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

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Automobile Engineering

Semester End Examination; May / June - 2018

Mechanical Vibration

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1 a. Define the terms: i) Simple harmonic motion ii) Free vibration iii) Forced vibration iv) Degree of freedom v) Time period 10

b. Find an expression for the natural frequency of the system shown in Fig. Q.1(b) by energy method, when the cylinder rolls without slipping. 10

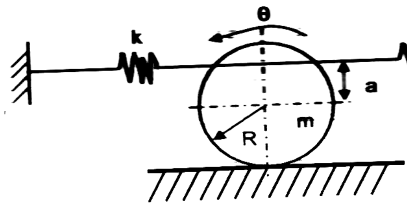

Figure Q. 1 (b)

2 a. What is meant by critical damping coefficient? Derive the expression for critical damping coefficient of a single degree of freedom spring-mass-damper system. 9

b. A vibrating system is defined by the following parameters : Mass is 6 kg, Spring stiffness is 300 N/m and damping coefficient is 50 N-s/m. Determine; 11

i) Critical damping coefficient ii) Damping factor iii) Logarithmic decrement

iv) Damped Natural frequency v) Ratio of two successive amplitudes

UNIT - II

3 a. Write the equation for the steady state response of a spring-mass-damper system due to rotating unbalance excitation. Also plot the response curves for different values of damping factor and discuss the salient points. 8

b. A machine of mass 20 kg is mounted on spring with stiffness 4000 N/m and the damping is 0.4 times the critical damping coefficient. A harmonic force $F(t) = 300 \sin(52.36\ t)$ acts on the mass. For the steady state vibration of the system. Determine; 12

i) The steady state amplitude of motion of the system

ii) Phase difference between the amplitude of steady state motion and the excitation force

iii) The transmissibility iv) The force transmitted v) The maximum velocity of motion

4 a. Define displacement transmissibility and derive an expression for the same. 10

b. A vehicle has a mass of 490 kg and the total spring constant of suspension system is 58800 N/m. The profile of the road may be approximated to a sine wave amplitude 40 mm and wave length 4 m. Determine; 10

Contd...2

i) The critical speed of the vehicle

ii) The amplitude of steady state motion of the mass when the vehicle is driven at critical speed and the damping factor is 0.5

iii) The amplitude of steady state motion of the mass when the vehicle is driven at 57 km/hr and the damping factor is 0.4.

UNIT - III

5 a. With the help of frequency response curves, discuss the principles of working of a Vibrometer and an Accelerometer. 12

b. An instrument for measuring acceleration records 30cycles/s. The natural frequency of the instrument is 800 cycles/s;

i) What is acceleration of the machine part to which the instrument is attached, if the amplitude recorded is 0.02 mm? 8

ii) What is the amplitude of vibration of the machine part?

6 a. An accelerometer having a natural frequency of 1000 cycles/min and a damping factor 0.7 is attached to a vibrating system. Determine the maximum acceleration of the system when the recorded acceleration is ω_n^2 = 0.5 m/s^2, when the system performs a harmonic motion at 800 cycles/min? 8

b. A rotor of mass 12 kg is mounted midway on a 25 mm diameter horizontal shaft supported at the ends of two bearings. The span between the bearings is 900 mm. Because of some manufacturing defect the C.G of the rotor is 0.02 mm away from the geometric centre of the rotor. If the system rotates at 3000 rpm, determine the amplitude of steady state vibrations and dynamic force transmitted to the bearings. Take E = 200 GPa. 12

UNIT - IV

7 a. Briefly explain the principal modes and Normal modes of vibration. 6

b. For the system shown in Fig. Q.7(b), obtain the fundamental natural frequencies and draw the mode shapes. 14

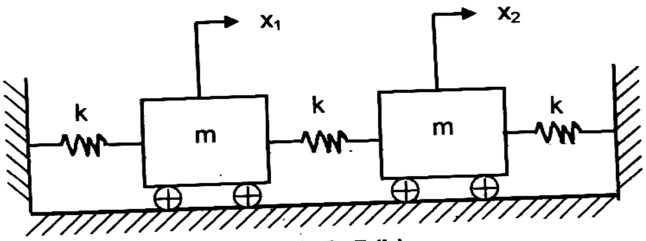

Figure Q. 7 (b)

8 a. State and prove Maxwell's reciprocal theorem. 6

b. The following information is given for the automobile shown in Fig. 8(b). Mass (m) = 1000 kg, front spring stiffness (k_1) = 18 kN/m; rear spring stiffness (k_2) = 22 kN/m; distance between front axle and C.G (I_1) = 1.0 m; Distance rear axle and C.G (I_2) = 1.5 m; Radius of gyration (r) = 0.9 m. Determine the normal modes of vibration and locate the nodes for each node. 14

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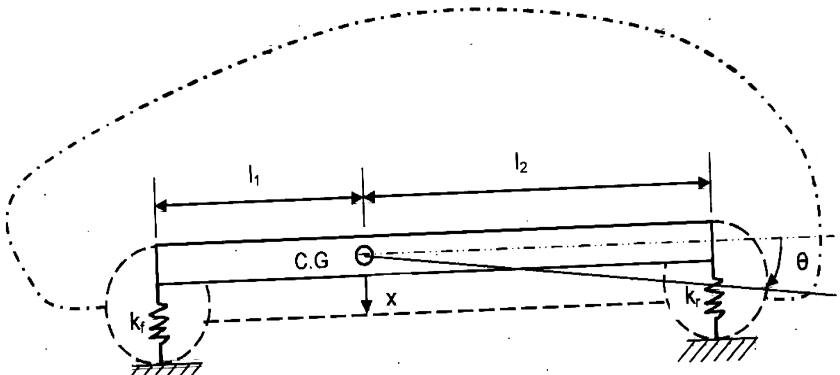

Figure Q. 8 (b)

UNIT - V

9 a. Explain the orthogonality principle. 6

b. Find the fundamental natural frequency and the corresponding mode shape for the system shown in Fig. Q.9(b) by the method of matrix iteration. 14

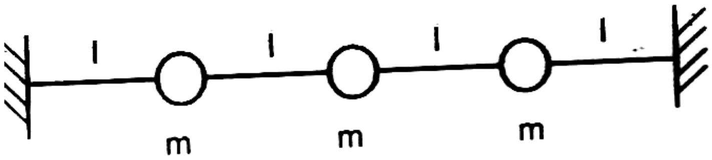

Figure Q. 9 (b)

10. Determine the natural frequencies for the system shown in Fig.Q.10 by using Holzer's method. 20

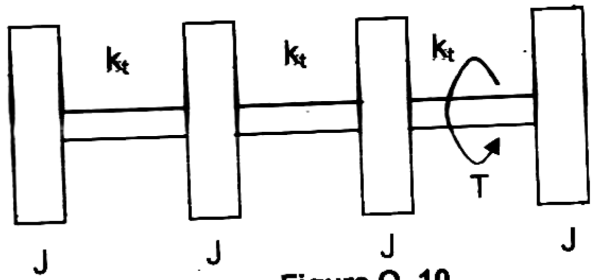

Figure Q. 10

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