P 7401

M.E. DEGREE EXAMINATION, MAY/JUNE 2006.

First Semester

Structural Engineering

ST 132 — STRUCTURAL DYNAMICS

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

Assume any missing data suitably.

PART A — (10 × 2 = 20 marks)

1. Define : Damping, Degrees of Freedom.

2. State D'Alembert's principle.

3. State the orthogonal property of mode shapes.

4. What do you mean by decoupling of equations in dynamics?

5. Sketch the first two mode shapes of a free-free beam in flexural free vibrations.

6. Name any four methods of extracting eigen values in structural dynamics, numerically.

7. What is base isolation?

8. How will you contain resonance in structures?

9. In a single degree of freedom system, the amplitude decreases to 0.2 of the initial value after six consecutive cycles. Find approximately the damping coefficient of the system.

10. By Raleigh's method, obtain an approximate fundamental frequency of a uniform cantilever beam. Take $\psi = \left(\frac{x^2}{L^2}\right)$.

PART B — (5 × 16 = 80 marks)

11. (i) Obtain the first three frequencies and mode shapes of a simply supported beam subjected to free flexural vibrations. (10)

(ii) Hence obtain the dynamic displacement of a simply supported beam subjected to a concentrated load *Q (t)* at its quarter span. (6)

12. (a) A free vibration test was conducted on an empty elevated water tank. Through a cable attached to the tank, where a lateral (horizontal) force of 80 kN was applied, it pulled the tank horizontally by 60 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) 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?

Or

(b) A single degree of freedom system has the following properties :

Mass $m = 4.5\ kg$

Stiffness $K = 1800\ kN/m$

Forcing function $F(t) = 46 \sin\left(\frac{\pi t}{0.6}\right)$ in the interval $0 < t < 0.6s$.

Neglect damping and evaluate its response numerically.

13. (a) (i) Find the fundamental frequency of a uniform cantilever beam of mass m and length l using Rayleigh's method. Assume $\chi = \frac{x^2}{(L)}$. (6)

(ii) If a lumped mass 'm' is attached to the beam at a distance of (H_3) from the fixed end, find the new fundamental frequency. (10)

Or

(b) For the shear building shown in fig. Q. 13(b) determine the frequencies and mode shapes.

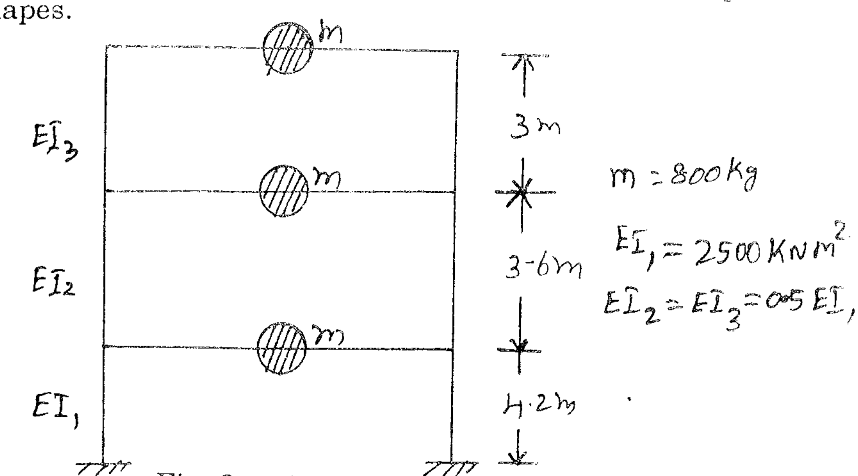

Fig. Q 13(b).

14. (a) A six storey shear building is shown in fig. Q 14(a). Determine the fundamental frequency and the mode shape by Holzer method. Height of each storey = $3m$.

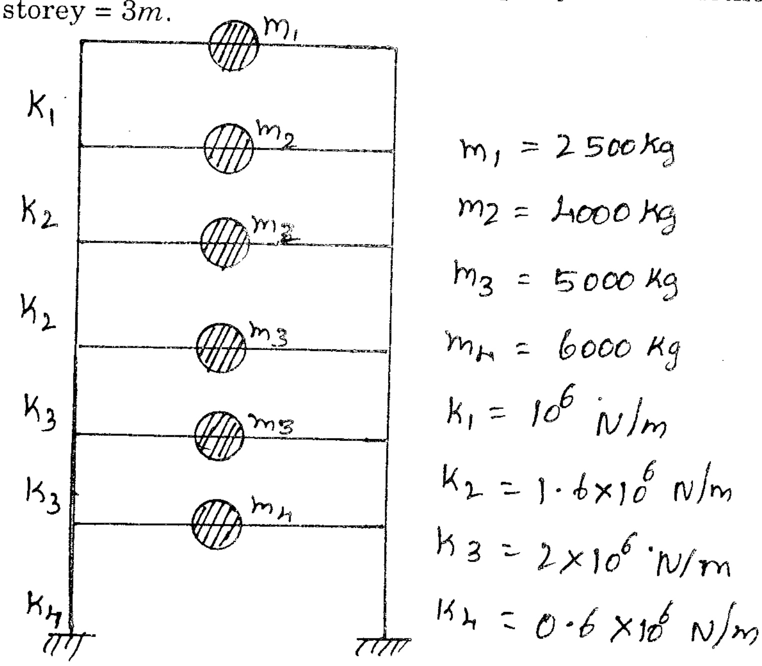

Fig. Q 14(a)

Or

(b) For a two degrees of freedom system, the mass matrix is $[m] = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$, stiffness matrix $[k] = \begin{bmatrix} 6 & -2 \\ -2 & 4 \end{bmatrix}$ and the forcing function $\{f(t)\} = \begin{Bmatrix} 0 \\ 10 \end{Bmatrix}$. Determine the displacement at the top storey level.

15. (a) Determine the base shear and base moment in the columns of the frame shown in fig. Q 15(a) due to a horizontal earthquake motion for 2% viscous damping. Take spectral acceleration as 1.08 m/s^2. The columns are square having 300 mm in size and E = 24 kN/mm^2.

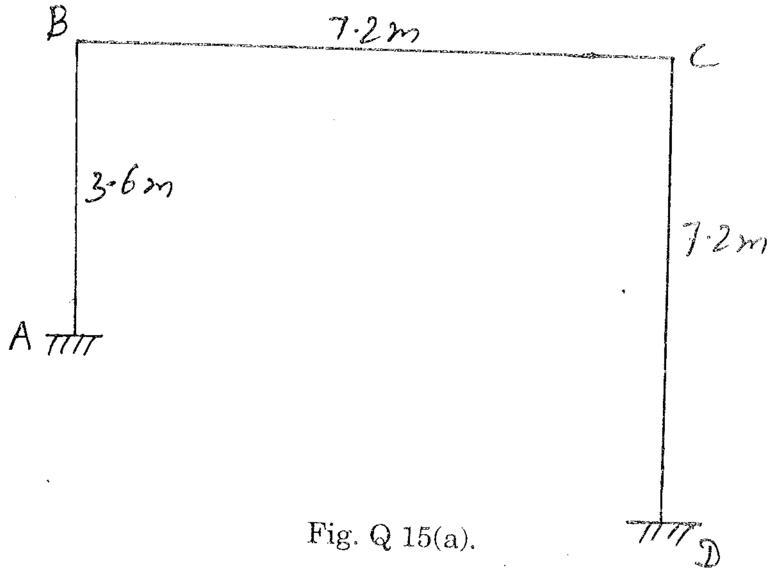

Fig. Q 15(a).

Or

(b) Write short notes on the following : (16)

(i) Wind induced vibrations on structures

(ii) Elastic Rebound Theory

(iii) Base isolation.