Proposal for M.Tech. in ME(Design)

Motivation

Industrial needs

With the rapid growth of industries and industrial competition, todays industries have focus on both Design and Manufacturing of new product and at the same time modification in the current product according to need of consumer. Further, analysis of failed component helps industry in improving their product. There is always a demand for design engineers in the industry.

Educational motivation

Study of design from Mechanical perspective is always in the demand in industry. Failure analysis, design & development of new product and condition monitoring are always of the interest for the engineers.

Objectives

Proposed M.Tech in Mechanical Engineering with Design specialization provides an opportunity for engineering students to develop a design and failure analysis experience in the budding engineers. This will offer them a chance to design and analyze products from the design perspective. Therefore, the long-term goal of this programme is to enhance learning towards design and analysis of products and services. It will cater to the need of today's industrial and social environment as well as maintenance of the products which has now become so common in use.

Eligibility for Admission

Candidates with a Bachelor's Degree in Mechanical Engineering, Automobile Engineering, Production Engineering are eligible for admission to this M.Tech. programme. Other conditions as per PG manual will apply.

Course Structure

Semester I (20 Credits)		
1.	Professional and Communication Skills	1-0-2-2
2.	Core1: Analytical Methods in Engineering	3-0-0-4
3.	Core 2: Advanced Mechanics of Solids	3-0-0-4
4.	Core 3: Mechanical Vibrations and condition monitoring	3-0-0-4
5.	Elective I	3-0-0-4
6.	Design Lab 1	0-0-3-2
Semester II (18 Credits)		
1.	Core 4: Finite Element for Mechanical Engineering	3-0-0-4
2.	Elective I	3-0-0-4
3.	Elective II	3-0-0-4
4.	Elective III	3-0-0-4
5.	Design Lab II	0-0-3-2
Semester III (18 Credits)		
1.	Dissertation	0-0-0-16
2.	Seminar I	0-0-2-2
Semester IV (18 Credits)		
1.	Dissertation	0-0-0-16
2.	Seminar I	0-0-2-2

List of electives (more may be floated. Will be run as per availability of faculty members):

1. Design of Mechanisms and Manipulators
2. Industrial robotics
3. Fault Diagnosis and Prognosis of Engineering Systems
4. Biomechanics
5. Sensor and Actuators
6. Computer Aided Graphics and Design
7. Computer aided Design
8. Rapid Product Development Technologies
9. Engineering Optimization
10. Rotor dynamics
11. Fluid Power Systems and Factory Automation
12. Robot Dynamics and Analysis
13. Fuzzy logic and Neural Networks
14. Computational Fluid Dynamics
15. Autotronics and Vehicle Intelligence
16. Smart Materials and Structures
17. Material Handling, Storage And Assembly Automation
18. Machine Tool Control and Condition Monitoring
19. Mechatronic System Dynamics & Design
20. Fatigue and Fracture
21. Micro Electromechanical Systems (MEMS)
22. BioDesign
23. Multibody Systems & Vibration Design
24. Design for Manufacture and Assembly
25. Design for Noise Vibration and Harshness
26. Tribological Systems Design
27. Mechatronic Products Design
28. Designing with new Materials
29. Machine tool Design
30. Automotive Design
31. Plant Equipment Design
32. Experimental Modal Analysis & Dynamic Design
33. Stress Analysis
34. Computer Aided Design of Machines
35. Fracture Mechanics
36. Experimental Stress analysis

Course Contents

ME---- ANALYTICAL METHODS IN ENGINEERING (3-0-0-4)

AIM: To introduce fundamental mathematical concepts

INTRODUCTION

SOLUTION METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS (ODEs)

First order differential equations, nth order differential equations

FIRST-ORDER PARTIAL DIFFERENTIAL EQUATIONS (PDEs)

Classification, Analytical Solutions for Linear and Semi-linear equations

SECOND-ORDER PDEs

Classification, Transformations to Canonical forms for Hyperbolic, Elliptic and parabolic Equations.

CONCEPTS IN APPROXIMATE SOLUTIONS OF DIFFERENTIAL EQUATIONS

Space of Functions: Inner product, Orthogonal functions, Norm, Projection of a Function onto an Orthogonal set, Gram-Schmidt Orthogonalization and Orthonormal set, Parseval's theorem

FOURIER SERIES

Series of Trigonometric functions, Convergence of Fourier Series: Piecewise Continuous and Smooth function, Evaluation of Fourier Coefficients: Even and Odd functions, Even and odd extensions of a function, Uniform Convergence of a Fourier Series, Parseval's theorem for Fourier Series, Application of Parseval's theorem to estimate the Mean Square Error

ANALYTICAL SERIES SOLUTIONS OF PDEs

Separation of Variables, Extension of Separation of Variables methodology by Method of Superposition, Rectangular coordinate system, Cylindrical coordinate system (Bessel function), Spherical coordinate system (Legendre function), Hyperbolic Equations, Elliptic Equations, Parabolic Equations

FOURIER TRANSFORM AND ITS APPLICATIONS

Fourier Series to Fourier Integral, Properties of Fourier Transformation, Problems in Infinite and Semi-infinite Media, Solution of PDEs in Infinite and Semi-infinite Media, Dirac Delta Function

LAPLACE TRANSFORM AND ITS APPLICATIONS

Fourier Transform to Laplace Transform, Review of Laplace Transform, Laplace Inverse Transform by Complex Number Residue theory, Solution of PDEs by Laplace Transform

ME--- ADVANCED MECHANICS of SOLIDS (3-0-0-4)

Aim:

Aim of the course is to introduce the students about 3D-stress and strains developed in actual components. This will help them to realize the design of components from strength and other point of view.

Contents:

Analysis of Stresses and Strains in rectangular and polar coordinates: Cauchy's formula, Principal stresses and principal strains, 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress, Differential equations of equilibrium, Plane stress and plane strain, compatibility conditions. Introduction to curvilinear coordinates.

Generalized Hooke's law and theories of failure. Energy Methods.

Bending of symmetric and unsymmetric straight beams, effect of shear stresses, Curved beams, Shear center and shear flow, shear stresses in thin walled sections, thick curved bars.

Torsion of prismatic solid sections, thin walled sections, circular, rectangular and elliptical bars, membrane analogy.

Thick and thin walled cylinders, Composite tubes, Rotating disks and cylinders.

Euler's buckling load, Beam Column equations.

Strain measurement techniques using strain gages, characteristics, instrumentations, principles of photo-elasticity.

Textbooks

1. L. S. Srinath, Advanced Mechanics of Solids, 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.

References:

1. R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill Publishing Co, 1999.
2. A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 5th Edition, John Willey and Sons Inc, 1993.
3. S. P. Timoshenko, J. N. Goodier, Theory of Elasticity, 3rd Edition, McGraw Hill Publishing Co. 1970.
4. P. Raymond, Solid Mechanics for Engineering, 1st Edition, John Willey & Sons, 2001.
5. J. W. Dally and W. F. Riley, Experimental Stress Analysis, 3rd Edition, McGraw Hill Publishing Co., New York, 1991.

ME ---- MECHANICAL VIBRATIONS AND CONDITION MONITORING [3-0-0-4]

Review of Free and forced vibrations of single degree of freedom system. Vibration isolation and transmissibility, Vibration measuring instruments.

Multi Degrees of freedom systems, Introduction, Influence co-efficient, Maxwell reciprocal theorem, Automobile vehicle suspension, coupling, Vibration absorbers, Various numerical methods for solution of multi degree of freedom systems.

Whirling of shafts with and without air damping. Discussion of speeds above and below critical speeds.

Vibration of Continuous Systems: Introduction, vibration of string, longitudinal vibration of rods, torsional vibration of rods, Euler's equation for beams, simple problems.

Non-linear vibration, Phase Plane, Conservative systems, Stability of equilibrium. The Duffing Oscillator.

Introduction to condition monitoring of machinery, Condition monitoring methods, Types and Benefits of Vibration Analysis. Vibration Signals from Rotating and Reciprocating Machines. Signal Classification, Stationary and Cyclostationary signals.

Text Books:

1. Thomson, W.T., Theory of vibration with applications, Third Edition,1997.
2. Rao, S. S., Mechanical Vibrations, Fourth Edition, Addison Wesley, 2004.

Reference Books:

1. Randall. R.B., Vibration-Based Condition Monitoring: Industrial, Aerospace and Automotive Applications, Wiley, United Kingdom, 2011.
2. Caollacott, R. A.; Chapman, Mechanical Fault Diagnosis and Condition Monitoring, Chapman and hall, 1977.
3. Rao, J. S., Advanced Theory of Vibration, Wiley Eastern Ltd. New Delhi, 1992.

FINITE ELEMENTS METHODS IN MECHANICAL ENGINEERING (3-0-0-4)

1. Introduction to FEM

   Need of finite element method, process of finite element method, field and boundary conditions, steps involved in fem, weighted residual methods, virtual work as the 'weak form' of equilibrium equations for analysis of solids or fluids, variational principles, establishment of natural variational principles for linear, self-adjoint differential equations, maximum, minimum, or a saddle point, constrained variation principles, lagrange multipliers and adjoin functions.
2. Plane Strain and Stress

   Introduction, two – dimensional elements, completeness of polynomials, rectangular elements – lagrange family, rectangular elements – 'serendipity' family, triangular element family- CST and LST Elements. Full integration, reduced integration, selective reduced integration.
3. Errors and Accuracy

   Error, mistakes and accuracy. Convergence criteria, discretization error and convergence rate, non-conforming elements and the patch test.
4. Plate Bending and Shell Elements:

   Kirchhoff and Mindlin Elements. Membrane and shear Locking. 8-noded and 9-noded elements, Heterosis Element
5. Three – Dimensional Stress Analysis

   Introduction, modeling of solids, tetrahedral and hexahedron elements. Axisymmetric Elements.
6. Dynamic Considerations:

   Formulation; element mass matrices; Eigen values and eigenvectors evaluation generalized Jacobi method; tridiagonalization; implicit symmetric QR step with Wilkinson; shift for diagonalization; Guyan reduction.
7. Introduction to non-linear finite element.

Textbooks:

1. J N Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 1993.
2. R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3d ed., John Wiley, New York, 1989.

References:

1. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.
2. T J T Hughes, The Finite Element Method, Prentice-Hall, Englewood Cliffs, NJ, 1986
3. O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed. McGraw-Hill, 1989.

DESIGN LAB I (0-0-3-2)

Aim: This course is to introduce basic software tools related to design to the students and experiments related to core subjects

Contents:

1. Exercise on programming in Matlab/ Scilab – 2 Turns
2. Exercise on Modeling in Solidworks – 2 turns
3. Bending and Torsion analysis using Strain Gauge
4. Determining first three modes of the cantilever beam
5. Vibration Measurement and analysis on Gear box
6. Vibration Measurement and analysis on Bearing
7. Modeling of real system in CATIA and harmonic and transient analysis (3 turns)

DESIGN LAB II (0-0-3-2)

Aim: This lab work will be project based work in which a student will be trained to design and analysis of real world problem.

Contents:

1. Exercise on mechanism design and analysis in ADAMS – 2 Turns
2. Exercise on Dynamic analysis of Car in ADAMS – 2 Turns
3. Exercise on Modeling & analysis in hyperworks – 2 Turns
4. Exercise on analysis (static, modal, harmonic, transient, non-linear and impact analysis) using finite element software such as Ansys, Hyperworks, Nastran or ABAQUS) – 2 Turns
5. Design Project