Test paper 4 Dynamics of Ocean Structures

Maximum marks: 20 **Time: 50 minutes**

Answer any set of questions of your choice to make up the total attempted marks to 20. Qualifying marks of each question are indicated therein.

1. A weightless truss is subjected to a single mass "m" as shown in the Fig. 1. Area of cross-section of all members is same. Represent the structure as an equivalent spring-mass system and compute its natural period. (3)
2. Referring to Fig. 2, a) list the dynamic characteristics present in the model shown below; and b) draw a free-body diagram to show the forces acting on the rigid body. (1)
3. Derive the expression to estimate damping using half-power band width method (2)
4. Referring to Fig. 3, do both the figures represent mathematical models that are dynamically equivalent? Give reasoning for your answer (1)
5. Show that the logarithmic decrement is also given by the following equation:
   $\delta = \frac{1}{n}\ell n\left(\frac{x_0}{x_n}\right)$ where x_n represents the amplitude after n cycles have elapsed. Plot the curve showing the # of cycles elapsed against ξ for the amplitude decay of 50%. (3)
6. Show that decay in the amplitude per cycle, in case of coulomb damping is constant. Comment on this *limitation* imposed on structural designer (3)
7. Briefly explain a) Decibel; b) octave; and c) beating phenomenon (3)
8. Referring to Fig. 4, derive [M], [K] and {f(t)} for the system whose degrees-of-freedom are marked as x_1 and x_2 respectively. (3)
9. Derive equations of motion for the system shown in Fig. 5. Use Lagrange's method (3)
10. Derive the design conditions for efficient dynamic vibration absorber that uses an auxiliary spring-mass system to control the response of a primary spring-mass system (2)
11. A rectangular pulse of time duration "s" is shown in Fig. 6. Find the maximum dynamic load factor for both the phases of loading. (3)
12. Determine fundamental frequency of the system whose mass matrix and influence coefficient matrix are given below:
   $[M]=\begin{bmatrix}100 & 0 & 0\\ 0 & 150 & 0\\ 0 & 0 & 100\end{bmatrix} \qquad [\delta]=\begin{bmatrix}6 & 5 & 3\\ 5 & 7 & 4\\ 3 & 4 & 8\end{bmatrix}$ (1)
13. Find the fundamental frequency of the spring mass system shown in Fig. 7. Use Stodla method. (3)
14. Determine natural frequencies and the corresponding mode shapes of the spring mass system shown in Fig. 8. Use influence coefficient method. Also compare the fundamental frequency of the above result with that of Dunkerley's method. (3)
15. A spring-mass system with (k_1,m) vibrates at a natural frequency of f_1. If a second spring of stiffness k_2 is added to the system in series, the natural frequency is reduced to ½ f_1. Find k_2 in terms of k_1. (2)
16. An unknown mass of m kg is attached to one end of spring of unknown stiffness k; natural frequency of the system is 94cpm. When a 0.453 kg of mass is added to mass m, natural frequency is changed to 76.7cpm. Find m and k. (3)
17. A mass m_1 hangs from a spring of stiffness k (N/m) and it is static equilibrium. A second mass m_2 drops through a height "h" and sticks to mass m_1 without rebound. Determine the response of the resulting motion. (3)

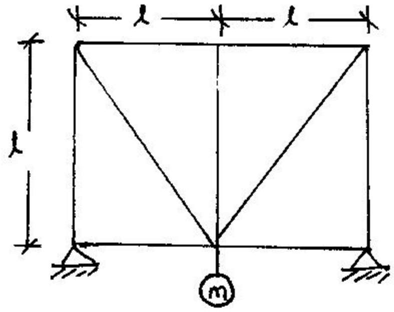


Fig. 1

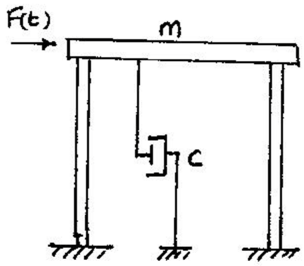
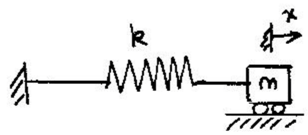


Fig. 2



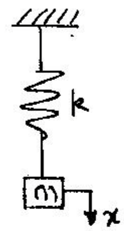


Fig. 3

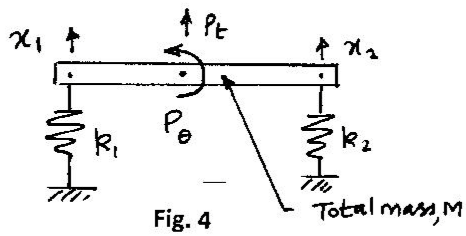


Fig. 4

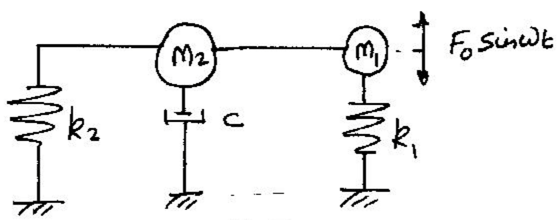


Fig. 5

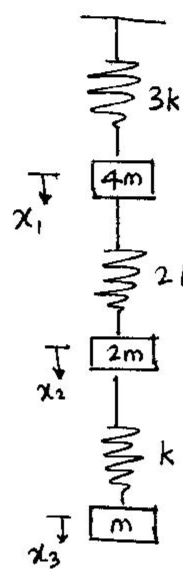


Fig. 7

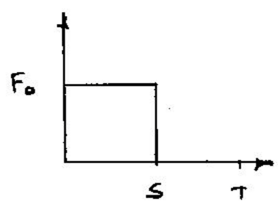


Fig. 6

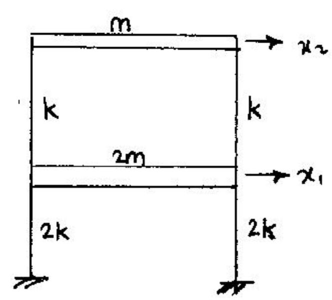


Fig. 8