirling, Unbalance response, Shaft Bow With structural damping – Free whirling, Unbalance response, frequency dependent loss factors with nonsynchronous damping, Effect of Bearing Compliance, Stability in supercritical region. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Modelling with Four Degrees of Freedom:** Generalised coordinates and equations of motion in real and complex coordinates, Static and couple unbalance and their effects, Uncoupled gyroscopic systems, Free whirling of coupled undamped systems, Unbalance response and Shaft bow. Model uncoupling of gyroscopic systems, Configuration and state space approaches. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Discrete multi-degree of freedom rotors:** Introduction, Transfer matrix approach for undamped systems, Damped systems, The finite element method for rotors, Beam elements, spring elements, Mass elements, Assembly and constraints, Damping matrices, Choice of coordinates: fixed Vs Rotating and Real Vs Complex coordinates, Computation of critical speeds, Computation of unbalance response Campbell and root locus diagrams, Reduction of dof : Nodal reduction, model reduction and component mode synthesis | | | | 10 |
| **IV** | **Transmission Shafts:** Modelling of rotors as continuous systems, Euler-Bernoulli and Timoshenko beam models. Dynamic stiffness, Analytical and Approximate solutions.  **Anisotropy of rotors and supports:** Isotropic rotors on Anisotropic supports – Influence of damping, nonisotropic rotors on isotropic supports.  **Torsional and Axial Dynamics:** Free and forced Torsional vibrations and critical speeds, Axial Vibration of rotors.  **Rotor Bearing Interaction**: Rigid body and flexural modes, Linearization of bearing Characteristics. Rolling element bearings, Fluid film bearings, Magnetic bearings, Bearing alignment in multi rotor bearings | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**   1. Giancarlo Genta, Dynamics of Rotating Systems, Springer, 2009 2. Rao, J.S., Rotor Dynamics, 3 Ed. New Age International, 2003 3. Butterworth Hienmann, 2003. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6232 | | **COMPUTER APPLICATIONS IN DESIGN** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  It helps the students to learn   1. The principles of CAD/CAM/CAE Systems 2. Graphics Programming, Geometric Modeling Systems 3. CAD, CAM and CAE Integration 4. Standards for Communicating between Systems  COURSE OUTCOMES: Students will be   1. Able to understand Principles and components of CAD/CAM/CAE systems 2. Able to do Graphics Programming, Geometric Modeling etc 3. Able to do CAD, CAM and CAE Integration 4. Able to do curve interpolation and surface modelling | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction To CAD/CAM/CAE Systems**  Overview, Definitions of CAD. CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example. Components of CAD/CAM/CAE Systems: Hardware Components ,Vector-Refresh(Stroke-Refresh) Graphics Devices, Raster Graphics  Devices, Hardware Configuration, Software Components, Windows-Based CAD Systems. **2.** | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Basic Concepts of Graphics Programming**:  Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.  **Standards:** Standards for Communicating Between Systems: Exchange Methods of Product Definition Data, Initial Graphics Exchange,Specification, Drawing Interchange Format, Standard for the Exchange of Product Data. Tutorials, Computational exercises involvingGeometric Modeling of components and their assemblies | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Geometric Modeling Systems**: Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, EulerOperators, Boolean Operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling  Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly, Features of Concurrent Design, Use of Assembly models,  Simplification of Assemblies, Web-Based Modeling: Representation and Manipulation of Curves: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve | | | | 10 |
| **IV** | B-Spline Curve, Evaluation of a B-Spline Curve, Composition of B-Spline Curves, Differentiation of a B-Spline Curve, Non uniform Rational B-Spline (NURBS) Curve, Evaluation of a NURBS Curve, Differentiation of a NURBS Curve, Interpolation Curves, Interpolation Using a Hermite Curve, Interpolation Using a B-Spline Curve, Intersection of Curves.  **Representation and Manipulation of Surfaces:** Types of Surface Equations, Bilinear Surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier Surface, B-Spline Surface, Evaluation of a-B-Spline Surface, Differentiation of a B-Spline Surface, NURBS Surface, Interpolation Surface, Intersection of Surfaces. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  1. Alavudeen & N. Venkateshwaran, “Computer integrated manufacturing”, PHI, 2005  2. Bresenham, J. E., “Ambiguities in incremental line rastering”, IEEE Computer Graphics  and Applications, Vol. 7, No. 5, May 2000  3. Chris McMahon & Jimmie Browne, “CAD CAM principles, practice and manufacturingmanagement”, Pearson Education, 2000  4. David Parrish, “Flexible manufacturing”, Butterworth - Heinemann Ltd, 2004  5. Donald Hearn & M. Pauline Baker, “Computer graphics”, Pearson Education, 2004  6. Eckland, Eric, “Improved techniques for optimising iterative decision – variable algorithms, drawing anti-aliased lines quickly and creating easy to use color charts”, CSC 462 Project Report, Department of Computer Science, North Carolina State University, Spring 1999  7. Foley, J. D. and A. Van Dam, “Fundamentals of interactive computer graphics”, Addison- Wesley 1982  8. Fu, K. S., Gonzalez, R. C. and Lee, C. S. G., “Robotics - control, sensing, vision and intelligence”, McGraw Hill  9. Ibrahim Zeid and R Sivasubramanian, “CAD/CAM theory and practice”, McGraw Hill, 2002  10. J. D. Foley, A. Van Dam, S. K. Feiner, J. F. Hughes and R. L. Phillips, “Introduction to computer graphics”, Addison Wesley, 1997 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6234 | | OIL HYDRAULICS AND PNEUMATICS | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To understand hydraulic / pneumatic fundamentals and the basic physics involved. 2. To identify fluids used hydraulic / pneumatic systems and to understand the type of valves used 3. To design and analysis different hydraulic and pneumatic circuits for different application 4. To identify and describe pneumatic components, production and distribution of air.  COURSE OUTCOMES:  1. Tolearn the hydraulic / pneumatic fundamentals and the basic and fluids used. 2. To learn the operations and characteristics of different types of valves used. 3. To design and analysis different hydraulic/pnuematic circuits for different application 4. To identify and describe pneumatic components, production and distribution of air. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Fluid power fundamentals**: Introduction–basic definitions fluid mechanics, units, standards and symbols – operation principle of fluid power – advantages and disadvantages – applications in various fields.  **Hydraulic cylinders**: Classification and characteristics - connection types and performance parameters – differential and float concepts – typical cylinder structure –ancillary hydraulic elements. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Control Valves**: Directional control valve – structure and operation of pilot – operated check valves and the directional control valves – standard symbols for representing the elements – concepts of position and way – actuation mechanisms. Pressure control valves– operation – remote pressure adjustment of the pilot – operated pressure relief valve pressure reducing valve, sequence valve, counterbalance valve and pressure switch. Flow control valves – throttle characteristics of various orifices – flow regulating valve. Cartridge valves, Proportional valves and servo valves. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | **Hydraulic circuits**: Rapid motion circuits, speed control circuits, synchronous circuits, sequential circuits, counter balance circuits and unloading circuits.  Design of circuits: Hydraulic circuit design for typical hydraulic systems and design calculations | 10 |
| **IV** | **Pneumatic circuits**: Compressed air production and distribution, pneumatic control components, examples of application including electro-pneumatic and hydro pneumatic controls.  Pneumatic circuit design and associated design calculations. | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCE**   1. S R Majumdar, Oil Hydraulics systems – principle and Maintenance. Mcgraw Hill Education (India) Pvt Ltd 2. Krishner, Joseph M. and Silas Katz, “Design Theory of Fluidic Components”,Academic press, 1975. 3. Dr. Heinza Zoebl. Techn, “Fundamentals of Hydraulic Circuitry”, Iliffe, 1970. 4. Leskiewics H.J. and Zarhmba M, “Pneumatic and Hydraulic components and instrumentations in automatic controls”, International Federation of Automatic Control, 1980. 5. J. Mooney, "Course on Basic Pneumatics," Design Engineering, Machine Design, fluid power reference issues 6. Pippengar, John J. and Koff, Richard M, “Fluid Power Controls” Mcgraw Hill, 1959. 7. Pippengar, John J. and Hicks, Tyler G, Industrial Hydraulics” McGraw Hill 1979.Kirshner, Joseph M, “Fluid amplifiers”, McGraw Hill, 1966. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME6236 | | ACCOUSTICS AND NOISE CONTROL | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  By going through the syllabus, students must be able to understand:   1. Behaviour and effects of pressure waves 2. Energy and interpretation of field variables 3. How to control energy waves 4. Various designs related with acoustic source.  COURSE OUTCOMES: After completion, students must be able to,   1. Do measurement of sound propagation and methods sound level. 2. Analyze the wave propagation in various medias. 3. Calculate various factors for acoustic propagation and its effect on various objects including on human being. 4. The design of various components for acoustic application. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Sound propagation, decibels, acceptance noise levels, Air columns, acoustical measurements, Doppler Effect, microphones and loud Speakers. Recording and reproduction of sound, Fourier’s theorem and musical scale, Perception of Music, Octaves and Octave Bands.Acoustics of buildings. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Acoustic field variables-Derivation of wave equation-Physical interpretation of the wave equation solution-One Dimensional Waves in a Gas-Acoustic Energy and Acoustic Intensity-Energy in a plane progressive wave-Acoustic Impedance. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Industrial noise control strategies Noise ratings, The Human Ear and Voice, human tolerance levels, equivalent sound level and loudness contours - Noise control through barriers and enclosures and absorbent linings - Combining Sound Levels in Decibels. Acoustic Resonance-Resonance of a pipe closed at both ends-Resonance of a pipe closed at one end, open at the other. | | | | 10 |
| **IV** | Directionality of acoustic sources and receivers-Directivity index-Screens-SilencersHelmholtz resonator design-Expansion chamber silencer design-Dissipative silencersActive and passive control of noise. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**   1. Engineering Noise Control - D.A. Bies& C.H. Hausen.. 2. Noise & Vibration Control - Leo N. Beraneck 3. Turner and Pretlove, Acoustics for Engineers, Macmillan, 1991 4. Kinsler, Frey, Coppens& Sanders. Fundamentals of Acoustics.3rd Edition. John Wiley, 1982 5. Smith, Peters and Owen, Acoustics and Noise Control, Addison-Wesley-Longman, 2nd edition 1996 6. Bies and Hanson, Engineering Noise Control, theory and practice E&FN Spon, 2nd edition, 1996 | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME6266 | SEMINAR - I | 3-1-0-4 | 2015 |
| COURSE OBJECTIVES:  This course is designed to improve written and oral presentation skills and to develop confidence in making public presentations, to provide feedback on the quality and appropriateness of the work experience, and to promote discussions on design problems or new developments or ethical and safety issues in the workplace.  Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the first semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student’s paper, presentation and his/her participation in the seminar. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME6288 | MINI PROJECT | 3-1-0-4 | 2015 |
| COURSE OBJECTIVES:  To develop practical ability and knowledge about practical tools/techniques in order to solve the problems related to the industry, academic institutions. Guide line: In Mini Project the student shall undergo Mini Project of two months duration. The mini project is designed to develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student.  For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation.  Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME6292 | DESIGN AND ANALYSIS LAB | 3-1-0-4 | 2015 |
| **Experiment #1**  **Structural Analysis**  Part A: FE Modeling of a stiffened Panel using a commercial preprocessor.  Part B: Buckling, Bending and Modal analysis of stiffened Panels.  Part C: Parametric Studies.  **Experiment #2**  **Design Optimization**  Part A: Shape Optimization of a rotating annular disk.  Part B: Weight Minimization of a Rail Car Suspension Spring.  Part C: Topology Optimization of a Bracket.  **Experiment #3**  **Thermal analysis**  Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.  Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral  Surfaces Insulated.  **Experiment #4**  **Thermal Stress Analysis**  Part A: A Thick Walled Cylinder with specified Temperature at inner and outer Surfaces.  Part B: A Thick Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.  **Experiment#5**  **CFD Analysis**  Part A: CFD Analysis of a Hydro Dynamic Bearing using commercial code.  Part B: Comparison of predicted Pressure and Velocity distributions with Target solutions.  Part C: Experimental Investigations using a Journal Bearing Test Rig.  Part D: Correlation Studies.  **Experiment #6**  **Welded Joints.**  Part A : Fabrication and Testing.  Part B : FE Modeling and Failure Analysis .  Part C : Correlation Studies. | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME7241 | | DESIGN OF PRESSURE VESSELS AND PIPING | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To give a broad exposure to pressure vessels,pipingand related equipment 2. To acquaint the students with their actual designs, involving layout, 3. Mechanical design, with real examples from the industry. 4. Design of pipping system for various industries.  COURSE OUTCOMES: The student, at the end of the course, should be able –   1. To conceive a design based on the information provided for a particular application 2. To learn the sizing of the equipment 3. To predict the thermal behavior and carry out a stress analysis 4. To come up with a mechanical design as per the relevant codes, cost economic analysis and to familiarize the use of ASME codes | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Design and analysis of unfired pressure vessels-stress analysis for modern pressure vessels, membrane stress Analysis of Vessel Shell components –Cylindrical shells, spherical Heads, conical heads –Thermal Stresses –Discontinuity stresses in pressure vessels, excessive elastic deformation, plastic instability, brittle, rupture, creep. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Design of Tall cylindrical self-supporting process columns –** supports for short vertical vessels – stress concentration – at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings - theory of reinforcement – design of circumferential stiffeners, design of covers, pressure vessel design -related components like relief values etc. –Use of ASME codes. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Buckling and Fracture Analysis in Vessels**, Elastic buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading, Control and significance of Fracture Mechanics in Vessels - FEM application. | | | | 10 |
| **IV** | **Design and analysis of piping systems–**Piping layout and piping stress Analysis, pipes and tubing under external and internal pressure - design of tube - sheets and tube seats, and use of post - weld heat treatment to effect residual stress in final rupture. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**   1. John F. Harvey, “Pressure Vessel Design”, CBS publishers, 2007. 2. Henry H. Bedner, “Pressure Vessels”, Design Hand Book, CBS publishers, 2007. 3. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Presented at ASME Pressure Vessels and Piping Conference, 1997. 4. ASME Code for Pressure Vessel Design. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME7243 | | **EXPERIMENTAL STRESS ANALYSIS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To understand statistical analysis of experimental data 2. To understand measuring of force, torque and strain 3. To understand stress analysis using 2D and 3D photo elasticity 4. To understand interpretation of results  COURSE OUTCOMES:  1. Study statistical distributions, correlation and regression 2. Able to measure force, torque and strain 3. Able to analyze stress using 2D and 3D photo elasticity 4. Able to interpret results of experiments | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.  **Analysis of Experimental Data:** Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.  **Force, Torque and Strain Measurement:** Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Stress Analysis:** Two Dimensional Photo elasticity **-** Nature of light, - wave theory of light,- optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, IsoclinicsIso chromatics fringe order determination - Fringe multiplication techniques - Calibration Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.** | | | | 10 |
| **IV** | **Three Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses**.**  **Text Books:**  **1. Holman,**“Experimental Methods for Engineers” 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007.  **2. R. S. Sirohi, H. C. Radha Krishna,** “Mechanical measurements” New Age International Pvt. Ltd., New Delhi, 2004  **3. Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.  **4. Instrumentation, Measurement And Analysis -**Nakra&Chaudhry, B C Nakra K KChaudhry, Tata McGraw-Hill Companies, Inc, New  York, Seventh Edition, 2006. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  Data Acquisition and Processing: General data acquisition system, signal  1. Measurement Systems Application and Design - Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989  2. Design and Analysis of Experiments - Montgomery D.C., John Wiley & Sons, 1997.  3. Experimental Stress Analysis - Dally and Riley, McGraw Hill, 1991.  4. Experimental Stress Analysis - Sadhu Singh, Khanna publisher, 1990.  5. PhotoelasticityVol I and Vol II - M.M.Frocht, John Wiley and sons, 1969.  6. Strain Gauge Primer - Perry and Lissner, McGraw Hill, 1962. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME7245 | | **CONTINUUM MECHANICS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  Analysis of stress-strain relations.  2. Solution of plane elasticity problems in rectangular and polar coordinates using analytical methods including thermal loads, body forces and surface tractions  3. Understandings of plasticity and viscoelasticity. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Deformation and Strain:** Particles and points, continuum configuration-deformation and flow concepts. Position vector, displacement vector-Lagrangian and Eulerian description, deformation gradient, displacement gradient.Deformation tensors, finite strain tensors, small deformation theory, infinitesimal strain tensors.Relative displacement- linear, rotation tensors.Transformation properties of strain tensors.  Principal strains, strain invariants, cubical dilatation, spherical and deviator strain tensors, plane strain, Mohr’s circle, and compatibility equations. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Linear Elasticity:** Generalized Hooke’s law, Strain energy function, isotropy, anisotropy, elastic symmetry. Isotropic media-elastic constants. Elastostatic and Elastodynamic problems. Theorem of superposition, uniqueness of solutions, St. Venant’s principle.  **Two dimensional elasticity**- plane stress, plane strain, Airy’s stress function. Two dimensional elastostatic problems in polar coordinates.  Hyperelasticity, Hypoelasticity, linear thermo elasticity. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Plasticity:** Basic concept and definitions, idealized plastic behavior. Yield condition- Tresca and Von-Mises criteria. Stress space-ı-plane, yield surface. Post yield behavior-isotropic and kinematic hardening. Plastic stress-strain equations, plastic potential theory. Equivalent stress, equivalent plastic strain increment. Plastic work, strain hardening hypothesis. Total deformation theory-elastoplastic problems.  Elementary slip line theory for plane plastic strain | | | | 10 |
| **IV** | **Viscoelasticity:** Linear viscoelastic behavior. Simple viscoelastic models-generalized models, linear differential operator equation. Creep and Relaxation- creep function, relaxation function, hereditary integrals. Complex moduli and compliances. Three dimensional theory viscoelastic  stress analysis, correspondence principles  **Text Books:**  1. George. E. Mase, Continuum Mechanics, CRC Press, 2000.  2. J. N. Reddy, Introduction to Continuum Mechanics with Applications, Cambridge University Press, New York, 2008.  3. W. Michael Lai, David Rubin, Erhard Krempl, Introduction to Continuum Mechanics, Butterworth-Heinemann , 4th Ed, 2010. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  1. Batra, R. C., Elements of Continuum Mechanics, Reston, 2006.  2. George E. Mase, Schaum's Outline of Continuum Mechanics, McGraw-Hill, 1970.  3. Dill, Ellis Harold, Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity, CRC Press , 2006.  4. Fung Y. C., A First Course in Continuum Mechanics, Prentice-Hall, 2e, 1977.  5. Gurtin M. E., An Introduction to Continuum Mechanics, Academic Press, 1981. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME7251 | | **MECHATRONICS SYSTEM DESIGN** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To educate the student regarding integration of mechanical, electronics, electrical and computer systems in the design of CNC machine tools, Robots etc. 2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics. 3. To through light on working principle and fabrication of the modern MEMS and micro systems 4. To impart knowledge on the design and manufacturing of user friendly system.   **COURSE OBJECTIVE:**   1. The student will be able to design pneumatic and hydraulic systems incorporating senors and transducers. 2. Student acquires wide spread knowledge of electrical actuators and AC/DC motors, stepper motors etc.. 3. Student acquires knowledge of signal conditioning methods 4. Student acquires ability to identify manufacturing of common mechatronic system and trouble shorting. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction: Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of MechatronicProducts and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers:  Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors.  System Models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Signal Conditioning: Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals , Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.  MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process,  Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. | | | | 10 |
| **IV** | Data Presentation Systems: Basic System Models, System Models, Dynamic Responses of System.  Advanced Applications in Mechatronics: Fault Finding, Design, Design for manufacturing, User-friendly design  **Text Books:**  1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999  2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002 | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996  2. Shetty and Kolk “Mechatronics System Design”- Cengage Learning, 2010  3. Mahalik “Mechatronics”- Tata McGraw-Hill Education, 2003  4. HMT “Mechatronics”- Tata McGraw-Hill Education, 1998  5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Grew Hill, 2002  6. “Fine Mechanics and Precision Instruments”- Pergamon Press, 1971. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME7253 | | **DESIGN FOR MANUFACTURE** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES: To educate students a clear understanding of factors to be considered in designing parts  1. To study selective assembly techniques 2. To understand design consideration in manufacturing 3. To understand tolerance standards   **COURSE OBJECTIVE:**   1. Clear understanding of factors to be considered in designing parts 2. Able to apply concepts of selective assembly techniques 3. Able to apply design consideration while manufacturing 4. Apply tolerance standards and design gauges | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Effect of Materials And Manufacturing Process On Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, Weighted properties and limits on properties methods. Tolerence Analysis: Process capability, mean, varience, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, Laminated shims, examples. Datum Features : Functional datum, Datum for manufacturing, Changing the datum. Examples. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Design Considerations: Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and Machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviates and cores.  Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations. | | | | 10 |
| **IV** | True positional theory: Comparison between co-ordinate and convention method of feature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging.  Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  1. Harry Peck , “Designing for Manufacturing”, Pitman Publications, 1983.  2. Dieter , “Machine Design” - McGraw-Hill Higher Education, -2008  3. R.K. Jain, "Engineering Metrology", Khanna Publishers, 1986  4. Product design for manufacture and assembly - Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker. Inc. CRC Press,Third Edition  5. Material selection and Design, Vol. 20 - ASM Hand book | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| 05ME7255 | | **VIBRATION CONTROL AND CONDITION MONITORING** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   1. To understand the concepts of vibration isolation, absorption and active control 2. To select methods for condition monitoring 3. To measure vibration and analyze signals for predictive maintenance 4. To understand dynamic balancing and alignment issues   **COURSE OBJECTIVES:**   1. To apply the concepts of vibration isolation, absorption and active control 2. Able to select methods for condition monitoring 3. Able to measure vibration and analyze signals for predictive maintenance 4. Able to understand dynamic balancing and alignment issues | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | **Vibration Control** - Review of Fundamentals of Single Degree Freedom Systems, Multi Degree Freedom Systems and Continuous systems. Reduction of Vibration at the Source - Control of Vibration – by Structural design – Material Selection – Localized additions – Artificial damping  – Resilient isolation, Vibration isolation, Vibration absorbers. Active vibration control – review of smart materials – types and characteristics - smart structures. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | **Selecting methods of condition monitoring** - Machine condition monitoring and diagnosis –  Vibration severity criteria – Machine maintenance techniques – Machine condition monitoringtechniques – Vibration monitoring techniques – Instrumentation systems – Choice of monitoring parameter. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | **Predictive Maintenance and Signature Analysis**- observational and estimation techniques, online techniques specially dealing with instrumentation system, offline technique like visual inspection, non destructive testing and destructive testing for materials, fluids and generalmechanical and electrical components, predictive analysis of potential failures and end of useful life. Diagnostic maintenance, applications to specific industrial machinery and plants. | | | | 10 |
| **IV** | **Dynamic balancing and alignment of machinery**: Dynamic Balancing of Rotors, Field Balancing in one Plane, two Planes, and in several Planes, Machinery Alignment, “Rough” Alignment Methods, The Face- Peripheral Dial Indicator Method, Reverse Indicator Method, Shaft-to-coupling spool method.  Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft.  **Text Books:**  1. Harry Peck , “Designing for Manufacturing”, Pitman Publications, 1983.  2. Dieter , “Machine Design” - McGraw-Hill Higher Education, -2008  3. R.K. Jain, "Engineering Metrology", Khanna Publishers, 1986  4. Product design for manufacture and assembly - Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker. Inc. CRC Press,Third Edition  5. Material selection and Design, Vol. 20 - ASM Hand book | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCE**  1. Singiresu S. Rao, “Mechanical Vibrations”, Addison-Wesley Publishing Company, 1995.  2. J.O. Den Hartog, “Mechanical Vibrations”, McGraw Hill, Newyork, 1985.  3. R.A.Collacott, “Vibration monitoring and diagnosis”, Wiley, 1979  4. R.A.Collacott, “Mechanical Fault diagnosis and condition monitoring”, Wiley, 1977.  5. First course on “Condition monitoring in the process industries”, Manchester, edited byM.J.Neale, Nov 1979.  6. Newman, “Management of Industrial Maintenance”, Butterworth, 1978.  7. “Condition Monitoring Manual”, National Productivity Council, New Delhi.  8. “Terotechnology”, Institute of mechanical Engineers, 1975.  9. Rao, J.S., “Vibratory Condition Monitoring of Machines”, CRC Press, 2000.  10. “Hand Book of Condition Monitoring”, Elsevier Science, 1996. | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME7267 | SEMINAR - II | 3-1-0-4 | 2015 |
| COURSE OBJECTIVES:  This course is designed to improve written and oral presentation skills and to develop confidence in making public presentations, to provide feedback on the quality and appropriateness of the work experience, and to promote discussions on design problems or new developments or ethical and safety issues in the workplace.  Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the first semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student’s paper, presentation and his/her participation in the seminar. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME7287 | PROJECT PHASE I | 3-1-0-4 | 2015 |
| COURSE OBJECTIVES:  To learn the planning process of a real project, like selection of subject, present status of the project, schedule the activities, and finally the expected results/outcome. Guide lines: In Master’s Thesis Phase-I, the students are expected to select an emerging research area in the field of specialization. After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Master’s Thesis. It is mandatory that the students should refer National and International Journals and conference proceedings while selecting a topic for their thesis. He/She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.  Students should submit a copy of Phase-I thesis report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the thesis. The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation, by a panel of internal examiners in which one will be the internal guide. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Phase–II of the thesis. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| 05ME7288 | PROJECT PHASE II | 3-1-0-4 | 2015 |
| COURSE OBJECTIVES:  To execute the project. Guide lines : In the fourth semester, the student has to continue the thesis work and after successfully finishing the work, he / she has to submit a detailed bounded thesis report. The evaluation of M Tech Thesis will be carried out by a panel of examiners including atleast one external examiner appointed by university and internal examiner.  The work carried out should lead to a publication in a National / International Conference or Journal. The papers received acceptance before the M.Tech evaluation will carry specific weightage. | | | |