This question paper contains 4 printed pages.

3168

Your Roll No. .....

ME Civil (Structural Engg.) J

Paper CE . 663— STRUCTURAL DYNAMICS

Time : 3 hours *Maximum Marks* : 100

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any five qustions All questions carry equal marks

Assume suitable missing data, if any Use of IS 1893–Part 1:2002 is permitted Use of Laplace Transform tables is also permitted

Q1(a): For the simplified analysis of the response of a bridge to moving loads the bridge deck is idealized as a simply supported beam of span L, mass per unit length m' and flexural rigidity EI. A single wheel load of magnitude F (neglect the mass of the wheel) traverses the bridge at a speed of v. Assume a displacement shape function given by $\varphi(x) = \sin(\pi x/L)$, obtain the equation of motion for flexural vibration of the deck.

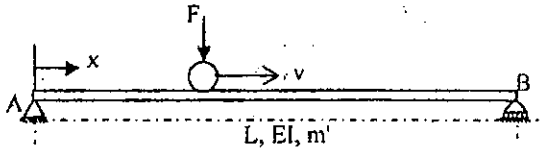

FIGURE -1

10 Marks

Q1(b): Attempt any two of the following:

(i) Dynamic Forces due to an unbalanced mass in a rotating m/c.

(ii) Write a short note on dynamic dofs and modeling of the systems.

(iii) Explain d'Alemberts's Principle.

10 Marks

Q2 (a): Develop the equation of motion for the system shown below in figure 2 modeling as SDOF system.
Rigid mass less bar of length ℓ:

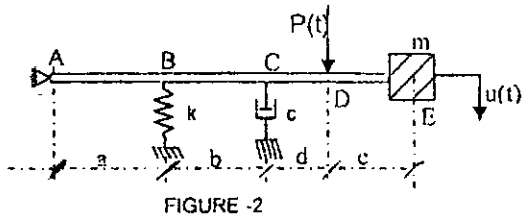

FIGURE -2

10 Marks

Turn over

Q2 (b): **Explain and define the generalized** and constrained coordinates taking a suitable example. **10 Marks**

Q3(a): Use the Laplace Transform method to determine the response of a damped SDOF system with natural frequency ω_n, damping factor ξ and mass m, initially at rest in equilibrium and subject to step excitation force $F(t) = F_0$.

12 Marks

Q3 (b): The water tank completely filled with water rests on a staging at a height of 20 m and subjected to a force p(t) as shown in figure 3 caused by an above ground explosion. Determine the maximum base shear and base bending moment at the base of tower supporting the tank.

Consider	Weight of the tank	W	= 17516 kN
	Stiffness	k	= 1440 kN/m
	Natural Time Period	T_n	= 0.90 secs

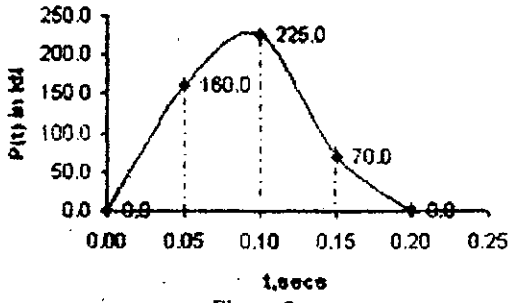

Figure 3

8 Marks

Q4(a): A sensitive instrument with weight 450 N is to be installed at a location where the vertical acceleration is 0.1 g at a frequency of 10 Hz. This instrument is mounted on a rubber pad of stiffness 15 kN/m and damping such that the damping ratio of the system is 10%.

(a) What is the acceleration transmitted to the instrument?

(b) If the instrument can tolerate only an acceleration of 0.005g, suggest a solution assuming that the same rubber pad is to be used.

8 Marks

Q4(b): An un-damped SDOF system is subjected to following forcing function shown in figure 4 and with initial displacement $(u_{st})_0$ and initial velocity $(u_{st})_0 / t_d$, where $(u_{st})_0 = P_0/k$. Write the expression for displacement at time t_d using Duhamel integral.

12 Marks

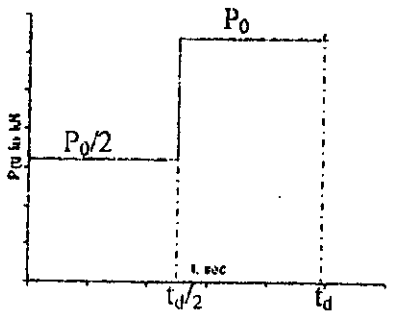

Figure 4

Q5 (a): Obtain the Fourier Transform of the forcing function shown in figure 5 below using time shifting method.

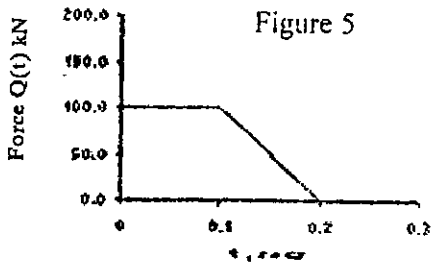

Figure 5

7 Marks

Q5(b): Write the equation of motion of the 2 degree of freedom system shown in figure 6 below using Lagrange's equation in terms of relative displacements.

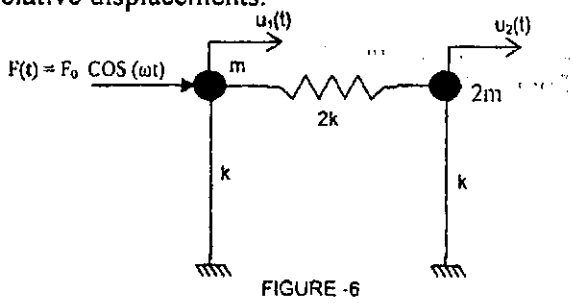

FIGURE -6

6 Marks

Q5(c): Obtain the natural frequency and normal mode shapes for the system shown in figure 6 above.

7 Marks

Q6 (a): For the three storey shear frame shown in figure 7, determine the damping matrix using Caughy's model. Take mg = 890 kN and k = 106811 kN/m. Consider damping ratio for all the three modes as 5%.

10 Marks

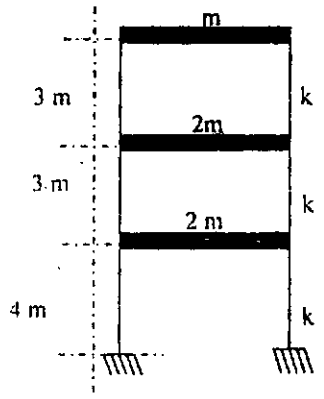

FIGURE -7

Mode Shapes			Natural frequency in each mode
$\{\phi_1\}$	$\{\phi_2\}$	$\{\phi_3\}$	ω rad /sec
0.401	0.803	0.401	ω_1 =12.57
0.695	0	-0.695	ω_2=34.33
0.803	-0.803	0.803	ω_3=46.89

Q6 (b): For the three storey shear frame shown in figure 7 and data as given in question 6 (a) determine effective modal masses and effective modal heights.

10 Marks

Q7: For the three storey shear frame shown in figure 7 do the seismic analysis and draw the shear force diagram using SRSS rule, CQC rule and Absolute sum rule and compare the data with seismic coefficient method. Take suitable data from IS 1893-Part 1: 2002 for Delhi zone.

20 Marks

Q8: Explain and write a note on:

(i) Fourier Spectra
(ii) Power Spectra
(iii) Response Spectra

20 Marks