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M.E. DEGREE EXAMINATION, JANUARY 2013.

First Semester

Structural Engineering

ST 9202/203102/ST 912/UST 9102/10211 SE 103 — STRUCTURAL DYNAMICS

(Regulation 2009/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. If two springs with stiffness of K_1 and K_2 are connected in series, what is the equivalent stiffness of the combined system.

2. What is meant by transmissibility?

3. Write the equations that govern motion in a discrete 2- DOF system.

4. What do you mean by mass participation of a mode?

5. What do orthogonality of modes mean?

6. When do you model a system as a multiple d.o.f. system?

7. Define virtual work.

8. Write the general differential equation of a beam subjected to external vibration.

9. Give examples of structures that could be analysed as 1-D problems.

10. Draw the variation of force with time, when the load is applied suddenly.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) Determine the effective stiffness of the combined spring system shown in Fig. 1 and write the equation of motion for the spring-mass system. (7)

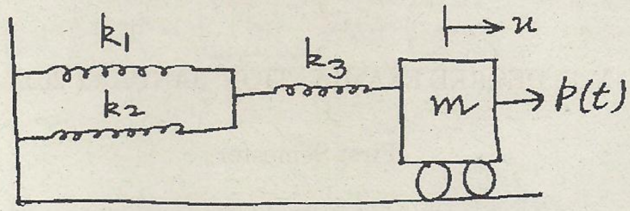

Fig. 1

(ii) A sensitive instrument with weight 50 kg is to be installed at a location where the vertical acceleration is 0.1 g at a frequency of 10 Hz. The instrument is fixed on a rubber pad of stiffness 80 N/M and damping ratio of 5%.

(1) What acceleration is transmitted to the instrument?

(2) If the instrument can tolerate only an acceleration of 0.005g, suggest a solution assuming that the same rubber pad is to be used. (9)

Or

(b) An SDF system with natural period T_n and damping ratio 3 is subjected to a periodic force as shown in Fig. 2, with an amplitude P_0 and period T_0.

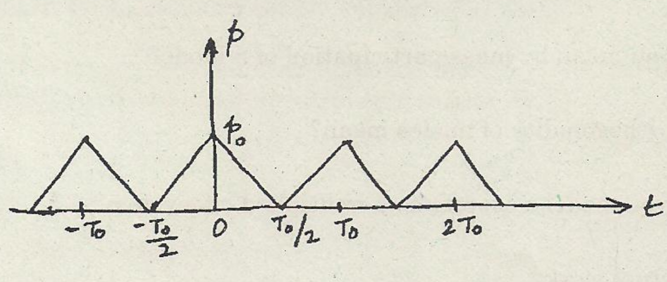

Fig. 2

(i) Expand the forcing function in its Fourier series.

(ii) Determine the steady state response of an undamped system. ($2 \times 8 = 16$)

12. (a) A mass less cantilever beam of length L supports two lumped masses mL/2 and mL/4 at the mid point and free end as shown in Fig. 3. The flexural rigidity of the beam is uniform, EI. with the four degrees of freedom shown in Fig. 3, and the applied forces $P_1(t)$ and $P_2(t)$, formulate the equations of motion of the system.

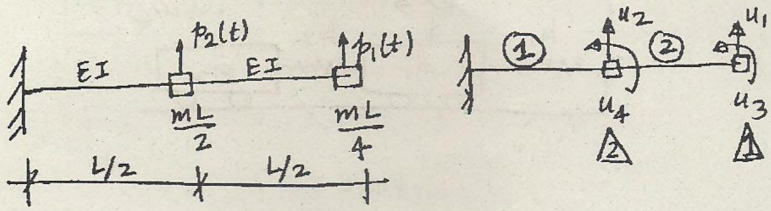

Fig. 3

Or

(b) Formulate the free vibration equations for the two element frame of Fig. 4. The frame is massless with lumped masses at the two nodes shown. EI is constant. Determine the natural frequencies and modes of vibration of the system.

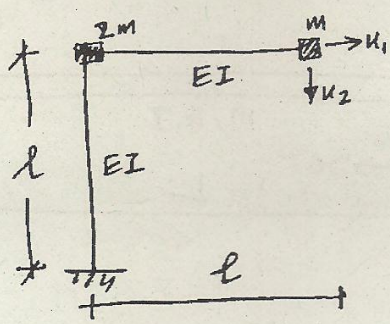

Fig. 4

13. (a) The floor masses and storey stiffness of the three storey frame, idealised as a shear frame, are shown in Fig. 5. Where M = 100 Kg-m/sec^2 and K = 150 N/mm. Determine the fundamental frequency and mode shape by inverse-vector iteration.

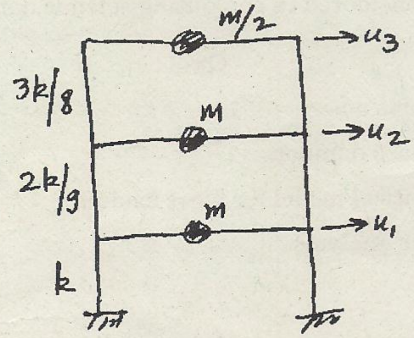

Fig. 5

Or

(b) Consider the system and excitation shown in Fig. 6. By modal analysis, determine the steady state response of the system.

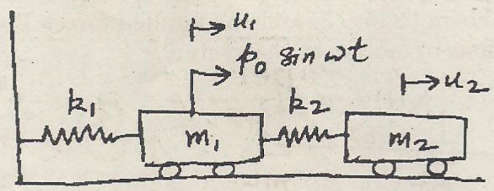

Fig. 6

14. (a) Find approximate solution for the first two natural frequencies and modes of lateral vibration of the uniform cantilever beam shown in Fig. 7, by Rayleigh-Ritz method using the shape functions $\psi_1(x) = 1 - \cos\frac{\pi x}{2L}$ and $\psi_2(x) = 1 - \cos\frac{3\pi x}{2L}$.

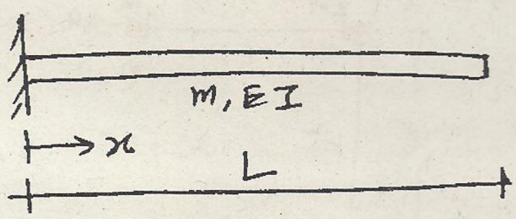

Fig. 7

Or

(b) Find the first three national frequencies and modes of a uniform beam clamped @ one end and simply supported at the other. Sketch the modes.

15. (a) What is meant by nonlinear response history analysis and what are the factors to be considered in computing seismic demands.

Or

(b) Write short notes on

(i) Tuned mass dampers (5)

(ii) Mathematical model for blast loading (5)

(iii) Push over analysis. (6)

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