BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2022– 2023

Dynamics of Structures (CE G551) – Comprehensive Examination

Duration: 180 Mins. (Open book) **Max. Marks: 40** **Date: 19-12-2022**

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1. Determine the response (i.e., x(t)) of an undamped system starting from rest due to a suddenly applied force P_0 that decays linearly varying with time, as shown in **Fig. 1**. **[8]**

2. A massless cantilever beam of length 3L/2 has two lamped masses mL and mL/2 considering four DOFs ($u_1, u_2, u_3,$ and u_4), as shown in **Fig. 2**. The masses mL and mL/2 are applied with force $P_1(t)$ and $P_2(t)$ respectively. Formulate the equation of motion of the beam in terms of only translational DOFs u_1 and u_2. Axial and shear deformations in the beam are neglected. **[8]**

3. An SDOF system with k/m = 81, m = 2 kg, and ξ = 5% is subjected to a periodic loading as shown in **Fig. 3**. Find the response of the system by taking the first two terms of Fourier series of the loading. **[8]**

4. The three-storey shear frame along with the stiffness of columns and lumped masses (k/m=100; m=2 kg) is shown in **Fig. 4**. Answer the following questions. **(a)** Find the frequencies and corresponding mode shapes of the frame. Also, draw the mode shapes. **(b)** Construct the Rayleigh damping matrix by assuming the frequency of the 1st mode with damping ratio ξ_1 = 4% and frequency of the 2nd mode with damping ratio ξ_2 = 2%. **(c)** Find the values of displacement, velocity, and acceleration of the frame at t=1.52 sec using Newmark's method based on average acceleration. The time step (Δt) is taken as 0.02 sec. The displacement, velocity and acceleration of the frame at t=1.5 sec are $u^T = [0.06 \;\; 0.035 \;\; 0.02]$; $\dot{u}^T = [0.25 \;\; \text{-}0.02 \;\; 0.1]$; $\ddot{u}^T = [0.15 \;\; -0.12 \;\; 0.6]$; respectively, and loading at t=1.52 sec is $P^T(1.52s) = [0.5 \;\; \text{-}0.2 \;\; 0.4]$. **[5+ 5+ 6]**

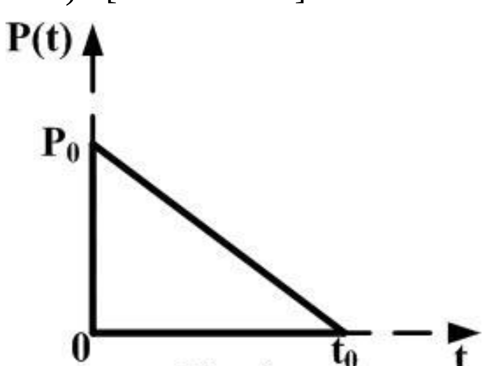

Fig. 1

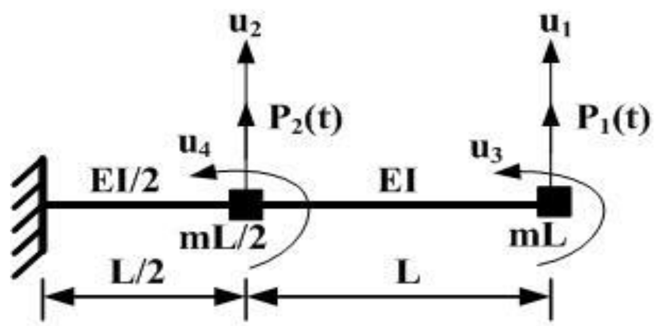

Fig. 2

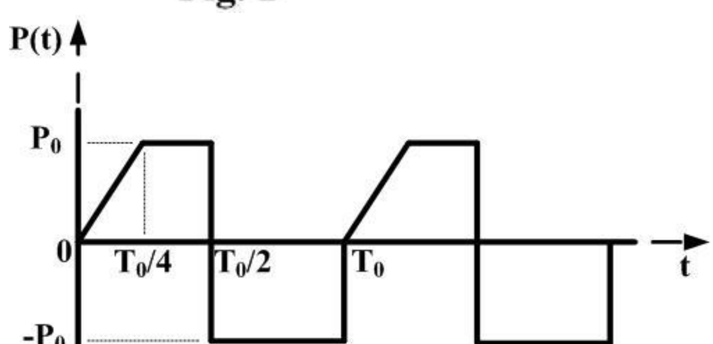

Fig. 3

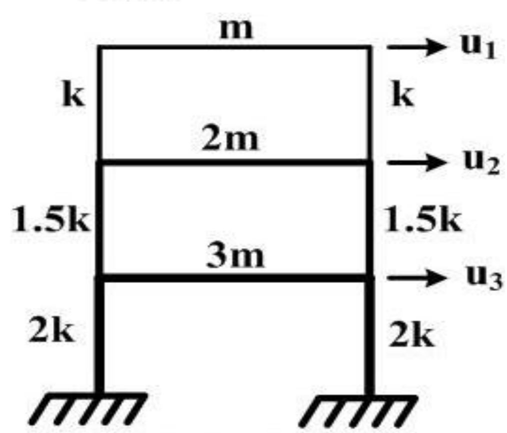

Fig. 4