Structural Dynamics - Video course

COURSE OUTLINE

Structural dynamics is a basic core course at the Master's level in Structural Engineering and an advanced elective course at the undergraduate level in most Civil Engineering programme at most universities in India.

The present Structural Dynamics course introduces the basic concepts of dynamic loading and the response of structures to such loads, and then uses these concepts to illustrate applications in practical structures.

It begins with the derivation of the basic equations of motion for an ideal single degree-of-freedom structure using various approaches, and the solution of these equations for different types of loading, with the emphasis on the physical behaviour of the structure to different types of loads to establish simplified methods of analysis (Topic 2).

A focus on the numerical methods for response analysis is given in Topic 3, and an emphasis on earthquake response of structures is provided in Topic 4.

This naturally then leads to development of equations for multi-degree-of-freedom structures, with multi-storied buildings as the example structures, and free and forced vibration response analysis of these multi-storied buildings (Topics 5-7).

A simplified analysis of MDOF systems using the concept of generalized single degree-of-freedom systems is introduced in Topic 8.

An introduction to the dynamics of continuous systems is provided in Topic 9. Example problems are solved throughout the course to illustrate the theoretical concepts.

Contents:

Dynamics of single DOF systems; Earthquake response of SDOF systems - response spectra; Numerical methods for dynamic analysis;

Equations of motion for MDOF systems; free vibration analysis; response analysis of MDOF systems - mode superposition method, damping considerations, and codal provisions; Dynamics of continuous systems.

COURSE DETAIL

Sl.No	Topic	No. of Hours
1.	**Introduction:** • Types of dynamic loads; • Basic background of methods available and motivation for structural dynamics.	01
2.	**Dynamics of Single Degree-of-Freedom Structures**: • Dynamic equation of equilibrium; • Free vibration of single degree of freedom systems;	09

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Civil Engineering

Pre-requisites:

1. Structural Analysis at UG level.

Coordinators:

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	• Forced vibration: harmonic and periodic loadings; • Dynamic response functions, force transmission and vibration isolation; • SDOF response to arbitrary functions.	
3.	**Numerical Evaluation of Dynamic Response of SDOF Systems**: • Time domain analysis: finite difference methods; • Frequency domain analysis: basic methodology.	04
4.	**Earthquake Response of SDOF Systems**: • Earthquake excitation, response history and construction of response spectra; • Response spectrum characteristics, tripartite plot, and design spectrum.	03
5.	**Multi Degree of Freedom Systems - Basics**: • Dynamic equations of equilibrium, static condensation; • Symmetricplan and plan-asymmetric systems.	03
6.	**Free Vibration Response of MDOF Systems**: • Undamped systems: natural modes and their properties; • Numerical solution for the eigenvalue problem; • Solution of free vibration response for undamped systems; • Free vibration analysis of systems with damping.	05
7.	**Dynamic Analysis of Linear MDOF Systems**: • Introduction, modal analysis; • Response-history for earthquake excitations using modal analysis; • Response spectrum analysis for peak responses; • Concept of Caughey damping as a general type of proportional damping.	05
8.	**Generalized Single Degree of Freedom Systems**: • Basic concepts, mass-spring system; • Lumped mass systems; • Systems with distributed mass and elasticity; • Rayleigh's method, shape function selection.	04
9.	**Introduction to Dynamics of Continuous Systems**:	06

	• Equations of motions for axial vibration of a beam; • Equations of motion for flexural vibration of a beam; • Free vibration analysis; • Introduction to forced vibration analysis using modal superposition method.	

References:

1. R.W. Clough, J. Penzien, Dynamics of Structures, McGraw Hill, 2nd ed. 1993.
2. A.K. Chopra, Dynamics of Structures and Application to Earthquake Engineering, Pearson, 3rd Ed. 2005.