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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Mechanical Engineering

Semester End Examination; May / June - 2018

Mechanical Vibrations

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Fig. 1(a) shows the same vibratory system in two different orientations. Establish equation of motion and hence find the expression for natural frequency in each case. 10

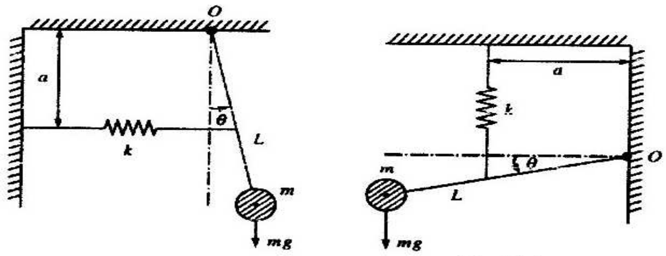


Fig 1(a)

b. A disc of a torsional pendulum has MI of 600 kg-cm^2 and is immerse in a viscous fluid. The brass shaft attached to it is 10 cm diameter and 40 cm long. When the pendulum is vibrating the observed amplitudes on the same side of the rest position for successive cycles are 9°, 6°and 4°. Determine; 10

i) Logarithmic decrement ii) Damping torque at unit velocity iii) Periodic time of vibration

Assume that for the brass shaft, G = 4.4×10^{10} N/m^2.

2 a. The mass of a spring mass dashpot is given an initial velocity (from the equilibrium position) of Aw_n where w_n is the undamped natural frequency of the system. Find the equation of motion for the cases when, i) $\zeta = 1.5$ ii) $\zeta = 1.0$ iii) $\zeta = 0.3$. 12

b. Find the natural frequency for the spring mass pulley system shown in Fig. 2(b) assuming the cord inextensible and there being no slip between the chord and the pulley. 8

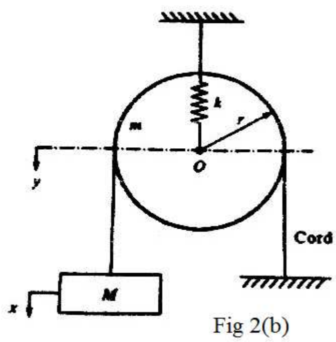


Fig 2(b)

UNIT - II

3 a. A weight of 500 N is suspended by a spring of stiffness of 12e3 N/m is forced to vibrate by a harmonic force of 10 N. Assuming a viscous damping of ζ = 1000 N-s/m. Find;

i) The resonant frequency ii) Amplitude of resonance

iii) Phase angle at resonance iv) Frequency corresponding to peak amplitude 12

v) Peak amplitude vi) Phase angle corresponding to peak amplitude

b. The static deflection of an automobile on its springs is 10 cm. Find the critical speed when the automobile is travelling on a road, which can be approximated by a sine wave of amplitude 8 cm and a wave length of 16 m. Assume the damping to be given by $\zeta = 0.05$. Also determine the amplitude of vibration at 75 km/hr. 8

4 a. A single cylinder vertical petrol engine of total mass 320 kg is mounted upon a steel chassis and causes a vertical static deflection of 2 mm. The reciprocating parts of the engine have a mass of 24 kg and move through a vertical stroke of 1500 mm with shm. A dashpot attached to the system offers a resistance of 490 N at a velocity of 0.3 m/s. Determine; 10

i) The speed of driving shaft at resonance

ii) The amplitude of steady state vibration when the driving shaft of the engine rotates at 480 rpm

b. Derive the equation for absolute displacement when a system is being excited by motion of the support itself. 10

UNIT - III

5a. A vertical shaft 15 mm diameter rotates in bearing with a span of 1 m carries a disc of mass 15 kg midway between the two bearings. The mass centre of the disc is 0.3 mm away from the geometric axis. If E is 2e11 N/m^2 and stress in the shaft is not to exceed 70e6 N/m^2. Determine; 12

i) Critical speed of the shaft

ii) Range of speed over which it is not safe to run the shaft

Neglect the mass of the shaft and damping in the system.

b. A body is subjected to two harmonic motions as given below. What extra harmonic motion should be given to the body to bring it to its static equilibrium? Solve analytically as well as graphically; 8

$X_1 = 15 \sin\left(\omega t + \frac{\pi}{6}\right)$ and $X_2 = 8 \cos\left(\omega t + \frac{\pi}{3}\right)$.

6a. A periodic motion observed on oscilloscope is as shown in Fig. 6(a). Represent this motion by a harmonic series. 12

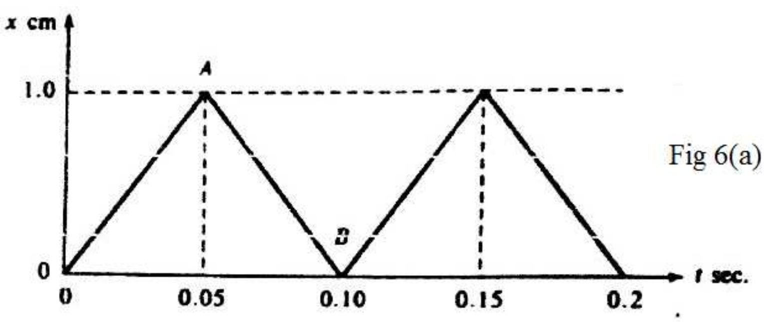


Fig 6(a)

b. A commercial Vibrometer having amplitude of vibration of the machine as 5 mm and damping factor 0.2 perform harmonic motion. If the difference between the maximum and minimum recorded value is 12 mm and the frequency of vibrating part is 15 rad/s. Find out the natural frequency of Vibrometer. 8

UNIT - IV

7 a. Fig. 7(a) shows two rails cars of 10 tonne each. They are coupled by springs of total stiffness 2.946e6 N/m. Find the natural frequencies of the system. 10

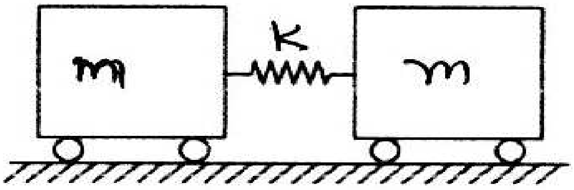


Fig 7 (a)

b. The automobile has a mass of 200 kg and a wheel base of 3 m, its CG is located 1.3 m behind the front wheel axis and has a radius of gyration about its CG as 1.2 m. The front springs have a combined stiffness of 6000 N/m and rear springs 6500 N/m. Find the natural frequencies. The principal axis of vibration of the automobile and locate the node for each mode. 10

8 a. For the system shown in Fig. 8(a) find the natural frequency of vibration and the principal mode of vibration (also sketch the mode). 14

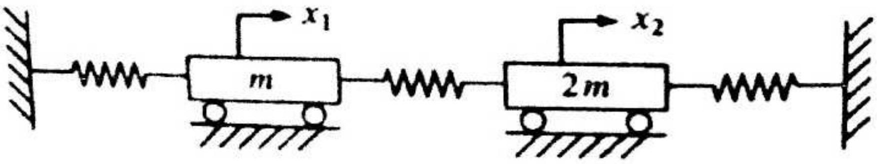
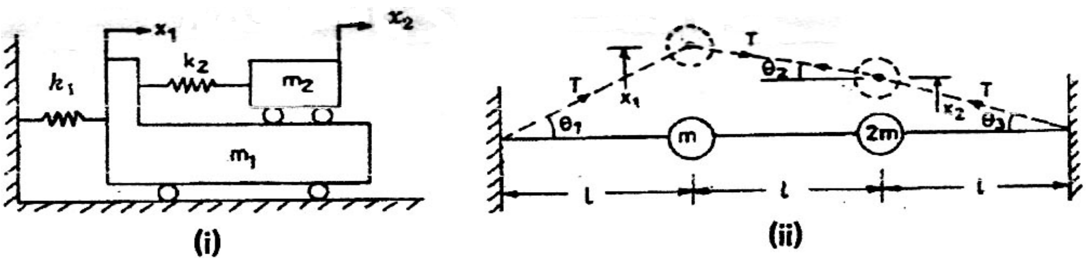


Fig 8(a)

b. Write the equation of motion for the system shown in Fig. 8(b) (i) and (ii). 6



UNIT - V

9 a. Using Stodala method find the three natural frequencies for the system shown in Fig.9.(a) when $k_1 = k$, $k_2 = 2k$, $k_3 = 3k$, $m_1 = m$, $m_2 = 2$ m and $m_3 = 3$ m. 12

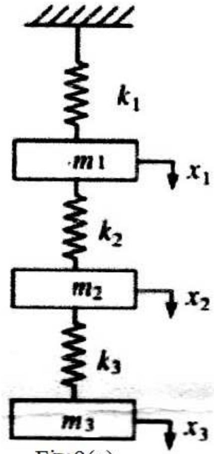


Fig 9(a)

b. A shaft of negligible mass 6 cm diameter and 5 m long is simply supported at the ends and carries four weights 50 kg each at equal distance over the length of the shaft. Find the frequency of vibration by Dunkerley's method. Take E = 2e5 N/mm^2. 8

10. Using Holzer method find the three natural frequencies for the system shown in Fig. 9(a) when $k_1 = k_2 = k_3 = 1$ N/m and $m_1 = m_2 = m_3 = 1$ kg. 20

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