CE4035 DYNAMICS OF STRUCTURES

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Prerequisite: Nil
Total hours: 42

Course Objectives

1. To expose the students to the need for the dynamic analysis of structures
2. To formulate the mathematical models of a vibrating system
3. To study the different dynamic characteristics of single degree of freedom system
4. To determine response of a single and multi- degree of freedom system under free vibration and forced vibration
5. To introduce continuous systems and practical vibration analysis of structural systems

Total Hours: 42 Hrs.

Module 1: (11hours)

Introduction to Dynamics of Structural Systems: continuous systems and discretisation; significance of single degree of freedom system in dynamic analysis of structural systems.

Free Response of Singe-Degree-of-Freedom Linear Systems: General considerations; characteristics of discrete system components; differential equation of motion of second-order linear systems; free vibration response of undamped and damped single degree of freedom systems; logarithmic decrement; critical, under- and over-damped systems.

Module 2: (11hours)

Forced Response of Singe-Degree-of-Freedom Systems: Response of second-order systems to harmonic excitation; harmonic motion of support; complex vector representation of harmonic motion; vibration isolation; vibration measuring instruments; energy dissipation and structural damping; superposition and response to periodic excitation; Fourier series; the unit impulse and impulse response; unit step function and step response; response to arbitrary excitation; the convolution integral; general system response.

Module 3: (11hours)

Multi-Degree-of-Freedom Systems: Equations of motion; generalised coordinates; matrix formulation; stiffness and mass matrices; linear transformations and coupling; undamped free vibration; eigenvalue problem; natural frequencies and mode shapes; orthogonality of modal vectors; expansion theorem; response to initial excitation; modal analysis; solution of eigenvalue problem by matrix iteration; power method; Rayleigh's coefficient; general response of discrete linear systems; modal analysis.

Module 4: (9hours)

Continuous System: Relation between discrete and continuous system; boundary value problem; free vibration; eigenvalue problem; axial vibration of rods; bending vibration of beams; orthogonality of natural modes; expansion theorem; Rayleigh's quotient; response of systems by modal analysis; introduction to approximate methods of analysis of continuous systems; Rayleigh-Ritz method; finite element method.

Introduction to Analytical Dynamics: Work and energy; principle of virtual work; D'Alembert's principle; Lagrange equations of motion.

References.

1. Meirovitch L, Elements of Vibration Analysis, McGraw Hill
2. Clough R.W. and Penzien J, Dynamics of structures, McGraw Hill
3. Chopra, A.K., Dynamics of structures – Theory and Application to Earthquake Engineering, Prentice Hall
4. Thomson W.T. and Dahleh M.D, Theory of Vibration with Applications, Pearson Education
5. Craig, Jr. R.R, Structural Dynamics, John Wiley
6. Hurty, W.C. and Rubinstein M.F, Dynamics of Structures, Prentice Hall.

Course Outcome:

The student will be able to:

1. Mathematically model a structural system for dynamic analysis
2. Carry out free vibration analysis of single degree of freedom
3. Analyse a single degree of freedom systems to subjected to harmonic loading, periodic loading and general dynamic loadings
4. Perform free vibration and forced vibration analyses of multi degree of freedom systems
5. Learn to analyse a continuous system both as a distributed parameter system and as an approximate discrete parameter system with multiple degrees of freedom.