Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 712002N **Date: 26-12-2013**

Subject Name: Structural Dynamics

Time: 10.30 am – 01.00 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)** Derive the equation for the displacement response of a forced undamped single-degree-of-freedom (SDOF) system due to initial displacement x_0 and initial velocity v_0. **07**

(b) For a beam element, derive the consistent mass matrix in terms of mass per unit length and span of the beam. **07**

Q.2 **(a)** A vertical cantilever of mild steel tube section is 3.0 m long and supports 5 kN weight at its top. The tube has 250 mm external diameter and 5 mm wall thickness. The system is subjected to a harmonic force of 2 kN amplitude and 4 Hz frequency. Find the maximum steady state displacement and bending stress in the tube. Take damping as 5% of critical damping. Take E = 210 GPa. **07**

(b) A simply supported beam, having uniform mass of 2000 kg/m, carries a concentrated mass of 20×10^3 kg at its midpoint. If the flexural rigidity and span of the beam is 2000 kN-m^2 and 5 m, respectively, Calculate the natural frequency of the beam by assuming the shape function $\psi(x) = \frac{16}{5}\left[\frac{x}{L} - 2\left(\frac{x}{L}\right)^3 + \left(\frac{x}{L}\right)^4\right]$. **07**

OR

(b) A free vibration response of an electric motor of weight 500 N mounted on foundation is shown in Figure 1. Determine the spring constant and damping coefficient of the foundation. **07**

Q.3 **(a)** A single-degree-of-freedom (SDOF) with natural time period T_n and damping ratio ζ is subjected to the periodic force shown in Figure 2 with an amplitude F_0 and time period T. Expand the forcing function in its Fourier Series. **06**

(b) From the fourth order differential equation, calculate the first three natural frequencies of a propped cantilever beam having uniform mass of 2500 kg/m, span of 5 m and flexural rigidity of 2000 kN-m^2. **08**

OR

Q.3 **(a)** Derive an expression for the response of single-degree-of-freedom (SDOF) system subjected to harmonic earthquake ground motion. **08**

(b) For a free undamped vibration system shown in Figure 3, Formulate the equation of motion. Also, sketch the mathematical model of the system. **06**

Q.4 **(a)** Write short note on "Normalization of Modes". **04**

(b) A single spring mass system has spring constant of 10 kN/m and mass of 2500 kg. If it is loaded by an impulsive load as shown in the Figure 4, derive the equation for the displacement response of the system after completion of the impulse. **10**

OR

Q.4 **(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 as shown in the Figure 5, derive the equation for the displacement response of the system. **10**

(b) Derive the equivalent stiffness when springs are joined in a series and in parallel forms. **04**

Q.5 **(a)** For the two-storey shear building shown in Figure 6, obtain natural frequencies and mode shapes. **07**

(b) Show that the modes of vibration of the two-storey shear building shown in Figure 6 satisfy the orthogonality properties. **07**

OR

Q.5 **(a)** Calculate the natural frequencies and mode shapes of the three-storey shear building shown in Figure 7. **07**

(b) If the third floor of the three-storey shear building shown in Figure 7 is pulled by 10 mm in the horizontal direction and left to vibrate, derive the displacement function of all the masses. **07**

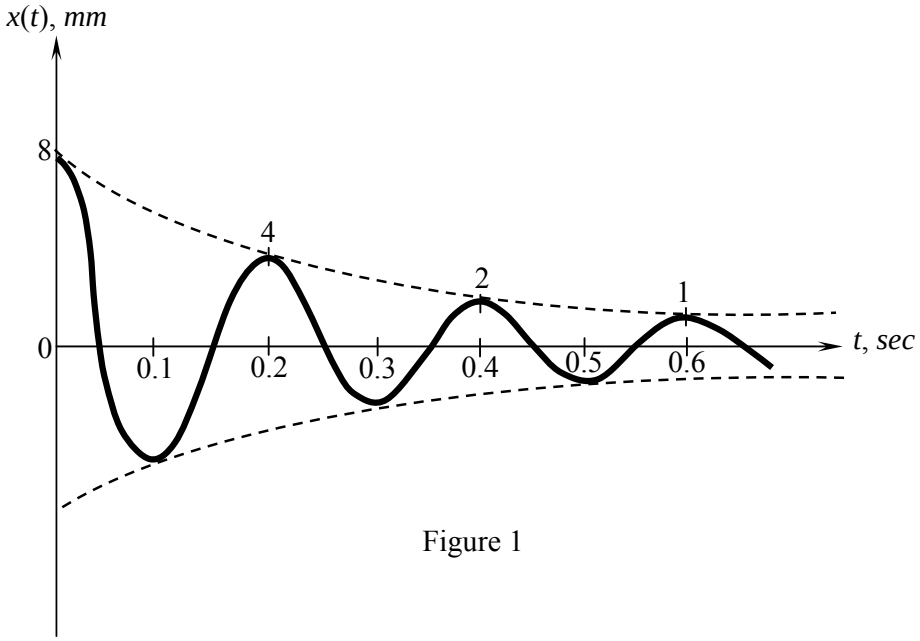

Figure 1

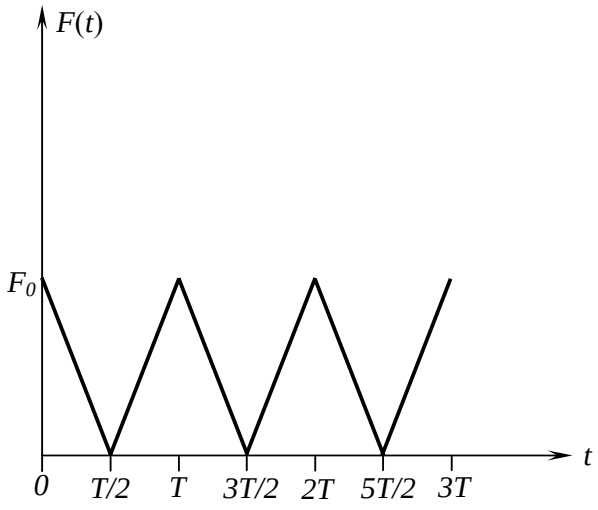

Figure 2

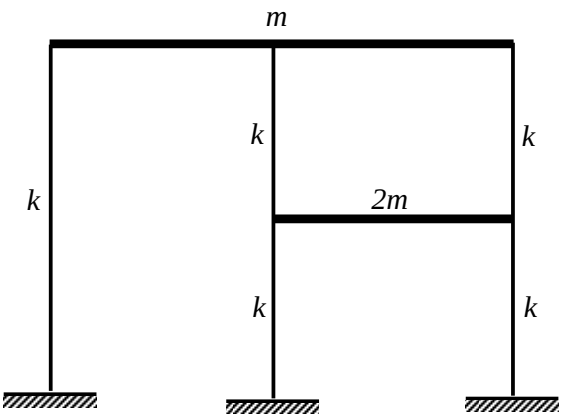

Figure 3

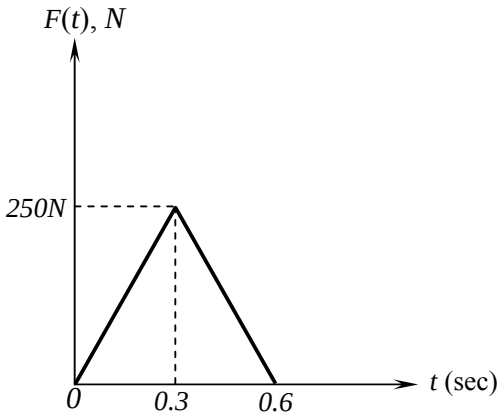

Figure 4

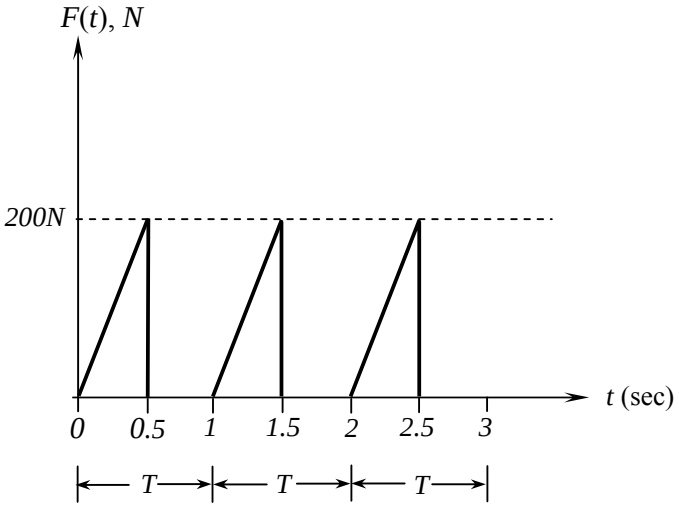

Figure 5

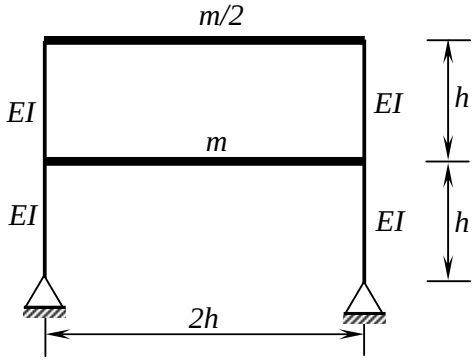

Figure 6

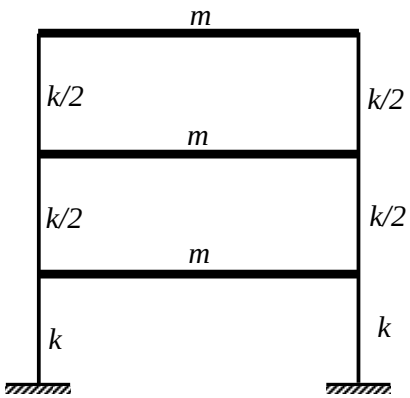

Figure 7

****