

DESIGN STREAM - COURSE SYLLABUS
Advanced Mechanics of Solids - ME5203

Description

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Content

Theory of stresses and strains. Conservative laws. Constitutive modeling. Linear elasticity. Solutions of plane problems. Solutions using potentials. Energy methods. Introduction to finite deformation, plasticity, stability, vibration, and wave propagation. Application to thick cylinders, rotating discs, curved beams, beams on elastic foundations, torsion of non-circular cross-sections, stress concentration problems, Hertzian contact stresses. Introduction to modeling of mechanical components such as hooks, gears, pulleys, bearings, cylinders. Design for strength and deformation.

Text Books

[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.

Reference Books

[1] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.

[2] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

DESIGN STREAM - COURSE SYLLABUS

Finite Element Analysis - ME5204

Description

This course focuses on the fundamentals concepts and formulation of the finite element methods for solving differential equations arising in solid and fluid mechanics.

Course Content

-Overview of Engineering systems: Continuous and discrete systems (discussion on differential equations, matrix algebra) - Energy methods: Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, Rayleigh-Ritz Formulation, development of bar and beam element, application to truss and frames. - Finite elements for two-dimensions: Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates, Iso-parameteric mapping, numerical integration, Assembly procedure, solution techniques, introduction to finite element programming. - Applications to problems in engineering: plane elasticity, heat conduction, potential flow and Transient problems. Computer implementation.

Text Books

- [1] K J Bathe, Finite element procedures, Prentice Hall, Indian edition, 2006.
- [2] J Fish and T Belytschko, A first course in finite elements, Wiley, USA, 2007.
- [3] R D Cook, D A Malkus, M E Plesha, RJ Witt, Concepts and Applications of finite element analysis, John Wiley & Sons, 4th edition, 2002.

Reference Books

- [1] B Szabo and I Babuska, Introduction to finite element analysis, John Wiley & Sons, UK, 2011.
- [2] OC Zienkiewicz and RL Taylor, The finite element method, Volume 1 & 2, 5th edition, Butterworth Heinemann, New Delhi, 2000.

DESIGN STREAM - COURSE SYLLABUS

Theory of Vibration - ME5205

Description

The primary objective of this course is to enable you to build and solve mathematical models of vibrating systems. The emphasis is on linear systems subject to sinusoidal or periodic excitations. The course requires a math background in Fourier series, solving ordinary differential equations (ODEs) and basic linear algebra (including eigenvalue problems).

Course Content

Building Vibration Models - Assumptions and approximations; Practical case study - deriving the equations of motion; highlight need for single degree-of-freedom (SDOF) models SDOF Models - Free vibration without and with damping; viscous and other damping types; Forced vibration - harmonic force, rotating unbalance/base excitation, vibration isolation; periodic forcing and concept of frequency response function (FRF); General Excitation - Impulse response, Step and pulse type forces, shock response spectrum Multi degree-of-freedom (MDOF) Models - Deriving equations of motion for complex models; Concept of mode shapes and associated mathematical properties; Use of modal superposition to obtain forced vibration response; Concept of proportional or Rayleigh damping; More on FRFs and their uses; Vibration absorber application Continuous system Models - Equations of motion for transverse vibration of strings, torsional vibration of shafts, axial and beam bending vibrations; forced vibration of continuous systems using modal Superposition; Approximation methods – Rayleigh-Ritz and Galerkin based solutions.

Text Books

1. W. T. Thomson, M. D. Dahleh and C. Padmanabhan, 2008, Theory of Vibration with Applications, Pearson Education India: New Delhi.
2. L. Meirovitch, 2001, Elements of Vibration Analysis, Tata McGraw-Hill: New Delhi.
3. S. S. Rao, 2003, Mechanical Vibrations, 4th Edition, and Pearson India: New Delhi.

Reference Books

1. B. Balachandran, E. B. Magrab, 2009, Fundamentals of Vibrations} Cengage Engineering: New Delhi.
2. V. Ramamurti, 2012, Mechanical Vibration Practice and Noise Control, Narosa: New Delhi.

DESIGN STREAM - COURSE SYLLABUS
Design with Advanced Engineering Materials - ME5207

Description

Understanding selection of materials for various engineering applications, high temperature materials (super-alloys), engineering plastics, elastomers, ceramics, and coatings.

Course Content

Engineering Design process and the role of materials; materials classification and their properties; material property charts; selection of materials based on function, objective, constraints and free variables; examples of material selection for typical applications; Computer aided materials selection. Selection of process based on material classification; pencil curve approach; material selection for multiple constraints and multiple objective cases; multiple constraints and conflicting objectives. Co-selection of material and shape; concept of macroscopic and microscopic shape factors; Four quadrant method of material selection. General Properties of plastics, polymers and elastomers; visco-elastic properties; short-term and long-term properties of plastics; mathematical modeling of plastic properties; Maxwell, Kelvin-Voigt Models; fatigue and fracture of plastics; selection of plastics based on mechanical properties, degradation due to environment, wear; Design methods for snap fits; case studies. Fundamentals of fiber reinforced plastics; Stress, strain analysis of continuous fiber composites, rule of mixtures, general deformation behavior of laminates. Introduction to high temperature materials; families of super alloys and their characteristics; creep and fatigue resistance of super alloys; role of precipitates in strengthening of super alloys; repair of super alloys after creep damage; coatings for high temperature materials. Fundamentals of ceramics, general properties, applications of ceramics for critical applications. Design considerations. Surface treatment of materials using coatings; type of coatings; PVD and CVD coatings. Basics of electro-plating and electro-less plating.

Text Books

1. Ashby, M.F., "Materials Selection in Design", Butterworth-Heinemann, 4/e, 2010.
2. Crawford, R. J., "Plastics Engineering", Butterworth-Heinemann, 3/e, 2002.
3. Donachie, M. J. and Donachie, S. J., "Super alloys: A technical guide", ASM International, 2002.

Reference Books

1. Carter, C.B., and Grant, N. M., "Ceramic Materials: Science and Engineering", Springer, 2007.
2. Bralla, J. C., "Design for Manufacturability Handbook", McGraw-Hill Professional; 2/e, 1998.