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B Total Pages 5

Register No: .... Name: ....

SAINTGITS COLLEGE OF ENGINEERING
KOTTAYAM, KERALA

(AN AUTONOMOUS COLLEGE AFFILIATED TO
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH. DEGREE EXAMINATION(S), JULY 2021

(MACHINE DESIGN)

Course Code: 20MEMDT103

Course Name: THEORY OF VIBRATIONS

Max. Marks: **60** **Duration:** **3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Define these terms: cycle, amplitude, phase angle, linear frequency, period, and natural frequency.
2. A simple pendulum is found to vibrate at a frequency of 0.5 Hz in a vacuum and 0.45 Hz in a viscous fluid medium. Find the damping constant, assuming the mass of the bob of the pendulum is 1 kg.
3. A mass m is suspended from a spring of stiffness 4000 N/m and is subjected to a harmonic force having an amplitude of 100 N and a frequency of 5 Hz. The amplitude of the forced motion of the mass is observed to be 20 mm. Find the value of m.
4. Discuss the basis for expressing the response of a system under periodic excitation as a summation of several harmonic responses?
5. Find the response of a single-degree-of-freedom system under an impulse for the following data: m = 2 kg, c = 4 N-s/m, k = 32 N/m, F = 4 δ(t), Initial velocity and displacement are 0.01m and 0.01 m/s respectively.
6. Discuss the properties of Dirac – Delta function δ(t),
7. Define these terms: mass coupling, velocity coupling, elastic coupling.
8. Discuss the concept of orthogonality of normal modes. What are orthonormal modal vectors?

PART B

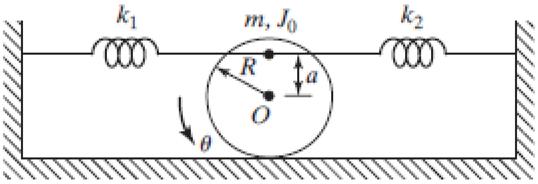
(Answer one full question from each module, each question carries 6 marks)

MODULE I

9. A shaft of diameter 75 mm and length 1m is fixed at one end and carries a flywheel of mass 1500 kg and radius of gyration 0.4 m at the other end. For the shaft material E= 210 GPa, G= 84 GPa. Find the natural frequencies of free longitudinal, transverse and torsional vibrations. (6)

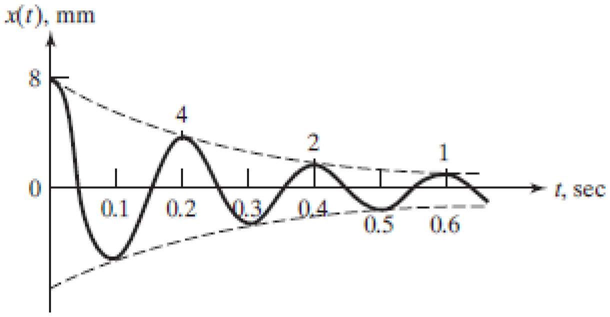
OR

10. A cylinder of mass *m* and mass moment of inertia J_0 is free to roll without slipping but is restrained by two springs of stiffness k_1 and k_2 as shown in Fig. Find its natural frequency of vibration. (6)

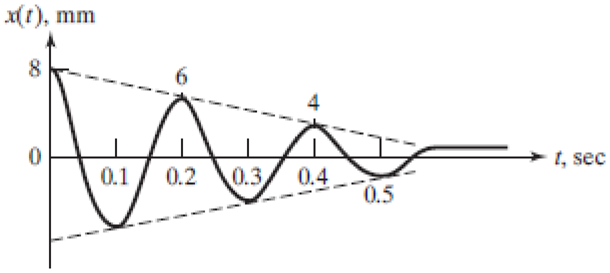


MODULE II

11. The free-vibration responses of an electric motor of weight 500 N mounted on different types of foundations are shown in Figs. (a) and (b). Identify the following in each case: (i) the nature of damping provided by the foundation, (ii) the spring constant and damping coefficient of the foundation, and (iii) the undamped and damped natural frequencies of the electric motor. (6)



(a)

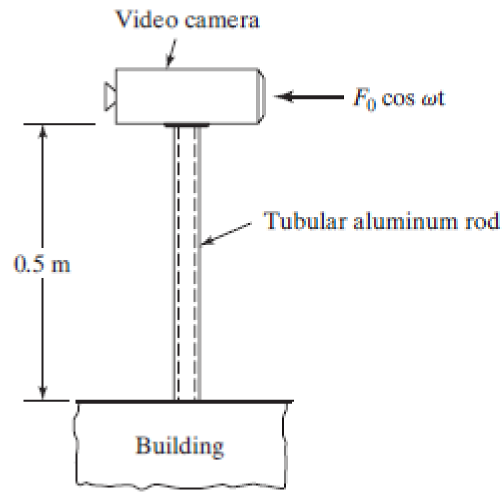


OR

12. The ratio of successive amplitudes of a viscously damped single-degree-of-freedom system is found to be 18:1. Determine the ratio of successive amplitudes if the amount of damping is (a) doubled, and (b) halved. (6)

MODULE III

13. A video camera, of mass 2.0 kg, is mounted on the top of a bank building for surveillance. The video camera is fixed at one end of a tubular aluminum rod whose other end is fixed to the building as shown in Fig. The wind-induced force acting on the video camera, is found to be harmonic with, *f(t)= 25 cos 75.39845 t N*. Determine the cross-sectional dimensions of the aluminum tube if the maximum amplitude of vibration of the video camera is to be limited to 0.005 m. (6)

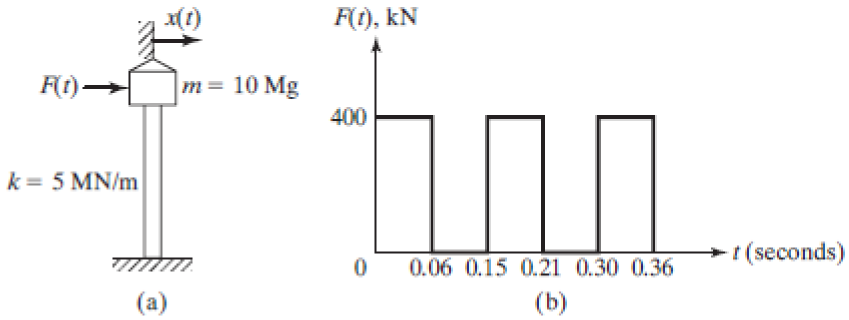


OR

14. A spring-mass-damper system is subjected to a harmonic force. The amplitude is found to be 20 mm at resonance and 10 mm at a frequency 0.75 times the resonant frequency. Find the damping ratio of the system. (6)

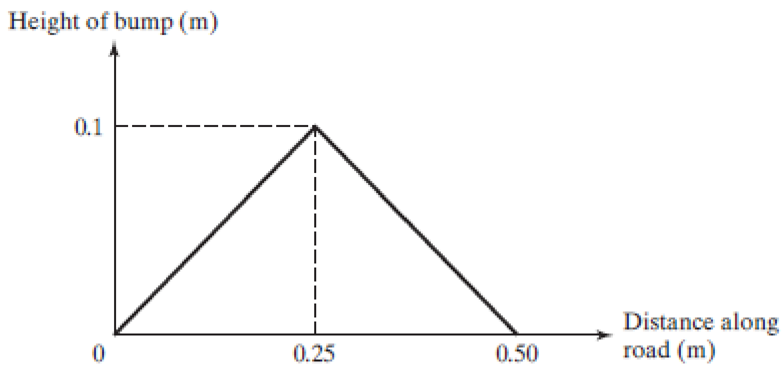
MODULE IV

15. Find the displacement of the water tank shown in Fig. under the periodic force treating it as an undamped single-degree-of-freedom system. (6)

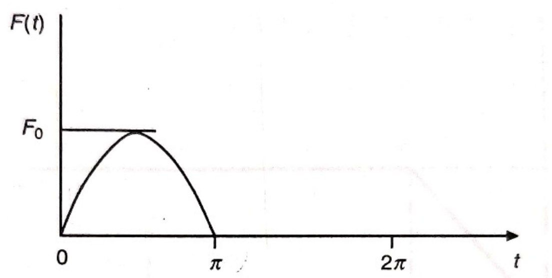


OR

16. An automobile, having a mass of 1000 kg, runs over a road bump of the shape shown in Fig. The speed of the automobile is 50 km/hr. If the undamped natural period of vibration in the vertical direction is 1.0 sec, find the response of the car by assuming it as a single degree of freedom undamped system vibrating in the vertical direction. (6)

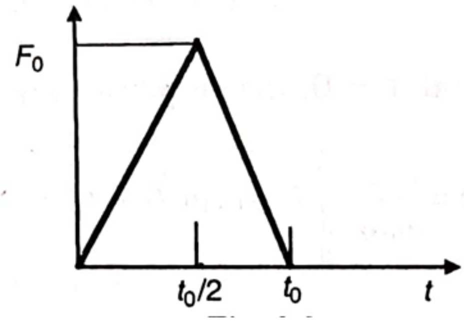


17. Determine the response of an under-damped system subjected to the half-sinusoidal excitation $F(t) = F_0 \sin(t)$ as shown in the figure?



OR

18. Determine the response of an undamped, single degree of freedom spring-mass system subjected to the triangular impulse as shown in the figure (6)

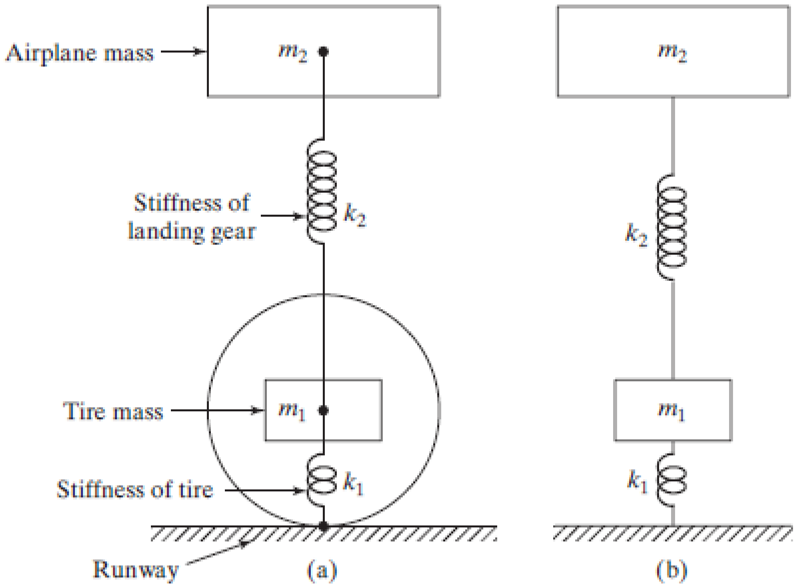


MODULE VI

19. A simplified model of the main landing gear system of a small airplane is shown in Fig. With m_1=100 kg, m_2 = 5000 kg, k_1= 10^4 N/m and k_2 = 10^6 N/m (6)

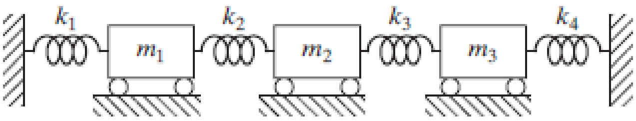
a. Find the equations of motion of the system.

b. Find the natural frequencies and the mode shapes of the system.



OR

20. Find the flexibility and stiffness influence coefficients of the system shown in Fig. Also, derive the equations of motion of the system. (6)



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