

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA VIZIANAGARAM
IV B.Tech I Semester Regular/Supplementary Examinations Oct/Nov 2025

STRUCTURAL DYNAMICS

(Civil Engineering)

Time: 3 hours

Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**

All Questions Carry Equal Marks

UNIT-I

1. a) Explain the fundamental objectives of dynamic analysis and differentiate it from static analysis with suitable examples. [7M]
- b) Describe the different types of dynamic loads that can be prescribed for structural analysis. Give examples for each type. [7M]

(OR)

2. a) List and briefly explain the steps involved in the Formulation of the Equations of Motion for a structural system. [7M]
- b) What are the various methods of discretization in structural dynamics? Explain the concept of lumping masses and stiffness with a diagram. [7M]

UNIT-II

3. a) Derive the equation of motion for an undamped single-degree-of-freedom (SDOF) system under free vibration. [7M]
- b) A machine weighing 2 kN is supported by a spring with stiffness 20 kN/m. If the machine is subjected to a harmonic force, calculate the natural frequency and the natural period of the system. [7M]

(OR)

4. a) What is logarithmic decrement? Derive the expression for logarithmic decrement in terms of damping ratio. [7M]
- b) The amplitude of a free vibration of a SDOF system is observed to decay to 25% of its initial value after 5 complete cycles. Determine the logarithmic decrement and the damping ratio of the system. [7M]

UNIT-III

5. a) Derive the equation of motion for a SDOF system subjected to forced vibration? [7M]
- b) SDOF system with mass 150 kg and stiffness 40 kN/m is subjected to a step load of 50 kN. Determine the maximum displacement of the mass. [7M]

(OR)

6. a) Explain the procedure to solve the equation of motion for a SDOF system under general dynamic loading using Duhamel's integral. [7M]
- b) A SDOF system has a mass of 10 kg, a stiffness of 1000 N/m, and a damping coefficient of 20 Ns/m. It is subjected to a harmonic force of $50\cos(10t)$ N. Calculate the amplitude of steady-state vibration. [7M]

UNIT-IV

7. a) Explain the process of selecting the degrees of freedom for a multi-degree-of-freedom (MDOF) system. [7M]
b) A two-story shear building has masses $m_1 = 1000$ kg and $m_2 = 800$ kg. The stiffness of the first story is $k_1 = 50$ kN/m and the second is $k_2 = 40$ kN/m. Formulate the MDOF equations of motion for undamped free vibration. [7M]

(OR)

8. A two-story shear building is idealized as a two-degree-of-freedom (2-DOF) system. The roof mass is $m_2 = m$ and the first-floor mass is $m_1 = 2m$. The stiffness of the first story is $k_1 = 2k$ and the stiffness of the second story is $k_2 = k$. Assume $m = 1000$ kg and $k = 1000$ kN/m. Determine the two natural frequencies and mode shapes. [14M]

UNIT-V

9. a) Determine the natural frequencies of a simply supported beam of length L , constant flexural rigidity EI , and uniformly distributed mass m per unit length. [7M]
b) Sketch and explain the first three mode shapes for a simply supported beam. [7M]

(OR)

10. a) Derive the equation of motion for the flexural vibrations of a beam in its elementary case. State the assumptions made. [7M]
b) A cantilever beam of length L , with a mass per unit length m and flexural rigidity EI , is fixed at one end and free at the other. Find the equation for its natural frequencies. [7M]
