Purpose of Course

To supply the students with the basic understanding of concepts, theories and methods of structural dynamics. Further, to understand and carry out analyses of structures exposed to external dynamic loads or initial values.

Manhattan Bridge (1909).
Brooklyn Bridge (1883).
Motivation

- Modern structures are becoming increasingly slender and correspondingly exposed to dynamic response with impact on structural failure and fatigue damage. Hence, the control and understanding of dynamic response become essential at the design and analysis of large and complex structures.
Aim

At the end of the course the student is supposed to possess documented knowledge and understanding of all concepts, theories and methods covered in the course. Further that the student is able to apply the theories to the analysis of dynamically exposed simple linear structures.
Prerequisites

- Knowledge of statics, ordinary and partial differential equations and mechanical physics at B.Sc. level.
Outline of Lectures

- Lecture 1
  - Introduction.
    - Harmonic and Periodic Motions.
    - Equation of Motion of Undamped Eigenvibrations.
    - Equation of Motion for Forced, Damped Vibrations.
    - Damping Models.
    - Analytical Dynamics.

- Lecture 2
  - Single-Degree-of-Freedom Systems (cont.).
    - Linear Viscous Damped Eigenvibrations.
    - Logarithmic Decrement.
Lecture 3

- Single-Degree-of-Freedom Systems (cont.).
  - Forced Vibrations due to Arbitrary Excitation.
  - D’Alembert’s Principle.
  - Vibrations due to Movable Support.
  - Earthquake Excitations.
  - Vibrations due to Indirectly Acting Dynamic Loads.

Lecture 4

- Multi-Degree-of-Freedom Systems.
  - Formulation of Equations of Motions.
    - Newton’s 2nd Law Applied to Free Masses.
    - D’Alembert’s Principle.
    - Basic Equations of Motion for Forced Vibrations of Linear Viscous Damped Systems.
    - Analytical Dynamics.
    - Properties of $K$, $M$ and $C$.
  - Undamped Eigenvibrations.
    - Generalized Eigenvalue Problem.
Lecture 5

- Multi-Degree-of-Freedom Systems (cont.).
  - Rigid Body Motions.
  - Solution to Undamped Eigenvibration Problems.
- Modal Analysis.
  - Orthogonality Conditions.
  - Modal Decoupling.
  - Modal Coordinate Equations.
  - Mechanical Energy in Modal Coordinates.
Lecture 6

- Multi-Degree-of-Freedom Systems (cont.).
  - Response to Harmonically Varying Loads.
  - Damping Models.
    - Rayleigh’s Damping Model.
    - Caughey’s Damping Model.
  - State Vector Formulation of Equations of Motion.
  - Numerical Time Integration.
    - Principle of Numerical Time Integration.
    - Euler Scheme.
    - 4th Order Runge-Kutta Scheme.
Lecture 7
- Multi-Degree-of-Freedom Systems (cont.).
  - System Reduction.
    - Truncated Modal Expansion with Quasi-Static Correction.
    - Guyan Reduction.
  - Vibrations due to Movable Supports.
    - Earthquake Excitations.

Lecture 8
- Multi-Degree-of-Freedom Systems (cont.).
  - Symmetric Structures.
  - Vibrations due to Indirectly Acting Dynamic Loads.
  - Tuned Mass Dampers.
    - Formulation of 2DOF Model.
    - Analysis and Design of Tuned Mass Dampers.
Lecture 9
- Continuous Systems.
  - Introduction to Continuous Systems.
  - Continuous Systems. Strings, Torsional Rods and Beams.
    - Vibrations of Flexible Strings.
    - Torsional Vibration of Rods.
    - Bernoulli-Euler Beams.
      - Undamped Eigenvibrations.
      - Orthogonality Property of Eigenmodes.
      - Forced Vibrations of Continuous Systems.

Lecture 10
- Continuous Systems (cont.).
  - Dynamic Modelling of Structures.
    - SDOF Model.
    - 2DOF Model.
  - Introduction to the Finite Element Method.
    - Equations of Motion of a Plane Bernoulli-Euler Beam Element.
    - Global Equations of Motion.
Literature:


