G 6503

M.E. DEGREE EXAMINATION, MAY/JUNE 2007.

First Semester

Structural Engineering

ST 1602 — STRUCTURAL DYNAMICS

(Regulation 2005)

Time : Three hours Maximum : 100 marks

Assume any missing data suitably.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the different forms of damping?

2. Differentiate between free and forced vibration.

3. "Dynamics problems are of eigen value type" – Is this statement true? Justify.

4. What do you mean by mode shape?

5. Name any three numerical integration procedures used in modal analysis.

6. What is a shear beam?

7. Define : Rotatory Inertia.

8. What is meant by transient response?

9. Define the term spectral density.

10. Give some practical situations wherein stochastic vibration occurs.

PART B — (5 × 16 = 80 marks)

11. (a) An automobile whose weight is 150 N is mounted on four identical springs. Due to its self weight, it sags 250 mm. Each shock absorber has a damping coefficient of 0.4 N for a velocity of 30 mm per second. The car is placed on a platform which moves vertically at resonant speed, having an amplitude of 10 mm. Find the amplitude of the car.

Or

(b) A free vibration test was conducted on an empty elevated water tank. Through a cable attached to the tank, where a lateral force of 100 kN was applied, it pulled the tank horizontally by 75 mm. The cable was suddenly cut and the resulting free vibration was recorded. At the end of 4 complete cycles, the time was 2 sec, and the amplitude was 30 mm. find (i) Damping ratio (ii) Effective weight and (iii) the number of cycles required for the displacement amplitude to decrease to 6 mm. If the weight of water required to fill the tank was 450 kN, what is the natural period and damping ratio with the tank full.

12. (a) The floor masses and storey stiffness of a three storeyed frame are shown in fig. 1. Determine the frequencies and mode shapes.

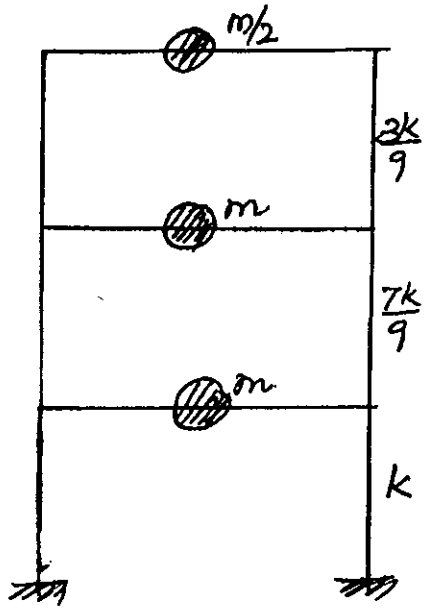

Fig. 1

Or

(b) For the system shown in fig. 2, determine the steady state response by Modal Analysis.

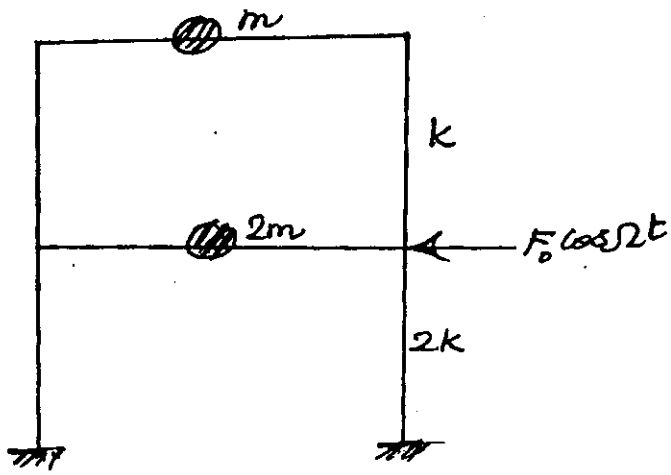

Fig. 2

13. (a) From first principles, determine the first three natural frequencies and mode shapes of a simply supported R.C. beam having a cross section of 250 mm × 600 mm with a span of 10. 8 m. Take EI = 10,000 kNm^2 and unit weight of the material as 3 kN/m^3.

Or

(b) A simply supported beam of mass $\overline{m}$ per unit length, flexural rigidity EI is subjected to a uniformly distributed static load 'q' which is suddenly removed. Derive an expression for the resulting free vibration and determine the amplitude of the first mode in terms of 'q'.

14. (a) The stiffness and mass matrices of a two-storey building are given by

$$[K] = 600 \begin{bmatrix} 1 & -1 \\ -1 & 3 \end{bmatrix} \text{ and } [m] = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

If the initial conditions are

$$u_1(0) = 2\,,\ u_2(0) = 1\,,\ \dot{u}_1(0) = \dot{u}_2(0) = 0$$

Determine expressions for the displacements $u_1(t)$ and $u_2(t)$ using mode super position method.

Or

(b) A 2 d.o.f. system shown in fig. 3 is subjected to a single harmonic force $p_1 = F_1 \cos \Omega t$. Determine the steady state response using mode superposition method.

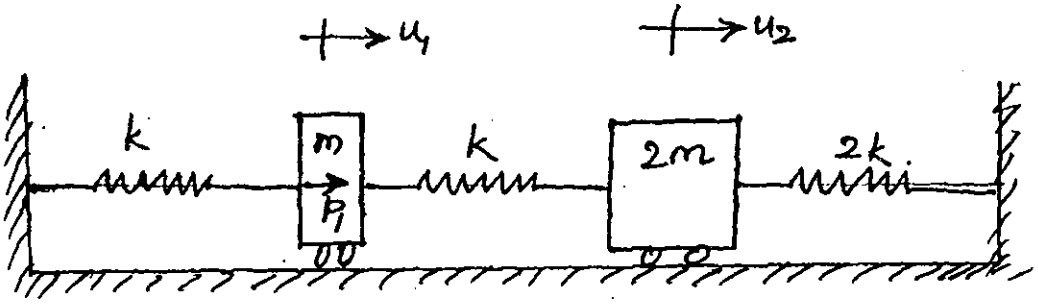

Fig. 3

15. (a) A random process has a constant spectral density $S(f) = 0.5\ \text{mm}^2/\text{cps}$ within the range 50 – 1500 cps. The values of the spectral density beyond this range are zeros. The mean value of the process is 250 mm. Determine its root mean square value and standard deviation.

Or

(b) Briefly describe how will you determine the stochastic response of a SDOF system.