Q 8326

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

First Semester

Structural Engineering

ST 1602 — STRUCTURAL DYNAMICS

(Regulation 2005)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define: Degrees of freedom, forced vibration.

2. What is the effect of damping in response of structures?

3. State and explain the orthogonal property of mode shapes.

4. How will you decouple the equations of motion in MDOF systems?

5. What do you mean by base isolation?

6. Differentiate between deterministic and random vibration.

7. Determine the natural frequency of the idealised shear wall shown in Fig.Q.7 by Rayleigh's method.

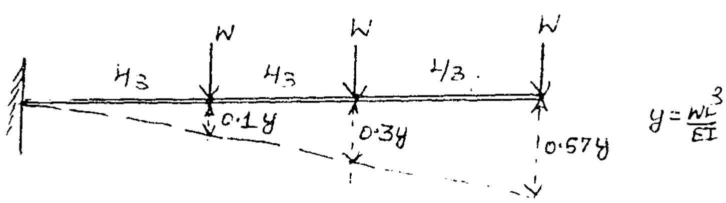

Fig.Q. 7

8. An undamped vibration pickup having a natural frequency of 1 Hz is used to measure a harmonic vibration of 3Hz. If the amplitude indicated by the pick up is 0.5 mm, what is the correct amplitude?

9. What are the force boundary conditions in free longitudinal vibration of a bar?

10. What do you mean by power spectral density?

PART B — (5 × 16 = 80 marks)

11. (i) Briefly describe how will you determine the response of a structural system subjected to random vibration. (8)

(ii) A random process has a constant spectral density $S(f) = 0.5\,mm^2/cps$, within the range of $50 - 1500\,cps$ (Hz). The values of the spectral density beyond this range are zeroes. The mean value of the process is 250 mm. Determine its root mean square value and the standard deviation. (8)

12. (a) (i) Show that the logarithmic decrement is given by the equation,

$\delta = \frac{1}{n} \log\left(\frac{u_0}{u_n}\right)$ where u_n represents the amplitude after 'n' cycles and u_0 = initial amplitude. (6)

(ii) A SDOF system has an undamped natural frequency of 1.10 Hz and a damping factor of 10%. The initial displacement is zero and the initial velocity is 0.5 m/s. Determine the damped natural frequency and the equation of motion for the system. (10)

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 80 kN was applied, it pulled back 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?

For the building frame shown in Fig.13a, find the natural frequencies and the mode shapes

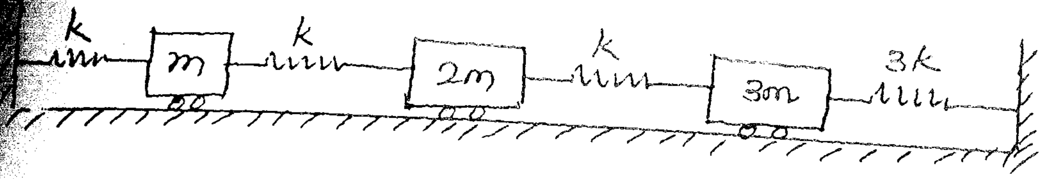

Fig.13(a)

Or

(b) For the two storey building shown in Fig.13b, compute the displacement at top storey level.

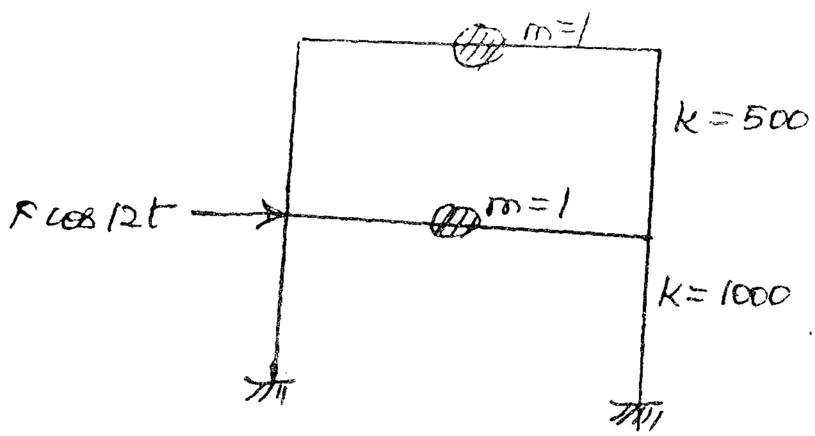

Fig.13(b)

14. (a) Determine from first principles the first three natural frequencies and mode shapes of a simply supported R.C. circular beam of 450 mm dia. with a span of 12 m. Take EI = 9000 kNm^2 and unit weight of the material as 25 kN/m^3.

Or

(b) A simply supported beam of span L is subjected to a distributed load,

$$q(x, t) = q_0 \sin \frac{\pi x}{L} \sin \Omega t .$$

Find the amplitude at the middle of the beam, if the operating frequency 'Ω' is equal to half the fundamental frequency of the beam.

15. (a) An idealised building is excited by ground motion $u = U \cos \Omega t$. Find the steady state shear force at the base, considering only the response in the fundamental mode by any numerical procedure (ref. Fig.15.a)

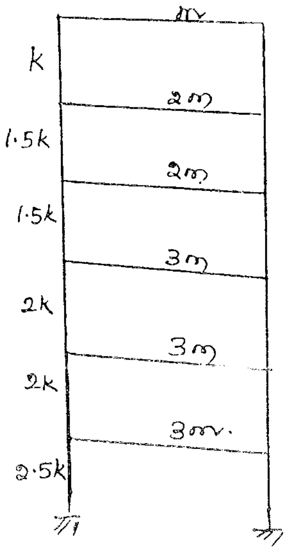

Fig.15(a)

Or

(b) A R.C. chimney idealised as lumped mass cantilever is subjected to the top level to a step force $F(t) = 6000\,kN$ with $m = 7000\,kg$, $EI = 24 \times 10^9\ kN\,m^2$. Solve by any numerical procedure, the equations of motion after transforming them to the first two modes by the lower acceleration method (or by any method) with $\Delta t = 0.1\ s$. (ref. Fig.15b)

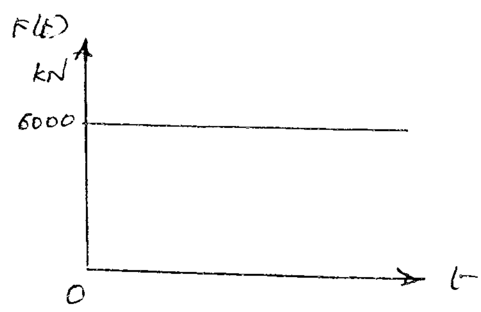

Fig.15(b)