

SCHEME AND SYLLABUS FOR M.TECH (FULL TIME) DEGREE COURSE

in

MECHANICAL ENGINEERING (2015 Scheme)

(Specialization: Machine Design)

(Faculty of Engineering)

At

ALAPPUZHA/PATHANAMTHITTA CLUSTER

of the

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY



M.Tech (Full Time) Degree Course in

MECHANICAL ENGINEERING

(Specialization: Machine Design)

SCHEME

Semester I

Exam Slot	Course Code	Course Title	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (Hrs.)	
A	03 MA 6001	Engineering Mathematics	3-0-0	40	60	3	3
B	03 ME 6201	Theory of Vibration	3-1-0	40	60	3	4
C	03 ME 6211	Finite Element Method	3-1-0	40	60	3	4
D	03 ME 6221	Advanced Theory of Mechanisms	3-1-0	40	60	3	4
E		Elective I	3-0-0	40	60	3	3
S	03 RM 6001	Research Methodology	1-1-0	100	0	2	2
U	03 ME 6811	Design Engineering Lab I	0-0-2	100	0	2	1
T	03 ME 6901	Seminar I	0-0-2	100	0	0	2
TOTAL			16-4-4	500	300	19	23

ELECTIVE I

03 ME 6231 Design for Manufacture, Assembly and Environments

03 ME 6241 Industrial Tribology

03 ME 6251 Mechatronics

03 ME 6261 Optimization Techniques for Engineering

SEMESTER II

<i>Exam Slot</i>	<i>Course Code</i>	<i>Course Title</i>	<i>L-T-P</i>	<i>Internal Marks</i>	<i>End Semester Exam</i>		<i>Credits</i>
					<i>Marks</i>	<i>Duration (Hrs)</i>	
A	03ME 6202	Continuum Mechanics	3-1-0	40	60	3	4
B	03ME 6212	Fracture Mechanics	3-0-0	40	60	3	3
C	03ME 6222	Design of Power Transmission Elements	3-0-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
V	03ME 6902	Mini Project	0-0-4	100	0	0	2
U	03ME 6812	Design Engineering Lab II	0-0-2	100	0	0	1
TOTAL			15-1-6	100	300	15	19

ELECTIVE II

- 03 ME 6232 Advanced Design Synthesis
- 03 ME 6242 Design Engineering
- 03 ME 6252 Design of Pressure Vessels and Piping
- 03 ME 6262 Mechanics of Composite Materials

ELECTIVE III

- 03 ME 6272 Advanced Machine Tool Design
- 03 ME 6282 Computational Fluid Dynamics
- 03 ME 6292 Experimental Stress Analysis
- 03 ME 6302 Advanced Theory of Vibration

SEMESTER III

<i>Exam Slot</i>	<i>Course code</i>	<i>Course Title</i>	<i>L-T-P</i>	<i>Internal Marks</i>	<i>End Semester Exam</i>		<i>Credits</i>
					<i>Marks</i>	<i>Duration (Hrs)</i>	
A		Elective IV	3-0-0	40	60	3	3
B		Elective V	3-0-0	40	60	3	3
	03ME 7903	Seminar II	0-0-2	100		0	2
	03ME 7913	Project Phase I	0-0-8	50		0	6
TOTAL			6-0-14	230	120		14

ELECTIVE IV

03 ME 7203	Computer Integrated Manufacturing
03 ME 7213	Acoustics and Noise Control
03 ME 7223	Plates and Shells
03 ME 7233	Applied Elasticity and Plasticity

ELECTIVE V

03 ME 7243	Industrial Instrumentation
03 ME 7253	Principles of Robotics and Applications
03 ME 7263	Advanced Finite Element Methods
03 ME 7273	Design of Thermal Systems

Semester IV

<i>Examination Slot</i>	<i>Course Number</i>	<i>Name</i>	<i>L-T-P</i>	<i>Internal Marks</i>	<i>End Semester Examination</i>		<i>Credit</i>
					<i>Marks</i>	<i>Duration (hours)</i>	
W	01ME7914	Project (Phase 2)	0-0-21	70	30		12
		TOTAL	0-0-21	70	30	-	12

	<i>Credits</i>
Grand total credits (Semester I to IV)	68

TABLE OF CONTENTS

COURSE CODE	SUBJECT	PAGE
SEMESTER I		
03 MA 6001	Engineering Mathematics	4
03 ME 6201	Theory of Vibration	6
03 ME 6211	Finite Element Method	8
03 ME 6221	Advanced Theory of Mechanisms	10
	Elective I	
03 ME 6231	Design for Manufacture, Assembly and Environments	12
03 ME 6241	Industrial Tribology	14
03 ME 6251	Mechatronics	16
03 ME 6261	Optimization Techniques for Engineering	18
03 RM 6001	Research Methodology	20
03 ME 6811	Design Engineering Lab I	21
03 ME 6901	Seminar I	23
SEMESTER II		
03 ME 6202	Continuum Mechanics	26
03 ME 6212	Fracture Mechanics	28
03 ME 6222	Design of Power Transmission Elements	31
	Elective II	
03 ME 6232	Advanced Design Synthesis	32
03 ME 6242	Design Engineering	34
03 ME 6252	Design of Pressure Vessels and Piping	36
03 ME 6262	Mechanics of Composite Materials	38
	Elective III	
03 ME 6272	Advanced Machine Tool Design	40
03 ME 6282	Computational Fluid Dynamics	42
03 ME 6292	Experimental Stress Analysis	44
03 ME 6302	Advanced Theory of Vibration	46
03 ME 6902	Mini Project	48
03 ME 6812	Design Engineering Lab II	49
SEMESTER III		
	Elective IV	
03 ME 7203	Computer Integrated Manufacturing	51
03 ME 7213	Acoustics and Noise Control	54
03 ME 7223	Plates and Shells	56
03 ME 7233	Applied Elasticity and Plasticity	58
	Elective V	
03 ME 7243	Industrial Instrumentation	61
03 ME 7253	Principles of Robotics and Applications	63
03 ME 7263	Advanced Finite Element Methods	64
03 ME 7273	Design of Thermal Systems	66
03 ME 7903	Seminar II	68
03 ME 7913	Project Phase I	69
SEMESTER IV		
03 ME 7914	Project Phase II	70

Course No 03MA 6001	Course Name: ENGINEERING MATHEMATICS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> • Apply knowledge of mathematics, science, and engineering • design and conduct experiments, as well as to analyze and interpret data • recognition of the need for, and an ability to engage in life-long learning • knowledge of contemporary issues, • ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. 			
Syllabus: Tensors, Green's theorem, Integral equations, Partial differential equations, The Pfaffian differential equations, D'Alembert's method. Green functions, Laplace equation - solution and application, Special functions, Beta, Gamma functions, Bessel functions, Numerical solutions of PDE			
Expected outcome:			
At the end of this course the student will be able to			
<ul style="list-style-type: none"> • Solve and understand the concepts of Tensors • Able to read and understand scientific papers clearly • Solve integral and partial differential equations • Use special functions for engineering problems • Solve PDE using numerical solutions 			
References:			
<ul style="list-style-type: none"> • Rutherford Aris , Vector, Tensors and Basic Equations of Fluid Mechanics • John Henry Heinbockel, Introduction to Tensor Calculus and Continuum Mechanics • Erwin Kreyzig, Advanced Engineering Mathematics • Ian Sneddon, Partial Differential Equations Ian Sneddon • K. SankaraRao, Introduction to Partial Differential Equations • S. S. Sastry, Introductory Methods of Numerical Analysis • Schaum's outline of Tensor Calculus • A. J. McConnell, Applications of Tensor Analysis 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	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, Tensor Calculus, Eigen values and Eigen vectors of Tensors.	12	20%
FIRST SERIES TEST			
II	Integral equations: - solution of integral equations by (i) transform method (ii) method of successive approximations, Integro - differential equations.	15	30%

	Partial differential equations: - The Pfaffiandifferential equations, parabolic, elliptic and hyperbolic equations. D'Alembert's method. Canonical form, Characteristics, Green functions, Laplace equation in polar co-ordinates - solution and application.		
III	Special functions: - Beta, Gamma functions, Bessel functions-recurrence relation, generating functions, Legendre's equations and Legendre's Polynomials - recurrence relation and orthogonality property.	12	20%
SECOND SERIES TEST			
IV	Numerical solutions of PDE: - Elliptic PDE - derivations of finite difference approximations - iterative method - solution of Poisson equation. Numerical solutions of parabolic PDE - Schmidt method, Durfort - Fankel method, implicit method, Crank- Nicolson method. Numerical solution of Hyperbolic PDE - finite difference method	13	30%
END OF SEMESTER EXAM (Modules I to IV)			

Course No: 03 ME 6201	Course Name: THEORY OF VIBRATION	L-T-P-Credits: 3-1-0-4	Year of Introduction: 2015
Course Objectives: An preliminary course in linear mechanical vibrations where students acquire the ability to <ul style="list-style-type: none"> • formulation of problems in vibration as mathematical models using Newton's second law or energy principles, • Application of mathematical or numerical techniques in determination of a complete solution to mechanical vibration problems, and • physical and design interpretations of the results 			
Syllabus: Single Degree of freedom system, Two degree of freedom systems, Multi-degree freedom system, Matrix formulation, Eigen Value problem , Lagrange's equation Vibration of continuous system, Approximate numerical methods, - Rayleigh method , Rayleigh -Ritz method, Holzer procedure, TransientVibration, LaplaceTransforms			
Expected outcome: <ul style="list-style-type: none"> • The course is based on the essential principles of Physics, Dynamics and Strength of Materials. These principles are used to understand the response characteristics of basic mechanical vibratory systems. The effects of such phenomena as resonance for engineering problems are discussed. Students learn to evaluate and understand the performance of such systems in. 			
References: <ul style="list-style-type: none"> • Leonard Meirovitch: Elements of Vibration Analysis, McGraw Hill • Thomson W.T: Theory of Vibration with Applications, Prentice Hall India. • RaoV,Jsrinivas, Mechanical Vibrations, PHI Learning Pvt. Ltd. • S.S Rao, Mechanical Vibrations, Pearson Education India 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Single Degree of freedom system: Analysis of un-damped, damped , free and forced SDOF systems ,Logarithmic decrement, magnification factor, Rotating and revolving unbalance, Base excitation, transmissibility, Seismic instruments , Transients - non periodic excitation of Single DOF systems - Impulsive response and Convolution Integral - Laplace Transform	6	25%
	Two degree of freedom systems: normal modes and natural frequencies - Principal co-ordinates -co-ordinate coupling, dynamic vibration absorbers and damped vibration absorbers.	7	
FIRST SERIES TEST			
II	Multi-degree freedom system: Introduction to multi-degree freedom system, Matrix formulation, Influence coefficients- Flexibility and stiffness- Eigen Value problem-frequency mode shape - Eigen value and Eigen vectors. Modal analysis - Mode	12	25%

	summation- De-coupling of equations -, Lagrange's equation - Generalized coordinates- Matrix Iteration - Stodola - and Sweeping methods		
III	Vibration of continuous system: string - Bar - Torsional and flexural vibration - Solution - Boundary conditions- Approximate numerical methods- Rayleigh method - Rayleigh -Ritz method- Holzer procedure for lumped masses. Introduction to Transfer matrices	12	25%
SECOND SERIES TEST			
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 transforms	13	25%
END OF SEMESTER EXAM (MODULES I - IV)			

Course No: 03 ME 6211	Course Name: FINITE ELEMENT METHOD	L-T-P- Credits: 3-1-0-4	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> To provide the fundamental concepts of the theory of the finite element method 			
Syllabus:			
<ul style="list-style-type: none"> Basic concepts of FEM, Truss structures, The direct stiffness method, Method of weighted residuals, Galerikin finite element method, application of Galerikin's method, Interpolation function for general element formation, polynomial forms- one dimensional elements, triangular elements, rectangular elements, three dimensional elements, isoperimetric formulations, axisymmetric elements, numerical integration: Gaussian quadrature, isoparametric formulation, axisymmetric stress analysis, general three dimensional stress - finite element formulations, strain and stress computations 			
Expected outcome:			
<ul style="list-style-type: none"> to obtain an understanding of the fundamental theory of the FEA method; to develop the ability to generate the governing FE equations for systems governed by partial differential equations; to understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements; and to understand the application and use of the FE method for heat transfer problems 			
References:			
<ul style="list-style-type: none"> K. J. Bathe, Finite element procedures Chandrupatla, Belegundu, Introduction to finite elements in engineering Desai C. S, Elementary Finite Elements Method Zienkiewicz O. C., The Finite Element Method Reddy J. N, An introduction to the Finite Element Method Larry J. Segerlind, Applied finite element analysis 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Basic concepts of FEM - a general procedure for finite element analysis, brief history of finite element method, linear spring as a finite element, elastic bar, spar/link/truss element. Strain energy, Castigliano's first theorem, minimum potential energy.	10	20 %
FIRST SERIES TEST			
II	Truss structures: The direct stiffness method - Nodal equilibrium equation, element transformation and direct assembly of global stiffness matrix, boundary conditions, constraint forces, element strain and stress, three dimensional trusses. Flexure - elements - elementary beam theory, flexure element, flexure element stiffness	6	20%

	matrix and element load vector, work equivalence for distributed loads, flexure element with axial loading.	7	
III	Method of weighted residuals - introduction, method of weighted residuals, the Galerkin finite element method, application of Galerkin's method to structural elements - spar element, beam element. Interpolation function for general element formation - compatibility and completeness requirements, polynomial forms- one dimensional elements, triangular elements, rectangular elements, three dimensional elements, isoperimetric formulations, axisymmetric elements, numerical integration: Gaussian quadrature.	7 7	30%
SECOND SERIES TEST			
IV	Applications in solid mechanics - plane stress, plane strain - rectangular element, isoparametric formulation of plane quadrilateral element, axisymmetric stress analysis, general three dimensional stress - finite element formulations, strain and stress computations, practical considerations. Torsion - boundary condition, torque. Introduction to FEM software.	13	30%

Course No: 03 ME 6221	Course Name: ADVANCED THEORY OF MECHANISMS	L-T-P- Credits 3-0-0-3	Year of Introduction: 2015
Course Objectives: Helps the students to understand: <ul style="list-style-type: none"> • The classification of space mechanisms and the synthesis theory of mechanism • The mathematical tools for mechanism analysis and applications • The type synthesis theory of space mechanism • The basic theory for planar and space mechanism motion analysis • The motion analysis of planar and space mechanism • The evaluation indexes for mechanism performance • The dimensional synthesis method of mechanism 			
Syllabus: Review of determination of velocity and acceleration, Analytical and graphical methods, special methods for velocity and acceleration determination, Two position and three position synthesis, Geometric methods of synthesis, Chebychev Spacing- Overlay method Coupler curves, Robert's Law, Cognate mechanisms, Analysis of Cams, Cam size determination, Cam profile determination-Analytical and graphical. Advanced curves, polydyne cams. Cam force, Follower response-Phase plane method, Johnson's Numerical Analysis, Static and Dynamic Force Analysis			
Expected outcome: The student can design and analyse mechanism for specific needs			
References: <ul style="list-style-type: none"> • Holowenko, A.R, "Dynamics of Machinery", Wiley. • Allen S. Hall, Jr., "Kinematics and Linkage Design", Prentice Hall. • Shigley, J.E, John J. Uicker, "Theory of Machines and Mechanisms", • Hartenberg and Denavit, "Kinematic Synthesis of Linkages", McGraw Hill. • Arthur G. Erdman ,George N. Sandor, "Mechanisms Design Analysis and Synthesis -Vol. I and II", Prentice Hall of India. • J.E.Shigley, "Kinematics analysis of Mechanisms", McGraw Hill. • Robert L. Norton, "Design of Machinery", Tata McGraw Hill. • Rothbart H.A., "Cams", Wiley. • Merit, "Gears", Pitman. • Pahlen R.M., "Fundamentals of Mechanical Design", McGraw Hill. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Kinematics: Review of determination of velocity and acceleration of points and links in mechanisms- 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	12	20%
FIRST SERIES TEST			
II	Synthesis of Mechanisms: Two position and three position synthesis of four bar linkage and slider crank mechanism. - Relative poles	13	30%

	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.		
III	Analysis of Cams: Basic curves, pressure, angle-Cam size determination-Cam profile determination-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.	12	20%
SECOND SERIES TEST			
IV	Static and Dynamic Force Analysis: Forces, Couples. Conditions of equilibrium- Free body diagram. 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.	13	30%
END OF SEMESTER EXAM (MODULES I TO IV)			

Course No: 03ME6231	Course Name: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> • Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline. • Application of systematic engineering synthesis and design processes • Ethical conduct and professional accountability 			
Syllabus: Principles for manufacturability, mechanisms selection, Factors influencing form design, Design features to facilitate machining, drills, milling cutters, keyways, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly, Casting consideration, Design for the environment, Basic DFE methods, Design guide lines, Lifecycle assessment, Techniques to reduce environmental impact, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards			
Expected outcome:			
<ul style="list-style-type: none"> • Understand the role of manufacture and assembly within the overall aerospace design process • Evaluate and select manufacturing and assembly processes relevant to the aerospace industry • Quantify cost and metrics for manufacturing and assembly processes relevant to the aerospace industry • Review and select suitable manufacturing and assembly processes for a complex, well-defined aerospace component 			
References:			
<ul style="list-style-type: none"> • Boothroyd, G, Design for Assembly Automation and Product Design • Bralla, Design for Manufacture handbook • Boothroyd, G, Hertz and Nike, Product Design for Manufacture • Dickson, John. R, Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, • Fixel, J. Design for the Environment McGraw hill. • Graedel T. Allen By. B, Design for the Environment • KevienOtto,Kristin Wood, Product Design 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits - Datum features - Tolerance stacks. Factors influencing form design :Working principle, Material, Manufacture, Design-Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.	12	20%
FIRST SERIES TEST			

II	Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.	13	25%
III	Casting consideration: Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA	12	25%
SECOND SERIES TEST			
IV	Design for the environment: Introduction - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - Example application - Lifecycle assessment - Basic method - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly - Design for recyclability -Design for remanufacture - Design for energy efficiency - Design to regulations and standards.	13	30%
END OF SEMESTER EXAM			

Course No: 03ME 6241	Course Name: INDUSTRIAL TRIBOLOGY	L-T-P-Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> To design efficient tribological contacts for various engineering applications by using theoretical and investigational resources. Develop the vital knowledge both practical and theoretical in the field of tribology. Be able to use theoretical models to conduct calculations important in design and classification of tribological contacts and use investigational means to practically enumerate their properties. 			
Syllabus: Friction, Types of friction, fluid-laws of friction, friction theories, Wear, Classification, theories of wear, stages of wear, Lubrication, Role of lubrication, Lubricants, viscosity, fundamentals of viscous flow, Hydrodynamic bearings: Journal bearings, Somerfield number and design charts, Hydrostatic lubrication, linear slider bearing, Analysis of oil pads -hydrostatic step bearings, Rolling element bearings			
Expected outcome:			
The students will be able to			
<ul style="list-style-type: none"> Communicate the composition of lubricant film, and its properties and operational conditions such as load, temperature and speed to make precise designs for the type of applications in the industry and modern technology. Comprehend the basic and advanced theory of friction, lubrication and wear. This will include, dry friction, hydrodynamic, elasto-hydrodynamic and boundary lubrication, wear mechanisms 			
References:			
<ul style="list-style-type: none"> Radzimovsky: "Theory of lubrication of bearings", Mir Publications, 1972. O'Conner, Boy: "Standard Hand Book of Lubrication Engineering", McGraw Hill. Fuller D.D., "Theory and practice of lubrication for Engineers", John Wiley, 1973. I.M.Hutchings: Tribology-University of Cambridge Gwidon.W.Stachowiak, Andrew.W.Batchelor-Butterworth Heinemann Publishers Bharat Bhusan: Introduction to Tribology- John Wiley & Sons, Inc. Khonsari ,Booser: Applied Tribology: Bearing Design and Lubrication. SushilkumarSrivastva: Tribology in Industries. BC Majumdar: Introduction to Tribology of Bearing 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
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 plates - radial flow between	12	25%

	parallel circular plates - The continuity equation and Reynold's equation.		
FIRST SERIES TEST			
II	Hydrodynamic bearings: Journal bearings eccentricity - pressure distribution - load carrying capacity - friction and power loss - ideal and real bearings - leakage factors, Sommerfeld number and design charts. Oil flow and heat dissipation in bearings - Analysis of hydro thrust bearings - Fixed and pivoted shoe bearings.	12	25%
III	Hydrostatic bearings: 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.	13	25%
SECOND SERIES TEST			
IV	Rolling element bearings: Types, bearing theory, static and dynamic capacities, bearing life, selection of bearings, lubrication and mounting of bearings. Bearing failures.	13	25%
END OF SEMESTER EXAM			

Course No: 03ME 6251	Course Name: MECHATRONICS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> To create strong footing in science and focus in mechanical, electronics, control engineering, and software, with a concrete command of the newest technologies. To help design, analyze, and test “smart” products and procedures that include suitable technology. 			
Syllabus: Introduction to Mechatronics, Measurement Systems, Control Systems, Actuators, types, selection and applications, Sensors and transducers, Programmable Logic Controllers, Design and mechatronics case studies			
Expected outcome:			
<ul style="list-style-type: none"> Design and conduct trials to appraise the performance of a mechatronics system or module with respect to conditions, as well as to analyse and read data. Design mechatronics component, system or process to encounter desired needs. Use the methods, skills, and current engineering tools essential for engineering practice. 			
References:			
<ul style="list-style-type: none"> Bolton.W, Mechatronics Smaili.A , Mrad.F , "Mechatronics integrated technologies for intelligent machines" DevadasShetty, Richard A.Kolk, “Mechatronics systems design” Godfrey C. Onwubolu, "Mechatronics Principles and Applications" NitaigourPremchandMahalik, “Mechatronics Principles, Concepts and Applications” Michael B.Histand, Davis G.Alcitore,“ Introduction to Mechatronics and Measurement systems”. Bradley D.A, Dawson.D, Buru N.C and Loader A.J, “Mechatronics” Lawrence J.Kamm, “Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics” 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems - Control Systems. Actuators - Mechanical - Electrical - Fluid Power -Piezoelectric - Magnetostrictive - Shape memory alloy - applications - selection of actuators.	12	25%
FIRST SERIES TEST			
II	Sensors and transducers :Introduction - Performance Terminology - Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Selection of sensors - Signal processing.	12	25%
III	Programmable Logic Controllers: Introduction	12	25%

	- Basic structure - Input and output processing - Programming - Mnemonics-Timers, counters and internal relays - Data handling - Selection of PLC.		
SECONDD SERIES TEST			
IV	Design and mechatronics case studies: Designing - Possible design solutions- Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine - Engine Management system - Automatic car park barrier - Data acquisition Case studies.	12	25%
END OF SEMESTER EXAM			

Course No: 03ME 6261	Course Name: OPTIMIZATION TECHNIQUES FOR ENGINEERING	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: In the course the student will learn to: <ul style="list-style-type: none"> • Integrate traditional design procedures with ideas and practises of modern optimization theory. • Create an suitable simulation model of the design problem • Verbalize the optimization problem • Use numerical optimization techniques and computer support tools in order to solve the problem. 			
Syllabus: Introduction to Optimization, Formulation and Solution methodologies, Single and Multivariable optimization, Constrained non-linear optimization, quadratic programming, Integer and dynamic programming, tabular and calculus methods of solutions, Calculus of variations			
Expected outcome: <ul style="list-style-type: none"> • Comprehend Engineering optimization. • Categorize the optimization problems. • Understand various methods of linear programming and Dynamic programming. 			
References: <ul style="list-style-type: none"> •H.A. Taha, Operations Research: An Introduction •S. Rao, Engineering Optimization: Theory and Practice •D. Belegundu, T.R. Chandrupatla, Optimization Concepts and Applications in Engineering •H. M. Wagner, Principles of Operations Research • Harris, Fundamentals of Queuing Theory •M.S. Bazaraa, J.J. Jarvis, H.D. Serali, Linear Programming and Network Flows • Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Classical optimization techniques: Introduction to Optimization, Formulation and Solution methodologies, Single variable optimization, Multivariable optimization with no constraints, with equality constraints and with inequality constraints. Unrestricted search method, Interval halving method, Fibonacci method, Golden Section method, quadratic interpolation method, pattern search method, steepest descent method, quasi-Newton method, Hook & Jeeve's method, Lagrange multiplier method	12	20%
FIRST SERIES TEST			
II	Constrained non-linear optimization: Kuhn-Tucker conditions, quadratic programming, Wolfe's method, method of feasible directions,	13	20%

	Frank-Wolf method, convex simplex method, separable programming, Kelley's cutting plane method, penalty and barrier methods		
III	Integer and dynamic programming: Dynamic programming, principle of optimality - tabular and calculus methods of solutions, introduction to integer programming - Gomory's cutting plane method, branch and bound method.	13	30%
SECOND SERIES TEST			
IV	Calculus of variations: Problems with fixed end points and moving boundaries, strong and weak variations, first variation, problems with integral constraints, statement only of the corner conditions for discontinuous case, sufficient condition for strong and weak extrema	13	30%
END OF SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
03RM6001	Research methodology	1-1-0	2	2015

Course Objectives:

- This course is designed to familiarize the student with the research process, problem identification strategies and formulation of a research plan by doing case studies

Syllabus

Introduction to Research Methodologies - Objectives -motivation in research- Significance of research - interaction between industries and research units –research and innovation

Research Formulation- - literature review–

Ethics in research: – copy right – plagiarism – citation – acknowledgement

Research Design – and Report writing

Case Studies : Department / stream specific case study and preparation of a research plan or a review paper

Expected Outcomes:

- Students will be able to write a review paper after critically evaluating the state of the art development in a topic of interest
- Students will acquire capability to write a research proposal in the form of a technical paper which

could lead the student towards his / her final thesis topic

- **No formal end semester examination is intended – Evaluation is based on internal oral presentations and a Technical Report or a Research Plan or a Review Paper**

References

1. R. Paneersalvam, “Research Methodology”, Prentice Hall of India Pvt. Ltd., 2011
2. Mike Martin, Roland Schinzinger, “Ethics in Engineering” , McGraw Hill Education, Fourth Edition, 2014
3. Vinod V Sople, “Managing Intellectual Property-The Strategic Imperative, EDA”, Prentice of Hall Pvt. Ltd., 2014
4. Kothari C R & Gaurav Garg – “Research Methodology- Methods and Techniques”, New Age International(P) Ltd Publications, 2006
5. Day A Robert, “How to write and publish a scientific paper”, Cambridge University, UK, 2012
6. Leedy P D, “Practical Research-Planning and Design”, Prentice Hall of India Pvt. Ltd.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	<p>Introduction –Need for research- objectives and motivations in research-</p> <p>Significance of research - -need for interaction between academic institutions, industrial and research establishments – research and innovation.</p> <p>Research Formulation- Identifying a research problem- - literature review– confirming to a research problem based on literature review.</p>	4	25%
FIRST INTERNAL EXAM			
II	<p>Research Ethics – Environmental impacts – Ethical issues - Intellectual Property Rights – Patents – legal formalities in filing patent in India – Copy right– plagiarism – citation and acknowledgement.</p>	3	25%
III	<p>Research design –Prepare research plan.</p> <p>Report writing – types of report – research report, research proposal, funding agencies for research</p>	3	

	concerned to the specialization, significance of peer reviewed articles and technical paper- - simple exercises - oral presentation		
SECOND INTERNAL EXAM			
IV	<p>Case Studies</p> <p>The student is expected to prepare a research plan relating to a topic of current interest in the concerned specialization, which has appeared in a recent journal. A minimum of 20 related referred articles should be critically studied. On the basis of this, the student is expected to prepare a review report/paper of publishable quality.</p> <p>This paper has to be presented for open defence before the departmental committee. (This would carry 50% marks)</p>	6	50%
END SEMESTER EXAM			

Course No: 03 ME 6811	Course Name: DESIGN ENGINEERING LAB I	L-T-P- Credits: 0-0-2-1	Year of Introduction: 2015
Course Objectives: The objective of the course is <ul style="list-style-type: none"> To familiarise with basic concepts of vibration through experiments To study the use of various components like accelerometer, Charge amplifier, Oscilloscope, FFT analyser, laser displacement meter etc. To familiarise with data acquisition systems. To familiarise with programming tools of MATLAB 			
Reference: Design Engineering lab Manual by Dr Jayaraj Kochupillai			
Expected outcome: After the completion of the course, a student will be able to: <ul style="list-style-type: none"> Understand the process of vibration through experiments Can operate different equipment like accelerometer, Charge amplifier, Oscilloscope, FFT analyser, laser displacement meter Can read and understand data using front ends like LabVIEW Programming vibration and structural problems in MATLAB 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
	Note: 1) These are independent laboratory exercises 2) A student may be given one or two problems stated herein 3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Evaluation 4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation (Any EIGHT experiments out of TWELVE) Experiment #1 Study of vibrations of a box stationed on flexible springs. Main Equipment needed: Motor , Box, Springs, Variator, Tachometer , etc Experiment #2 Study of absorber system and its tuning for a fixed fixed beam. Main Equipment needed: Motor, Tuned damper, Variator, Auxiliary mass, Tachometer, etc. Experiment #3 Study of free and forced vibration using universal vibration machine Main Equipment needed: Speed controller,		

	<p>motor, disc, tachometer, spring, damper, drum etc.</p> <p>Experimental #4 Estimation of damping of beam specimen for different damping treatments Main Equipment needed: Beam specimen of Steel, Viscoelastic material for attachments, Accelerometer, Charge amplifier, Oscilloscope</p> <p>Experiment #5 Torsion of Prismatic bar with Rectangular cross-section. Elastic solutions, MATLAB Simulation, Finite Element Analysis of any chosen geometry, Correlation studies.</p> <p>Experiment #6 To find the natural frequencies and mode shapes of a free-free beam experimentally and verify the same analytically: Main Equipment needed: Vibration exciter, arbitrary function generator, free-free beam, Oscilloscope, Amplifier, laser displacement meter.</p> <p>Experiment #7 Vibration Characteristics of a Spring Mass Damper System, Analytical Solutions, MATLAB Simulation, Correlation Studies.</p> <p>Experiment #8 Noise mapping of a machine using sound intensity probe: Main Equipment needed: Sound Intensity probe and FFT analyzer</p> <p>Experiment #9 To verify the inverse square law for sound : Main Equipment needed: Frequency generator, speaker and sound level meter</p> <p>Experiment #10 Study of various function of Sound Level Meter and use it for field measurements Main Equipment needed: Integrating Sound level Meter, Calibrator etc.</p> <p>Experiment #11 To study the sound of musical instruments Musical Instruments Main Equipment needed: microphone, amplifier, FFT Analyzer</p> <p>Experiment #12: Determination of natural frequencies and mode shapes of a free-free plate. Main Equipment needed: Laser displacement meter/Accelerometer, Oscilloscope, Exciter, plate, LabVIEW sound and vibration tool kit</p>		
--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	--

Course No.	Course Name	L-T-P	Credits	Year of Introduction
03ME6901	SEMINAR-I	0-0-2	2	2015

Course Objectives

1. To develop thought process of their own liking subject
2. To learn to write technical reports.
3. To present and defend their work in front of technically qualified audience.

Syllabus

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. They are required to choose a topic of their interest from Thermal Engineering related topics preferably from outside the M.Tech syllabus and give a seminar on that topic. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Course Outcomes

1. Student should develop thought process of their own liking subject
2. Students will learn to write technical reports.
3. Students will develop skills to present and defend their work in front of technically qualified audience.
4. Through independent learning and collaborative study, attain, and develop knowledge in the engineering sciences, , with disciplinary specialization and the ability to integrate information across disciplines.
5. Acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication that demonstrates respect and understanding in a complex society.

SEMESTER II

Course No: 03 ME 6202	Course Name: CONTINUUM MECHANICS	L-T-P-Credits: 4-0-0-4	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> • Instruct students for reading papers and textbooks inscribed in up-to-date index of symbolic notation: • Introduce student to basic notion and rules of tensor calculus as well as basic idea and laws of continuum mechanics. • Learn elastic behaviour of materials (hyper-elasticity, linear elasticity) and plasticity (basic concepts of small strain and large strain plasticity) 			
Syllabus: Mathematical Preliminaries, Theory of Matrices, Vector Calculus, Tensors, Stress Principles, Kinematics of Deformation and Motion, Fundamental Laws and Equations, Linearized Elasticity Problems			
Expected outcome:			
After this course, the students should learn:			
<ul style="list-style-type: none"> • Basics of tensor calculus – how to deliver expressions • How to define motion and deformation of body • Different stress measures • Basic laws of Continuum mechanics 			
References:			
<ul style="list-style-type: none"> • G. T Mase, G E. Mase, R E. Smelser. Continuum mechanics for engineers • J. N. Reddy, An Introduction to Continuum Mechanics with applications • Y. C. Fung, A First Course in Continuum Mechanics for Physical and Biological Engineers and scientists • Han-Chin Wu, Continuum mechanics and plasticity • Sudhakar Nair, Introduction to Continuum Mechanics • J.H. Heinbockel, Introduction to Tensor Calculus and Continuum Mechanics • W. Michael Lai, David Ribin, Erhard Kaempl, Introduction to continuum Mechanics • Morton E. Gurtin, An introduction to continuum mechanics • K. J. Bathe, Finite element procedures • S.P. Timoshenko, J.N. Goodier, Theory of Elasticity • D. S. Chandrasekharaiah, LokenathDebnath, Continuum Mechanics 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	<p>Mathematical Preliminaries: Summation Convention, Transformation Law for Different Bases, vector space: Metric, Norm</p> <p>Theory of Matrices: Inner product, Inner product Spaces, Cauchy – Schwarz inequality, Norm, Orthogonality, Orthonormal basis, Expansion in terms of orthonormal basis, Orthogonal complement, Decomposition of a vector with respect to a subspace and its orthogonal complement.</p> <p>Vector Calculus: Differentiation of a Vector with Respect to a Scalar, Curvilinear Coordinates</p>	13	20%

	The Fundamental Metric, Derivative of a Scalar Function of a Vector, Del Operator. Divergence and Curl of a Vector, Cylindrical and Spherical Coordinate Systems Gradient, Divergence, and Curl Theorems.		
FIRST SERIES TEST			
II	Tensors: Dyads and Polyads, Nonion Form of a Dyadic, dual vectors and tensors, Tensor Calculus, Eigenvalues and Eigenvectors of Tensors, Eigenvalues and eigenvectors of a real symmetric tensor, spectral theorem, Calculation of eigenvalues and eigenvectors . Stress Principles The Stress Tensor, Principal Stresses, Mohr's Circles for Stress, Plane Stress, Deviator and Spherical Stress States, Octahedral Shear Stress, Cauchy's Formula. Other Stress Measures - First Piola-Kirchhoff Stress Tensor, Second Piola-Kirchhoff Stress Tensor.	13	20%
III	Kinematics of Deformation and Motion: Particles, Configurations, Deformations and Motion, The Material Derivative, Deformation Gradients, , Finite Strain Tensors, Infinitesimal Deformation Theory, Compatibility Equations, Velocity Gradient, Rate of Deformation, Vorticity, Strain Measures, Cauchy-Green Deformation Tensors, Green Strain Tensor, Physical Interpretation of the Strain Components, Principal Strains, Polar Decomposition Theorem. Objective tensors, objective rates, Jaumann stress rate and hyper elasticity. Fundamental Laws and Equations: Conservation of Mass, Continuity Equation, Equations of Motion, Lagrangian Equations of Motion, Moment of Momentum ,Principle, Law of Conservation of Energy, Generalized Hooke's Law, Orthotropic Materials, Isotropic Materials, Transformation of Stress and Strain Components.	13	30%
SECOND SERIES TEST			
IV	Linearized Elasticity Problems Elasticity, Hooke's Law, Strain Energy, Hooke's Law for Isotropic Media, Elastic Constants Elastic Symmetry; Hooke's Law for Anisotropic Media, Isotropic Elastostatics and Elastodynamics, Superposition Principle, Saint-Venant Problem, Extension, Torsion, Pure Bending, Flexure, Plane Elasticity, Airy Stress Function, Three-Dimensional Elasticity.	13	30%
END OF SEMESTER EXAM			

Course No: 03 ME 6212	Course Name: FRACTURE MECHANICS	L-T-P-Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: The course will help the students to understand: <ul style="list-style-type: none"> • Applications of linear and nonlinear fracture mechanics principles in structural design. • Testing methods and understanding of fracture phenomena in metals and non-metals • Role of Fatigue crack growth and its mechanism 			
Syllabus: The geometry of stress and strain, elastic deformation, plastic and elasto plastic deformation - limit analysis- Fatigue testing methods - Linear elastic fracture mechanics - Linear elastic fracture mechanics - mixed mode problems-Elastic plastic fracture mechanics (EPFM)- Mechanisms of fracture and crack growth- Basic Aspects of Dynamic Crack Growth- Basic Principles of Crack Arrest.			
Expected outcome: On completion of the course the student should be able to: <ul style="list-style-type: none"> • Predict material failure for any combination of applied stresses. • Estimate failure conditions of a structure • Handle the testing for fracture • Analyse the crack and crack growth in materials 			
References: <ul style="list-style-type: none"> • M. Janssen, J. Zuidema and R. J. H. Wanhill., Fracture Mechanics. • Broek D., Elementary Engineering Fracture Mechanics • T.L. Anderson , Fracture Mechanics Fundamentals and Applications • Prashant Kumar, Elements of Fracture Mechanics • Kanninen, M.F and Popelar, C.H, Advanced fracture mechanics. • Knott, J.F., Fracture in engineering materials • Horteberg, R.W., Determination of fracture mechanics of engineering materials • John M. Barson and Stanely T. Rolfe, "Fracture and Fatigue Control in Structures 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: The geometry of stress and strain, elastic deformation, plastic and elasto plastic deformation - limit analysis. Damage tolerant fracture mechanics - Fatigue testing	12	20%

	methods - statistical nature of fatigue data - theories of fatigue - crack initiation and growth in fatigue - notches and stress concentration - Stress intensity solutions for 2-D and 3-D crack geometries - Fractography - Structure modes and types.		
FIRST SERIES TEST			
II	Fracture mechanics: Significance of fracture mechanics - Linear elastic fracture mechanics (LEFM)-Griffith energy balance approach - Irwin's modification to the Griffith theory - instability and R curve- Stress analysis of cracks- fracture toughness - modes I, II & III - mixed mode problems expressions for stresses and strains in the crack tip region - finite specimen width - superposition of stress intensity factors (SIF) - SIF of centre cracked plate, single edge notched plate, and embedded elliptical cracks R- curve concept- thickness effect- Crack tip plasticity: Irwin plastic zone size -Dugdale approach - shape of plastic zone - state of stress in the crack tip region - influence of stress state on fracture behavior- LEFM testing: Plane strain and plane stress fracture toughness testing -determination of R- curves.	13	30%
III	Elastic plastic fracture mechanics (EPFM): Development of EPFM - J- integral - Definition- Path independence- Application to engineering problems- crack opening displacement (COD) approach -COD design curve - relation between J and COD - tearing modulus concept - standard JIc test and COD test.	12	25%
SECOND SERIES TEST			
IV	Fatigue crack growth: Mechanisms of fracture and crack growth- Description of fatigue crack growth using stress intensity factor - effects of stress ratio - crack closure - prediction of fatigue crack growth under constant amplitude and variable amplitude loading - Fatigue Crack Initiation Time- to- failure (TTF) tests - crack growth rate testing - practical significance of sustained load fracture testing - Basic Aspects of Dynamic Crack Growth- Basic Principles of Crack Arrest - Fracture Mechanics Analysis of fast fracture and Crack Arrest.	12	25%
END OF SEMESTER EXAM			

Course No: 03 ME 6222	Course Name: DESIGN OF POWER TRANSMISSION ELEMENTS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives:			
<ul style="list-style-type: none"> To introduce the design procedure for different power transmission elements like chain and belt drives, gear boxes, Brakes and clutches 			
Syllabus: Design of Chain and belt drives, Friction drives, Design of speed gear boxes, Brakes, Clutches			
Expected outcome:			
<ul style="list-style-type: none"> The student can handle the design of different power transmission elements 			
References:			
<ul style="list-style-type: none"> Newcom and Spurr, "Braking of road vehicles", Chapman and Hall. Nieman, "Design of Machine elements - Vol. II", Springer Verlag. Reshetov, "Design of Machine elements", Mir Publication. Dobrovolsky, "Design of Machine elements", Mir Publishers. Wong, "Theory of Ground Vehicles", Wiley. 			
Course Plan			

Module	Contents	Hours	Sem. Exam Marks
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.	12	25%
FIRST SERIES TEST			
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	12	25%
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.	12	25%
SECOND SERIES TEST			
IV	Clutches: Friction Clutches, Centrifugal Clutches, Analysis, dynamics and thermal aspects of clutches, design of automobile clutch: single plate, multi plate, cone clutch, overrunning clutches.	12	25%
END OF SEMESTER EXAM			

Course No: 03 ME 6232	Course Name: ADVANCED DESIGN SYNTHESIS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives:			
Syllabus: Special methods of Velocity and Acceleration , coupler curves, , Geometric methods of synthesis- three accuracy points, four accuracy points- Algebraic methods of synthesis- Crank and follower synthesis, Spatial motion and spatial linkages			
Expected outcome:			
References:			
<ul style="list-style-type: none"> Kinematic synthesis of Linkages by Richard.S.Hartenberg, Jacques Denavit, McGraw Hill Book Company 			

- Kinematics and linkage design by Allen.S. Hall, Pentice Hall of India, Ltd.
- Theory of Mechanisms and Machines by Shigley, McGraw Hill International Edition.
- Dynamics of Machinery by A.R.Holowenko

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Floating Link, Special methods of Velocity and Acceleration Analysis using auxiliary points, Overlay method for conditioned crank mechanisms, coupler curves. Roberts - chebyshev theorem, Inflection circle, Euler Savery equation, Hartman construction, Bobillier construction, synthesis using Optimum transmission angle.	12	20%
FIRST SERIES TEST			
II	Synthesis- Two point synthesis, Geometric methods of synthesis with three accuracy points:- poles of four bar linkages, Relative poles of four bar linkages, Function generators, poles of slider crank mechanisms, Relative poles of slider crank mechanisms, Rectilinear recorder mechanisms.	13	25%
III	Geometric methods of synthesis with four accuracy points:- pole triangles, center point curves, Circle point curves, Construction of circle points, Cardinal points, opposite poles, Pole quadrilaterals, Function Generators, Rectilinear mechanisms.	12	25%
SECOND SERIES TEST			
IV	Algebraic methods of synthesis using displacement equations: - Displacement equation of four bar linkage, Crank and follower synthesis- three accuracy points, Crank and follower synthesis: - angular velocities and accelerations, Syntheses of slider crank mechanism with three accuracy points. Synthesis of slider crank mechanism with four accuracy points. Algebraic methods of synthesis using complex numbers. Spatial motion and spatial linkages, Types of spatial mechanisms, Single loop linkage and multiple loop linkages. Mechanisms in Robots	13	30%
END OF SEMESTER EXAM			

Course No: 03 ME 6242	Course Name: DESIGN ENGINEERING	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: By taking this course, the student will study: <ul style="list-style-type: none"> • the morphology of design • the design considerations for manufacturing • study the concept of assembly line design • the role of reliability in design 			
Syllabus: Morphology of Design, Organization for design, Design considerations, Design for Manufacture, Design for Assembly, reliability in design			
Expected outcome: The course will help the students to understand and handle the design process which is followed in in industries.			
References: <ul style="list-style-type: none"> • M.F.Spotts, "Mechanical Design Analysis", Prentice Hall. • KareHellan, "Introduction to Fracture Mechanics", McGraw Hill. 			

- P. Orlov, "Fundamentals of Machine Design Vol. I, II, III", Mir publications.
- C.O. Smith, "Introduction to Reliability in Design", McGraw Hill.
- L.Sreenath, "Concepts in Reliability", Affiliated East West Press.
- Woodson T.T., "Introduction to Engineering Design" McGraw Hill.
- W.H. Mayall, Industrial Design for Engineers, Iliffe.
- Pahl, G, and Beitz, W., "Engineering Design", Springer - Verlag, NY.
- Ray, M.S., "Elements of Engg. Design", Prentice Hall Inc.
- Suh, N.P., "The principles of Design", Oxford University Press, NY.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Design Fundamentals - Importance of design- The design process-Considerations of Good Design - Morphology of Design - Organization for design, Design considerations - material selection, functional design, cost analysis. Fatigue considerations in design - fatigue in materials - fracture mechanics approach to fatigue - theories of fracture - nucleation and growth of fracture - creep in materials - laws of creep - estimated time to rupture - relaxation and creep in bending.	12	20%
FIRST SERIES TEST			
II	Design for wear and corrosion resistance - contact stresses - the plastic flow process - shape factor - spring back - residual stresses. Design consideration of rubber springs, air springs and Belleville springs. Design for Manufacture - Design for Assembly - Designing for castings, Forging, Metal Forming, Machining and Welding.	12	20%
III	Advanced shaft design - deflection of stepped shafts - variable cross-section shafts - conjugate beam and strain energy method. Design of high speed cams - kinematic design and dynamic design - polydyne cams.	13	30%
SECOND SERIES TEST			
IV	Introduction to reliability in design - reliability function, failure data analysis, failure distribution functions, MTTF/MTBF, hazard rate and models, methods of improving reliability, reliability testing. Industrial product design - Creative design, ergonomics and aesthetic requirements - quality and maintainability considerations.	13	30%
END OF SEMESTER EXAM			

Course No: 03 ME 6252	Course Name: DESIGN OF PRESSURE VESSELS AND PIPING	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: To familiarise with the design procedures and codes used in the design of pressure vessels and piping systems			
Syllabus: Design and analysis of unfired pressure vessels, Shell components, Design of vessels, Design for wind load, Theory of reinforcement, Buckling of pressure vessels, Effect of supports on Elastic Buckling of Cylinders, Design and analysis of piping systems			
Expected outcome: The student will be able to design independently the systems as per industrial needs			
References: <ul style="list-style-type: none"> • John F. Harvey, "Pressure Vessel Design", CBS publishers, 2007. • Henry H. Bedner, "Pressure Vessels", Design Hand Book, CBS publishers, 2007. • William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Presented at ASME Pressure Vessels and Piping Conference, 1997. • ASME Code for Pressure Vessel Design 			

- Dennis R Moss Pressure vessel design manual Gulf publishing, 2003.
- Brownell, L. E., and Young, E. H., Process Equipment Design, John Wiley and Sons,
- SomnathChathopadhyay, Pressure vessels Design and practice, C.R.C Press

Course Plan

Module	Contents	Hours	Sem. Exam Marks
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.	13	25%
FIRST SERIES TEST			
II	Design of vessels: Design of tall cylindrical self-supporting process columns - supports for short vessels -Support for horizontal vessels- Design for wind load- Design for seismic load- Theory of reinforcement - Design of cone cylinder intersections - Use of codes	13	25%
III	Buckling of pressure 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	13	25%
SECOND SERIES TEST			
IV	Design and analysis of piping systems - pipes and tubing under external and internal pressure -design of tube-sheets and tube seats, and use of post-weld heat treatment to affect residual stress in final rupture.	13	25%
END OF SEMESTER EXAM			

Course No: 03 ME 6262	Course Name: MECHANICS OF COMPOSITE MATERIALS	L-T-P-Credits 3-0-0-3	Year of Introduction: 2015
Course Objectives: To develop an understanding of <ul style="list-style-type: none"> • The linear elastic analysis of composite materials. • The mechanics and manufacturing of composites 			
Syllabus: General characteristics, Applications. Static Mechanical Properties, Characteristics of fibers and matrices, Manufacturing, Stress Analysis of Composite Laminates, Failure predictions,			
Expected outcome: The student will get an indepth knowledge about the composite materials and about its mechanics, manufacturing and uses			
References: <ul style="list-style-type: none"> • Autar K Kaw, "Mechanics of Composite Materials", CRC Press. • Chawla K K, "Composite Materials", Springer - Verlag. • Carlos A., Cristóvão M., Manuel J. M. Freitas, "Mechanics of Composite materials and Structures". Kluwer Academic. • SeropeKalpakjian, Steven Schmid, "Manufacturing engineering and technology", Prentice Hall. • Mallick, P.K., "Fiber-Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc. • Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley, New York 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Definition- Need - General characteristics, Applications. Static Mechanical Properties - Fatigue and Impact Properties - Environmental effects - Long term properties, Fracture behavior and Damage Tolerance. Fibers-Glass, Carbon, Ceramic and Aramid fibers. Matrices - Polymer, Graphite, Ceramic and Metal matrices - Characteristics of fibers and matrices. Fiber surface treatments, fillers and additives, Fiber content, density and void content.	12	20%
FIRST SERIES TEST			
II	Mechanics: Rule of mixture - volume and mass fractions - density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi - empirical model -Longitudinal Young's modulus - transverse Young's modulus - major Poisson's ratio - In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber reinforced lamina - laminates - lamination theory. Inter laminar stresses.	13	30%

III	Manufacturing: Bag moulding - Compression moulding - Pultrusion - Filament Winding -Other manufacturing Processes - Quality Inspection Methods. Processing of MMC - diffusion bonding - stir casting - squeeze casting.	12	20%
SECOND SERIES TEST			
IV	Analysis: Stress Analysis of Composite Laminates, Failure predictions - maximum stress theory, maximum strain theory, Tsai-Hill theory, Laminate Design considerations, Modes of failure of composites - First Ply Failure, Partial Ply Failure, Total Ply Failure.	13	30%
END OF SEMESTER EXAM			

Course No: 03 ME 6272	Course Name: ADVANCED MACHINE TOOL DESIGN	L-T-P- Credits 3-0-0-3	Year of Introduction: 2015
Course Objectives: To familiarise with <ul style="list-style-type: none"> • Kinematic structure of machine • Design of machine tool structures • Control systems • Hydraulic and pneumatic systems for machine tool 			
Syllabus: Kinematics of Machine tools, Kinematic structure of Machine, Selection and Design of power drives, Design of Machine tool structures, Automatic machine tools and Transfer machines with control systems, Hydraulic & Pneumatic Systems for machine tools.			
Expected outcome: After this course, the student will <ul style="list-style-type: none"> • Study the kinematic structure of machines • Handle the design of different machine tool structures • Study the details of automatic machine tools • Study the different hydraulic and pneumatic systems for machine tools 			
References: <ul style="list-style-type: none"> • M. Weck, "Handbook Of Machine Tools, Vol. 1-4", John Wiley, USA • Cyril Donaldson, G.H.LeCain& V.C. Goold, "Tool Design", Tata McGraw Hill. • J. Tlusty&F.Koenigsbeger, "Machine Tool Structure, Vol. 1", Pergamon press, UK • Pippengar, John J. and Koff Richard M, "Fluid Power Controls", McGraw Hill. • Pippengar, John J. and Hicks, Tyler G, "Industrial Hydraulics", McGraw Hill. • Leskiewics H.J. and Zarhmba M., "Pneumatic and Hydraulic components and Instrumentations in Automatic Controls", International Federation of Automatic controls. • Acherkan N., "Machine Tool Design", Vol. I - IV, Mir Publications. • Mehta, N.K., "Machine Tool Design", Tata McGraw Hill 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Kinematics of Machine tools: Classifications of motions for shaping surfaces, Kinematic structure of Machine tools having mechanical and non-mechanical kinematic constraints. Machine tool dynamics, Selection of power drives. Design of drives. Transmission ratio, Design and classification of Speed and feed gear boxes, Step less drives, Bearing selection, Mechanism for rectilinear motion, Reversing devices.	12	25%
FIRST SERIES TEST			
II	Design of Machine tool structures like beds, columns, Tables, Cross rails, Carriages, Design	12	25%

	of slide ways and Circular ways-Static and Dynamic stiffness, Profiles, application of new materials - treatment of slide ways. Thermal aspect in machine tool design, Machine tool noise and concepts of noise control.		
III	Automatic machine tools and Transfer machines with control systems: Selection of control systems, Control systems with pre-selection of speeds or feeds, Manual and Automatic controls, Remote controls, Safety devices in machine tools. Significance of Machine tool automation, working members, Application of CAD/CAM/CIM in Machine tool design, N.C machines, C.N.C Machines, Transfer machines & their controls. Recent trends in machine tool design.	12	25%
SECOND SERIES TEST			
IV	Hydraulic & Pneumatic Systems for machine tools: General principles of Hydraulic and Pneumatic drives. Different types control valves for Hydraulic and Pneumatic circuits, Hydraulic & Pneumatic circuit design for machine tools.	12	25%
END OF SEMESTER EXAM			

Course No: 03 ME 6282	Course Name: COMPUTATIONAL FLUID DYNAMICS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: To give an in-depth knowledge in the field of computational fluid dynamics			
Syllabus: An overview of CFD, governing equations, Viscous flow, stream function, vorticity, transport equation and solution, Applications on flow past bodies, Grid generation and solution, Stability analysis, Numerical Grid Generation, Solution of time dependent problems, Finite volume method, Governing equations for incompressible variables in primitive variables, Calculation flow field - Algorithms for pressure velocity coupling.			
Expected outcome: The student will <ul style="list-style-type: none"> • Basics of CFD • The effects of flow past bodies and its applications • Stability analysis • Familiarise and train in the field of finite volume method 			
References: <ul style="list-style-type: none"> • J.D. Anderson, "Computational Fluid Dynamics", McGraw Hill. • Fletcher C.A., "Computational Techniques for Fluid Dynamics - Vol 1 & 2", Springer Verlag. • S V Patankar, "Numerical Heat Transfer", Hemisphere. • K Muralidhar, T Sundrarajan, "Computational Fluid Flow and Heat Transfer", Narosa Publishers. • K.Muralidhar, G. Biswas, "Advanced Engineering Fluid Mechanics", Narosa Publishers. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	An overview of CFD: Fluid properties, characteristics, governing equations - potential, inviscid and viscous flow. Classification of partial differential equations. Co-ordinate transformations: General and special (Cartesian, Cylindrical and Spherical Co-ordinates). Derivation of equations for generalized curvilinear coordinates, finite difference approximations for space and time coordinates.	12	10%
FIRST SERIES TEST			
II	Viscous flow: A Finite difference scheme for solution of viscous flow - stream function vorticity -vorticity transport equation-solution of stream function equations-wall vorticity estimation- solution of vorticity transport equation-procedure	13	30%

	for drawing contours (Stream function and iso-vorticity) plot and velocity vector plot. Applications on flow past bodies such as isolated airfoils and airfoils in cascades.		
III	Grid generation and solution: Stability analysis - solution of Laplace equation for regular and irregular geometrics using finite difference method. Numerical Grid Generation- Elliptical and Hyperbolic grids. Solution of time dependent problems- Explicit and implicit schemes. Implementation of prescribed and gradient boundary conditions.	13	30%
SECOND SERIES TEST			
IV	Finite volume method: Finite volume method for convection - diffusion equations- Governing equations for incompressible variables in primitive variables - upward - hybrid and power law schemes - Discretization for one, two and three dimensions - false diffusion - Calculation flow field - Algorithms for pressure velocity coupling- semi implicit method for pressure linked equations - solution of two and three dimensional problems in Cartesian and cylindrical coordinate systems.	13	30%
END OF SEMESTER EXAM			

Course No: 03 ME 6292	Course Name: EXPERIMENTAL STRESS ANALYSIS	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: Give an in depth knowledge about the techniques used in experimental methods			
Syllabus: Principal stresses and strains- Three dimensional stress, Strain gauges - Types and applications, Theory of photo elasticity and applications, Stress analysis techniques, application of Holography, Non-destructive testing			
Expected outcome: The student will get an in-depth knowledge in: <ul style="list-style-type: none"> • The use and application of strain gauges • Photo elasticity and its applications • Holography and its principles • The different methods of NDT 			
References: <ul style="list-style-type: none"> • Dalley and Riley, "Experimental stress Analysis", McGraw Hill. • Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi. • Dove and Adams, "Experimental Stress Analysis and Motion measurement", Prentice Hall. • Hetenyi, "Handbook of Experimental stress Analysis", John Wiley. • Perry and Lissener, "Strain gauge Primer", McGraw Hill. • W.J. McGonagle, "Non-destructive Testing", McGraw Hill. • American Society for Metals, "Metals Hand Book - Vol.7". 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Principal stresses and strains- Three dimensional stress - strain relationships -Plane stress and Plane strain conditions. Strain gauges - Types - Mechanical, Optical and Electrical strain gauges - Electrical resistance strain gauges - Gauge factor - Strain gauge circuitry - Temperature compensation - Bridge balancing and calibration of D.C and A.C bridges	12	15%
FIRST SERIES TEST			
II	Application of strain gauges :- Transverse sensitivity - Selection and mounting of strain gauges - Strain gauge rosettes - Analysis of strain gauge data and stress calculations -Recording equipments for static and dynamic strains - Strain gauge transducers - Introduction to semiconductor strain gauges - Residual stresses - Beneficial and harmful effects - Principle of residual stress measurement methods.	12	25%
III	Photoelasticity: Theory of photoelasticity -	13	30%

	Stress-optic law - Plain Polariscope & Circular Polariscope - Isoclinic & Isochromatic fringes - Partial fringe value and compensation techniques - Tardy's Method. Photoelastic model materials and their desired properties- use of photo elastic coatings. Applications of Photoelasticity for two dimensional models - Separation of Principal stresses - Scaling models to prototype. Introduction to 3D Photoelasticity.		
SECOND SERIES TEST			
IV	Other Stress analysis techniques- Moire fringe method and Brittle coating technique for stress analysis. Introduction to Holography in stress analysis. Non-destructive testing - Types - Dye penetrate methods, Radiography, X-ray and Gamma ray - X-ray fluoroscopy - Penetrameter - Magnetic particle method. Introduction to lasers in NDT - Ultrasonic flaw detection	13	30%
END SEMESTER EXAM			

Course No: 03 ME 6302	Course Name: ADVANCED THEORY OF VIBRATION	L-T-P- Credits: 3-0-0-3	Year of Introduction: 2015
Course Objectives: To give the students an comprehensive knowledge in the field of vibration			
Syllabus: Probability Theory & Random variables, Axioms of probability theory, Probability distributions and density functions of random variables, Stochastic Processes concepts and applications, power spectral density function, Stationarity and non-stationarity, Continuity & differentiability, Review of deterministic dynamics and impulse response functions of systems, Vibration control, Active Vibration Control, Experimental methods in vibration analysis			
Expected outcome: The student will learn the following: <ul style="list-style-type: none"> • Detailed knowledge in Probability • The basics of Stochastic Processes • Methods of vibration analysis • Familiarize vibration analysis through experimentation 			
References: <ul style="list-style-type: none"> • Leonard Meirovitch - Elements of Vibration Analysis, McGraw Hill. • Lin Y.K., –Probability Theory In Structural Dynamics, McGraw Hill. • Bendat & Piersol, –Random Data Analysis And Measurement Procedure I, Wiley Inter Science, John Wiley • Thomson W.T, Theory of Vibration with Applications., Prentice Hall India. • Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Probability Theory & Random variables- Introduction to Random vibration & probabilistic modeling. Axioms of probability theory: probability space & random variables. Probability distributions and density functions of random variables, joint and marginal distribution and density functions, functions of random variables. Expectations and moments of random variables, Baye's theorem, conditional random variables, conditional expectations. uences of random variables, stochastic convergence, limit theorems.	12	20%
FIRST SERIES TEST			
II	Stochastic Processes- Concepts of stochastic processes, probability distributions, moments, correlation and covariance functions. The power spectral density function, Stationarity and non- stationarity of stochastic processes, ergodicity of a stochastic process. Limits of a stochastic process, Continuity &	13	30%

	differentiability, stochastic derivatives and integrals.		
III	Linear Vibration Analysis- Review of deterministic dynamics and impulse response functions of systems, system response to random excitations.- Response to stationary & weakly stationary excitations and to delta-correlated excitations, Response to Gaussian excitations. Non-stationary excitations. Generalization to multi degree-of-freedom systems.	13	30%
SECOND SERIES TEST			
IV	Vibration control: Specification of Vibration Limits -Vibration severity standards-Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing - Vibration Control by Design Modification- - Active Vibration Control Experimental methods in vibration analysis: Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors-Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic and Electrostatics -Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes.	12	20%
END OF SEMESTER EXAM			

Course No: 03 ME 6902	Course Name: MINI PROJECT	L-T-P- Credits	Year of Introduction
Course Objectives: To give an opportunity to the student to achieve integrated mechanical design of a product through parts design assembly preparation of manufacturing drawings.			
Expected outcome: <ul style="list-style-type: none"> • Use of design principles and develop conceptual and engineering design of any components. • Ability to integrate the parts design with assembly and ability to prepare manufacturing drawings 			
Course Plan			
Guideline for review and evaluation: Each student's works under a project supervisor. The product system /component(s) to be designed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners			

Course No: 03 ME 6812	Course Name: Design Engineering Lab II	L-T-P- Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> • Give hands on training in modal analysis and vibration studies using experiments and simulation 			
Expected outcome:			
<ul style="list-style-type: none"> • The students will be able to conduct modal analysis independently. • Become experienced in the use of different software • Will be able to design and analyse vibration related experiments • Studies the experimentation on sound and vibration 			
Reference:			
Design Engineering Lab Manual by Dr Jayaraj Kochupillai			
Course Plan			
Contents		Hours	Sem. Exam Marks
<p>Note:</p> <ul style="list-style-type: none"> • These are independent laboratory exercises • A student may be given one or two problems stated herein • Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Evaluation • Any one of the exercises done from the following list has to be asked in the Examination for evaluation <i>(Any EIGHT experiments out of TWELVE)</i> <p>Experiment #1 Structural Analysis:FE modelling of a stiffened Panel using a commercial pre-processor, Buckling, Bending and Modal analysis of stiffened Panels, Parametric Studies.</p> <p>Experiment #2 Design Optimization: Shape Optimization of a rotating annular disk, Weight Minimization of a Rail Car Suspension Spring, Topology Optimization of a Bracket.</p> <p>Experiment #3 Determination of natural frequencies corresponding mode shapes of the disc and mode shapes Equipment Required: Accelerometers, oscilloscope, charge amplifier, electro-dynamics exciter, disk etc.</p> <p>Experiment #4 Modal analysis of a beam – by using impact hammer, and by using shaker: Equipment required: Accelerometers, oscilloscope, charge amplifier, impact hammer, electro-dynamic exciter, beam and its fixer etc.</p> <p>Experiment#5 Modal analysis of plate – by using impact hammer, and by using shaker: Equipment required: Accelerometers, oscilloscope, charge amplifier, impact hammer, electro-dynamic exciter, plate and its fixer etc.</p>			

<p>Experiment #6 Modal analysis of beam by modeling in CAD software and exporting the same to finite element analysis software. Any FEM Software package, (ANSYS/NASTRAN/ABACUS/ADINA/COMSOL) Any 3D modelling CAD package (Pro-E, Inventor, Solidworks, Catia)</p> <p>Experiment #7 Modal analysis of plate using to finite element analysis software. Any FEM Software package, (ANSYS/NASTRAN/ABACUS/ADINA/COMSOL) Any 3D modelling CAD package (Pro-E, Inventor, Solidworks, Catia)</p> <p>Experiment #8 Modal analysis of beam using computer program code Software - MATLAB/FORTRAN/C++</p> <p>Experiment #9 Modal analysis of plate using computer program code Software - ATLAB/FORTRAN/C++</p> <p>Experiment #10 For a single degree of freedom spring mass damper system subject to forced harmonic vibration, measure the FRF and identify the mass, stiffness and damping using the peak picking method. Requirements: Spring mass system, accelerometer, FFT analyzer, exciter</p> <p>Experiment #11 Determination of spatial distribution of SPL of a Noise Generator Equipment required: Signal generator, amplifier, speaker, sound level meter</p> <p>Experiment #12 Study of the frequency distribution of a signal generated and check the frequency content of human voice and compare it for two persons Equipment: Signal generator, oscilloscope, speaker and microphone</p>		
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	--

Course No: 03 ME 7203	Course Name: COMPUTER INTEGRATED MANUFACTURING	L-T-P- Credits	Year of Introduction
Course Objectives: <ul style="list-style-type: none"> • Enable the student to understand the manufacturing system and the process of automated manufacturing 			
Syllabus: CAD/CAM contents and tools, definitions, CAD/CAM hardware: Types of systems, Graphic displays, Line and circle drawing algorithms, Hardware integration and networking, CAD/CAM software graphics standards, Geometric modeling, parametric representation of analytic and synthetic curves, Types and representation of solids, Computer numerical control of machine tools, tooling for CNC , CNC Part Programming, Computer aided process planning, Traditional& computer aided process planning, Computer process monitoring: Process control methods			
Expected outcome: The student will be able to understand: <ul style="list-style-type: none"> • Computer aided design • Geometric modelling • CNC part programming • Computer aided process planning 			
References: <ul style="list-style-type: none"> • Alavudeen& N. Venkateshwaran, "Computer integrated manufacturing", PHI, 2005 • Bresenham, J. E., "Ambiguities in incremental line rastering", IEEE Computer Graphics and Applications, Vol. 7, No. 5, May 2000 • Chris McMahan & Jimmie Browne, "CAD CAM principles, practice and manufacturing management", Pearson Education, 2000 • David Parrish, "Flexible manufacturing", Butterworth - Heinemann Ltd, 2004 • Donald Hearn & M. Pauline Baker, "Computer graphics", Pearson Education, 2004 • 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 • Foley, J. D. and A. Van Dam, "Fundamentals of interactive computer graphics", Addison Wesley 1982 • Fu, K. S., Gonzalez, R. C. and Lee, C. S. G., "Robotics - control, sensing, vision and intelligence", McGraw Hill • Ibrahim Zeid and R Sivasubramanian, "CAD/CAM theory and practice", McGraw Hill, 2002 • J. D. Foley, A. Van Dam, S. K. Feiner, J. F. Hughes and R. L. Phillips, "Introduction to computer graphics", Addison Wesley, 1997 • Koren, Yoram, "Robotics for engineers", McGraw Hill • Mike Mattson, "CNC programming principles and applications", Delmar Cengage Learning, 1999 • Noff, Shimon Y., "Handbook of robotics", John Wiley & Sons • Shirley, Peter, "Fundamentals of computer graphics", 1st Edition, A. K. Peters Ltd., 2002 • Schilling, Robert J., "Fundamentals of robotics, analysis & control", Prentice Hall of India, 2004 			

- Rooks B. (Editor), "Robert vision & sensory controls", Vol.3, North Holland.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	CAD/CAM contents and tools, Definition of CAD/CAM tools, industrial look at CAD/CAM, CAD/CAM hardware: Types of systems: Mainframe-based Systems, minicomputer-based systems, microcomputer-based systems, workstation-based systems, input devices, output devices: architecture of graphics system. Graphic displays: raster display, rasterization, plasma displays, LCD displays, 3 dimensional viewers. Line and circle drawing algorithms: DDA algorithm, Bresenham's line algorithm, midpoint circle algorithm, windowing, clipping: line clipping. Transformations: Homogeneous coordinates 2D & 3D transformations, rotation, translation and scaling, combining transformations, hardcopy printers and plotters. Hardware integration and networking: star, ring and bus LAN Configurations. CAD/CAM software graphics standards. Basic definitions: Data structure, data base, DBMS, database coordinate system, user interface, software modules: operating system module, graphics module, application module, programming module, communication module.	12	25%
FIRST SERIES TEST			
II	Geometric modeling: Types and mathematical representation of curves, wire frame models, wire frame entities, curve representation, parametric representation of analytic curves: line, circles, parametric representation of synthetic curves: Bezier curves. Types and representation of surfaces: Surface models, surface entities, surface representation, parametric representation of analytic surfaces: ruled surfaces, surface of revolution, tabulated cylinder, parametric representation of synthetic surfaces: Bezier Surface. Types and representation of solids: Solid models, solid entities, solid representation, B-rep,	12	25%

	CSG, sweep representation.		
SECOND SERIES TEST			
III	Computer numerical control of machine tools: Principles types of CNC machine tools and their construction features - tooling for CNC - ISO designation for tooling - CNC operating systems - CNC Part Programming - detailed manual part programming on lathe & milling machines using G & M codes, programming (a typical control system), computer aided CNC part programming - generation of tool path, generation of G & M codes, optimization of toolpath (to reduce machining time), - CNC part programming with CAD system - machining centers, 5 axis machining - design changes for manufacturing problems. (Features available on typical CAM software).	12	25%
IV	Computer aided process planning: Group technology and process planning: concepts of group technology. Traditional & computer aided process planning, retrieval & generative process planning, machinability data systems, computer-generated time standards, generation of route sheets, selection of optimal machining parameters, methods. Computer process monitoring: Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control.	12	25%
END OF SEMESTER EXAM			

Course No: 03 ME 7213	Course Name: ACOUSTICS AND NOISE CONTROL	L-T-P- Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> • Give an in depth knowledge about acoustics and noise 			
Syllabus: Basic Acoustic Principles, Acoustic terminology and definitions, Energy density, Transmission and Transmission losses, Noise measurement, Noise reduction, Acoustic insulation, acoustic materials, noise criteria and standards, Environmental noise control: Noise ratings, human tolerance levels,Sound transmission through structures			
Expected outcome:			
The student will study:			
<ul style="list-style-type: none"> • Basic principles of acoustics • Noise measurement technique • Methods for noise reduction • Impact of noise in environment • Noise control techniques 			
References:			
<ul style="list-style-type: none"> • Kinsler and Frey, "Fundamentals of Acoustics", Wiley. • Berenek, L.L., "Noise and Vibration control", McGraw Hill. • Harris, C.K., "Handbook of Noise control", McGraw Hill. • Petrusowicz and Longmore, "Noise and Vibration control for industrialists", Elsevier. • Thumann and Miller, "Secrets of noise control", Fairmont press. • Graf, "Industrial noise and vibration", Prentice Hall. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Basic Acoustic Principles - Acoustic terminology and definitions - Plane waves- harmonic solution-velocity of sound in inviscid fluids-relationship between wave length particle velocity, acceleration - Energy density - acoustic intensity - reference standards and measurement- Transmission through one, two and three media. Transmission through pipes- branched and unbranched-resonators-Transmission loss reflection at plane surface-standing waves and standing wave apparatus, spherical waves - radiation - simple source -hemispherical source-radiating piston-pressure intensity distribution-Beam width and directivity index	12	25%
FIRST SERIES TEST			
II	Noise measurement: Decibel scale-relationship between pressure, intensity and power-sound level meter, noise	12	25%

	analyzer and graphic level recorder-measurement in anechoic and reverberation chambers.		
III	Noise reduction: Human reaction to sound-definitions of speech interference level, perceived noise level, phon and sone etc, hearing loss-principles of noise control-control at source, during transmission and at receiver-protection of receiver-Acoustic insulation-acoustic materials- acoustic filter and mufflers - plenum chamber-noise criteria and standards- noise and number index guide lines for designing quieter equipments - reducing machine noise generated by bearings, gears, motors, fans, propellers, generator sets, cooling towers, pump-sets, pipes etc.		
SECOND SERIES TEST			
IV	Environmental noise control: Noise ratings, human tolerance levels, equivalent sound level and loudness contours - Engine noise and muffler designs - Noise control through barriers and enclosures and absorbent linings - Vehicular noise and control. Sound transmission through structures - noise control by damping and other methods. Principles of noise control in an auditorium-requirements of a good auditorium.		
END OF SEMESTER EXAM			

Course No: 03 ME 7223	Course Name: PLATES AND SHELLS	L-T-P- Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> • A detailed study on the analysis of plates and shells 			
Syllabus: Review of equations of elasticity, Classical theory of plates, assumptions, equations of equilibrium in Cartesian coordinates and in polar coordinates, boundary conditions, limitations of classical theory, Buckling analysis of rectangular plates, governing equations- the Navier solution, Vibration of plates, Governing equations for natural flexural vibrations, Levy's solution, Rayleigh-Ritz method, Analysis of thin elastic shells of revolution, Classification of shell surfaces, geometric properties of shells of revolution, membrane theory, shells with double curvature, geometric considerations, equations of equilibrium, bending of spherical shells- vibration of cylindrical shells			
Expected outcome:			
The student will understand:			
<ul style="list-style-type: none"> • Classical theories • Types and analysis • Vibration analysis of different types plates and shells 			
References:			
<ul style="list-style-type: none"> • Reddy,J.N., "Theory and Analysis of Elastic Plates & Shells", C.R.C.Press,NY,USA, 2nd Edition • Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995 • Timoshenko, S. and Krieger S.W. Theory of Plates and Shells, McGraw Hill Book Company, New York 1990. • Wilhelm Flügge, stresses in shells, Springer - Verlag • Timoshenko, S. Theory of Plates and Shells, McGraw Hill, 1990 • Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, 1986 • Dr.N.Subramanian, Principles of Space Structures , Wheeler Publishing Co. 1999 • K. Baskar and T.K. Varadan, "Plates- Theories and Applications", Ane Books Pvt. Ltd., New Delhi, 2013 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications Classical theory of plates: Plates as	13	25%

	structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions - bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates- limitations of classical theory- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities)		
FIRST SERIES TEST			
II	Buckling analysis of rectangular plates: Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)	13	25%
III	Vibration of plates: Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported- Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method-Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities)	13	25%
SECOND SERIES TEST			
IV	Analysis of thin elastic shells of revolution: Classification of shell surfaces-geometric properties of shells of revolution-general strain displacement relations for shells of revolution- stress resultants-equations of motion of thin shells analytical solution for thin cylindrical shells-membrane theory- flexure under axisymmetric loads shells with double	13	25%

	curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis(elementary treatment only;discussion of various elements used and their capabilities-)		
END OF SEMESTER EXAM			

Course No: 03 ME 7233	Course Name: APPLIED ELASTICITY AND PLASTICITY	L-T-P- Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> To impart enhanced knowledge in elasticity and plasticity 			
Syllabus: Stress, strain, compatibility conditions, measurements, Constitutive equations, General theory, generalized Hooke's law, Airy's stress function, Membrane stresses, meridional stress and circumferential stress, Contact stresses, computing contact stresses – Analytical and numerical method, Plasticity, Plastic flow and its microscopic and macroscopic descriptions, Plastic Strain Analysis,			
Expected outcome:			
The student will study:			
<ul style="list-style-type: none"> Stresses and strains Contact stresses, plasticity 			
References:			
<ul style="list-style-type: none"> S P.Timoshenko and J. N. Goodier, <i>Theory of Elasticity</i>, McGraw Hill International. F.William and Hosford, <i>Mechanical Behavior Materials</i>, Cambridge, 2005. G E. Dieter, <i>Mechanical Metallurgy</i>, McGraw Hill, 2007. B.Richard, Hetnarski, and JózefIgnaczak, <i>Mathematical Theory of Elasticity</i>, Taylor and Francis, 2004. W. David , A. Rees, <i>Basic Engineering Plasticity</i>, Elsevier, 2006. A P.Boresi , R J.Schmidt and O. M. Sidebottom , <i>Advanced Mechanics of Materials</i>, John Wiley and Sons L.S.Srinath, <i>Advanced mechanics of solid</i>, TataGraw Hill Education, Second reprint,2008 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Stress at a point, stress tensor, stress concentration factor, stress transformations, principal stresses, octahedral stress, equations of equilibrium, strain tensor, principal strains, strain-displacement relations, compatibility conditions, measurement of surface strains using strain gauges.	12	25%
FIRST SERIES TEST			
II	Constitutive equations, General theory, generalized Hooke's law, equations of elasticity, formulation of the general elasticity problem, boundary conditions, two dimensional problems in rectangular and polar co-ordinates, Airy's stress function. Membrane stresses: Membrane stresses in axisymmetric shells, meridional stress and circumferential stress.	13	25%

III	Contact stresses, Introduction, geometry of contact surfaces, notation and meaning of terms, expressions for principal stresses, method of computing contact stresses - Analytical and numerical method.	12	20%
SECOND SERIES TEST			
IV	Plasticity, Plastic flow and its microscopic and macroscopic descriptions, stress-strain curves of real materials, definition of yield criterion, concept of a yield surface in principal stress space, yield criteria, tresca, vonMises, difference between tresca and von mises criteria. Plastic Strain Analysis, Prandtl-Reuss and Levy-Mises equations, deformation in plane stress-yielding of thin sheet in biaxial and uniaxial tension. Plane strain deformation-stress tensor, hydrostatic and deviatoric components, plastic potential, plastic instability, effect of strain rates and temperature effects on flow stress. Introduction to slip line theory, weighted residual method.	12	30%
END OF SEMESTER EXAM			

Course No: 03 ME 7243	Course Name: INDUSTRIAL INSTRUMENTATION	L-T-P- Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> To impart knowledge about instrumentation and measurements 			
Syllabus: Instruments and their representation, Static and Dynamic characteristics of Instruments, Mechanical measurements, Pressure, temperature and flow measurements, Measurement of vibration, measurement of noise			
Expected outcome:			
The students will:			
<ul style="list-style-type: none"> Familiarise and understand instruments and their characteristics Expertise in different measurement methods 			
References:			
<ul style="list-style-type: none"> B.C Nakra and K.K Choudhary, "Instrumentation Measurement and analysis", Tata McGraw Hill. Earnest O Doebelin, "Measurement systems Applications & Design", McGraw Hill. Rangan C.S., Sharma G.R, Mani V.S.V, "Instrumentation devices and Systems", Tata McGraw Hill, New Delhi. Donald P Eckman, "Industrial Instrumentation", Wiley Eastern Ltd., New Delhi. Beckwith Thomas G., and Buck, N. Lewis, "Mechanical Measurements", Oxford & IBH, New Delhi. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Instrumentation: Introduction to Instruments and their representation. Static and Dynamic characteristics of Instruments, analysis of steady state and transient response.	12	25%
FIRST SERIES TEST			
II	Mechanical measurements: Transducer Elements, Intermediate Elements, Indicating and recording Elements. Mechanical Measurements, a) Frequency Measurement b) Displacement Measurement c) Force Measurement, and d) Torque Measurement	12	25%
III	Pressure, temperature and flow measurements: Pressure and Vacuum measurement, Flow measurements, Temperature Measurements using Industrial Thermocouples, resistance thermometers, radiation temperature measurements.	12	25%
SECOND SERIES TEST			
IV	Measurement of vibration: Study of	12	25%

	vibrometer, vibration analyser- measurement of noise - Study of noise meter, noise analyser, Signal and system analysis.		
END OF SEMESTER EXAM			

Course No: 03 ME 7253	Course Name: PRINCIPLES OF ROBOTICS AND APPLICATIONS	L-T-P-Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> Impart knowledge on robotics and applications 			
Syllabus: Definition, configurations, Kinematic principles, dynamics: Types of motions, Path planning - trajectory planning and control, Robot motion planning - configuration space concepts. Robot programming concepts.			
Expected outcome:			
<ul style="list-style-type: none"> The student will get extensive knowledge on robotics 			
References:			
<ul style="list-style-type: none"> Shiman Y., "Handbook of industrial robotics", John Wiley & Sons, 1985 Deh S. R., "Robotics technology and flexible automation", Tata McGraw Hill, 1994 Craig, J. J., "Robotics: mechanics and control", Addison Wesley, 1989 Groover M. P., "Fundamentals of modern manufacturing materials, processes, and systems", Prentice Hall, 1996 Craig J., "Adaptive control of mechanical manipulators", Addison Wesley, 1988 Snyder W. E., "Industrial robots: computer interfacing and control", Prentice Hall, 1985 Song S. M., and Waldron K. J., "Machines that walk", MIT Press, 1988 Richard D. Klafter, Thomas A. Chmielwski, Michael Negin, "Robotics engineering, an integrated approach", Prentice Hall of India. 1989 Mikell. P. Groover et al., "Industrial robots - technology, programming and application", McGraw Hill, 1980 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Definition, configurations, work envelopes, specifications, and other basic parameters of robots.		
FIRST SERIES TEST			
II	Kinematic principles: Position and orientation, co-ordinate systems, relative frames, homogeneous co-ordinates, direct and inverse kinematics, differential motions and the Jacobians.		
III	Introduction to dynamics: Types of motions: slew - joint-interpolated - straight line interpolated motions. Path planning - trajectory planning and control. Drives: electrical, hydraulic, and pneumatic drives - basics and relative merits. Components: harmonic reduction units, servo valves, and grippers. Sensors: basic types including vision, force - torque wrist sensors.		
SECOND SERIES TEST			
IV	Robot application: Robot motion planning - configuration space concepts. Robot programming concepts: off line programming		

	and simulation - work cell application. Development: requirements - modeling - work cell calibration - layout planning.		
END OF SEMESTER EXAM			
Course No: 03 ME 7263	Course Name: ADVANCED FINITE ELEMENT METHODS	L-T-P- Credits	Year of Introduction
Course Objectives: To familiarise advanced topics in FEM to students			
Syllabus: Review of Elasticity Equations, Bending of Plates and Shells, Finite Element Formulation of Plate and Shell Elements, applications and examples, Non-linear problems, Iterative Techniques, Material non-linearity, Elasto Plasticity, Plasticity, Visco Plasticity, Geometric Non linearity, Dynamic problem: Direct Formulation, Free, Transient and Forced Response, Solution Procedures, Eigen solution, Governing Equations of Fluid Mechanics - Solid structure interaction, Error estimates and adaptive refinement.			
Expected outcome: The student will study <ul style="list-style-type: none"> • To analyse the bending of plates • How to solve non-linear problems • To solve fluid mechanics and heat transfer problems • Error estimation in finite element method 			
References: <ul style="list-style-type: none"> • Finite element procedures K. J. Bathe, PHI. • An Introduction to Nonlinear Finite Element Analysis, J.N Reddy, Oxford University Press. • Nonlinear Finite elements for continua and structures, Ted Belytschko, Wiley 2001. • Continuum Mechanics and plasticity, Han Chin Wu, CRC, 2001. • An introduction to continuum mechanics with applications, J.N Reddy, Cambridge university Press, 2008. • Nonlinear Finite Element Analysis of Solids and Structures VOLUME 1 ESSENTIALS - M.A. Crisfield, Wiley. • Nonlinear Finite Element Analysis of Solids and Structures Volume 2 Advanced Topics - M.A. Crisfield, Wiley. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Bending of plates and shells: Review of Elasticity Equations - Bending of Plates and Shells - Finite Element Formulation of Plate and Shell Elements - Conforming and Non Conforming Elements - C0 and C1 Continuity Elements - Degenerated shell elements- Application and Examples.	12	15%
FIRST SERIES TEST			
II	Non-linear problems: Introduction - Iterative Techniques - Material non-linearity - Elasto Plasticity - Plasticity - Visco Plasticity - Geometric Non linearity	14	35%

	- large displacement Formulation - Solution procedure- Application in Metal Forming Process and Contact Problems.		
III	Dynamic problem: Direct Formulation - Free, Transient and Forced Response - Solution Procedures - Eigen solution- Subspace Iterative Technique - Response analysis-Houbolt, Wilson, Newmark - Methods - Explicit & Implicit Methods- Lanchzos, Reduced method for large size system equations.	13	30%
SECOND SERIES TEST			
IV	Fluid mechanics and heat transfer: Governing Equations of Fluid Mechanics - Solid structure interaction - Inviscid and Incompressible Flow - Potential Formulations - Slow Non-Newtonian Flow - Metal and Polymer Forming - Navier Stokes Equation - Steady and Transient Solution. Error estimates and adaptive refinement: Error norms and Convergence rates - h- refinement with adaptivity - Adaptive refinement.	12	20%
END OF SEMESTER EXAM			

Course No: 03 ME 7273	Course Name: DESIGN OF THERMAL SYSTEMS	L-T-P- Credits	Year of Introduction
Course Objectives:			
<ul style="list-style-type: none"> To provide an exposure to the students about thermal system design. 			
Syllabus: Design Principles, Mathematical Modelling, different modes of mathematical models, selection, computer programmes for models, Design and Modelling of Thermal Equipment, Systems Optimization, Dynamic behaviour of thermal system Transient / unsteady state simulation, Steady state simulation, stability analysis, nonlinearities.			
Expected outcome:			
<ul style="list-style-type: none"> After the completion of the course, the student can handle the design of thermal equipment and systems independently 			
References:			
<ul style="list-style-type: none"> J. N.Kapur ,<i>Mathematical Modeling</i>, Wiley Eastern Ltd., New York. R. F. Boehm, <i>Developments in the Design of Thermal System</i>, Cambridge University Press. Y.Jaluria, <i>Design and Optimization of Thermal Systems</i>, McGraw- Hill. L. C.Burmeister, <i>Elements of Thermal-Fluid System Design</i>, Prentice Hall. F.P. Incropera and D.P. Dewitt, <i>Introduction to Heat Transfer</i>, Wiley. R.K.Shah and D.P.Sekulic, <i>Fundamentals of heat exchanger design</i>, John Wiley and Sons. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Design Principles, workable systems, optimal systems, matching of system components, economic analysis, and depreciation, gradient present worth factor. Mathematical Modelling: Equation fitting, nomography, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.	12	25%
FIRST SERIES TEST			
II	Design and Modelling of Thermal Equipment: Design and Modelling -Heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.	12	25%
III	Systems Optimization: Objective function formulation, constraint equations, mathematical formulation, Calculus method, dynamic programming, geometric programming, linear programming methods, solution procedures.	13	25%

SECOND SERIES TEST			
IV	Dynamic behaviour of thermal system Transient / unsteady state simulation, Steady state simulation, Laplace transformation, feedback control loops, stability analysis, nonlinearities.	13	25%
END OF SEMESTER EXAM			

Course No: 03 ME 7903	Course Name: SEMINAR II	L-T-P-Credits: 0-0-2-2	Year of Introduction: 2015
Course Objectives: Each student shall prepare a seminar paper on any topic of interest related to the core/ elective course s being undergone in the second 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. The seminar topic taken by the student must be in the field of their thesis work.			
Expected outcome: This course is designed to improve written and oral presentations 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.			

Course No: 03 ME 7913	Course Name: PROJECT PHASE I	L-T-P-Credits: 0-0-8-6	Year of Introduction: 2015
Course Plan			
<p>The thesis shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/ numerical work, design and/or development work that the candidate has executed.</p> <p>In Phase I of the thesis it is expected that the students should decide a topic of thesis, which is useful in the field or practical life. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/ experimentation carried out on the thesis topic.</p> <p>Students should submit Phase I thesis report in two copies covering the content discussed above and highlighting the features of work to be carried out in part I of the thesis. Students should follow standard practice of thesis writing.</p>			

Course No: 03 ME 7914	Course Name: PROJECT PHASE II	L-T-P-Credits: 0-0-21-12	Year of Introduction: 2015
Course Plan			
<p>In the fourth semester the student has continued thesis work and present the report. At the end of successfully finishing the work he/she has to submit a detailed report and has to present for a viva-voce. The work carried out should lead to a publication in a National/International Journal or Conference. They should have submitted the paper before M.Tech. evaluation and specific weightages should be given to accepted papers in reputed journals or conferences.</p>			