

GUJARAT TECHNOLOGICAL UNIVERSITY**M.E –Ist SEMESTER–EXAMINATION – JULY- 2012****Subject code: 712002N****Date: 07/07/2012****Subject Name: Structural Dynamics****Time: 2:30 pm – 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) What is damping? Define underdamped, critically damped and over damped system. Show that the damping can be neglected for frequency calculations. **07**
- (b) A spring-mass-dashpot system consists of a spring of stiffness 343 N/m. The mass is 3.43 kg. The mass is displaced 20 mm beyond the equilibrium position and released. Find the equation for the displacement response of the system, if the damping coefficient of the dashpot is equal to 13.72 N-sec/m. **07**

- Q.2** (a) A machine weighing 1100 N is mounted on a supporting system consisting of four springs and four dampers. The vertical deflection of the supporting system under the weight of the machine is measured as 20 mm. The dampers are designed to reduce the amplitude of vertical vibration to one-eighth of the initial amplitude after two complete cycles of free vibration. Find the following properties of the system: (i) undamped natural frequency, (ii) damping ratio, and (iii) damped natural frequency. Comment on the effect of damping on the natural frequency. **07**
- (b) A cantilever beam of span 10 m and flexural rigidity of 2000 kN-m² has self weight of 20 kN/m. Calculate the natural frequency of the beam using the shape function from the Macaulay's method. **07**

OR

- (b) Derive expression for the response of SDOF structural system to earthquake ground motion. **07**
- Q.3** (a) An air-conditioning unit weighing 5350 N bolted at the middle of two parallel simply supported steel beams as shown in the Figure 1. The clear span of the beams is 2.4m. The second moment of cross-section area of each beam is $4 \times 10^6 \text{ mm}^4$. The motor in the unit runs at 300 rpm and produces an unbalanced force of 260 N at this speed. Neglect the weight of the beams and 1 % viscous damping in the system; for steel $E = 2 \times 10^5 \text{ N/mm}^2$. Determine the amplitudes of steady state deflection and steady state acceleration of the beams at their mid-points which result from the unbalanced force. **07**
- (b) Explain orthogonality property of normal modes. **07**

OR

- Q.3** (a) Calculate the natural frequencies of the three-storey shear building shown in Figure 2. **07**
- (b) Show that the modes of vibration of the above shear building satisfy the orthogonality properties. **07**

- Q.4** (a) Calculate the natural frequencies of the three-storey shear building **07**

shown in Figure 3.

- (b) If the third floor in the above building is pulled by 20 mm in the horizontal direction and left to vibrate, derive the displacement function of all the floors. **07**

OR

- Q.4** (a) Calculate the fundamental natural frequency and fundamental mode of the system shown in Figure 4 using Stodola's method. **07**

- (b) A uniform cantilever tower of length L has mass per unit length $= m$ and flexural rigidity EI . Assuming the shape function **07**

$\psi(x) = \frac{3}{2} \left(\frac{x}{L} \right)^2 - \frac{1}{2} \left(\frac{x}{L} \right)^3$. Formulate the equation of motion for the system excited by ground motion, and determine its natural frequency.

- Q.5** (a) A single spring mass system has spring constant of 2000 N/m and mass of 20 kg. If it is loaded by a periodical load for which a single period is as shown in the Figure 5, derive the equation for the displacement response of the system. **07**

- (b) A simply supported beam, having uniform mass of 1000 kg/m, carries a concentrated mass of 10×10^3 kg at its midpoint. If the flexural rigidity and span of the beam is 2000 kN-m² and 5 m, respectively, calculate the natural frequency of the beam. Assume the shape function as **07**

$$\psi(x) = \sin\left(\frac{\pi x}{L}\right).$$

OR

- Q.5** (a) From the fourth order differential equation, calculate the first three natural frequencies of a simply supported beam having uniform mass of 3000 kg/m, span of 5 m and flexural rigidity of 2000 kN-m². **07**

- (b) A single spring mass system has spring constant of 10 kN/m and mass of 2000 kg. If it is loaded by an impulsive load as shown in the Figure 6, derive the equation for the displacement response of the system after completion of the impulse. **07**

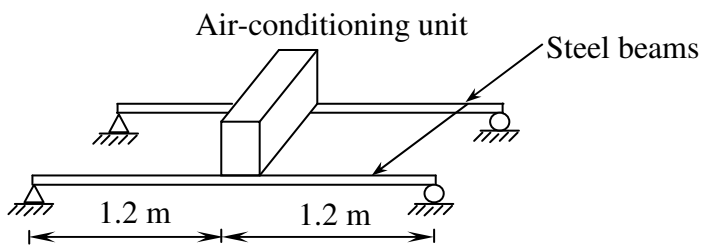


Figure 1.

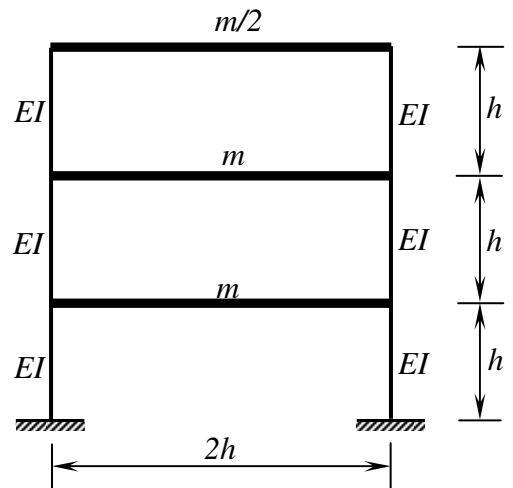


Figure 2.

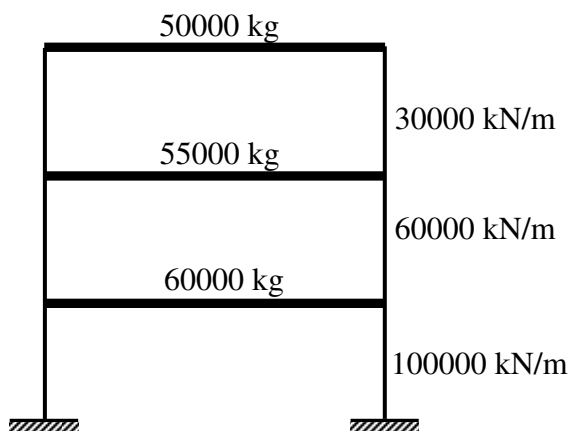


Figure 3.

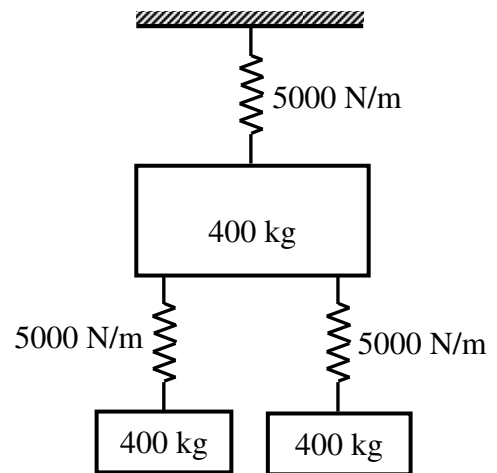


Figure 4.

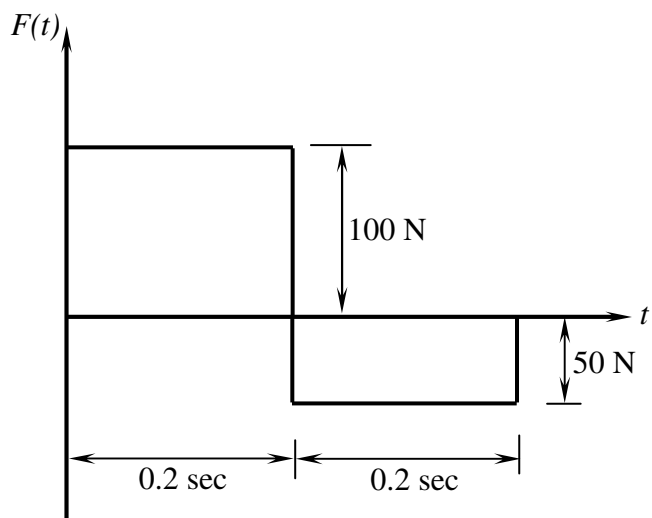


Figure 5.

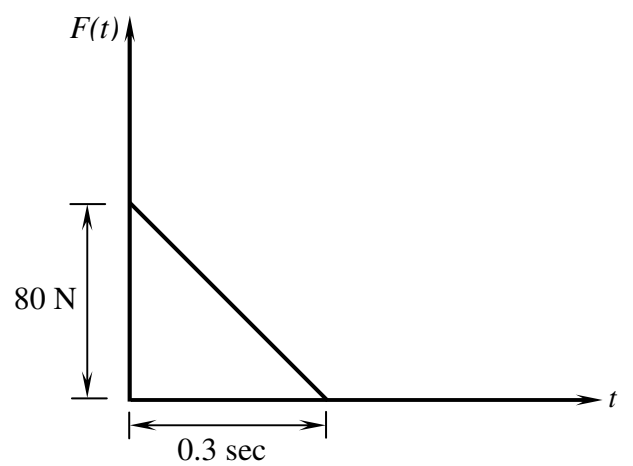


Figure 6.
