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10AU73

Seventh Semester B.E. Degree Examination, May 2017
Mechanical Vibration and Vehicle Dynamics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Explain the following :
(i) Causes of vibration (ii) Control of vibration (iii) Beats phenomenon **(06 Marks)**

b. A rectilinear motion of a point is given by a = –10x, (where a is the acceleration and x is the displacement) is of simple harmonic type. The amplitude is 5 cm. Determine,
(i) The time period and frequency
(ii) Displacement, velocity and acceleration after 20 seconds. **(06 Marks)**

c. Split the harmonic motions, x = 5 sin (ωt + 45°) into two harmonic motions one having phase of zero and other of 60°. Check the solution graphically. **(08 Marks)**

2 a. A block of mass 0.05 kg of suspended from a spring having a stiffness of 25 N/m. The block is displaced downward from its equilibrium position through a distance of 2cm and released with an upward velocity of 3 cm/sec. Determine :
(i) Natural frequency
(ii) Period of oscillation
(iii) Maximum amplitude of vibration
(iv) Maximum velocity
(v) Maximum Acceleration
(vi) Phase angle. **(10 Marks)**

b. A circular disc of 5 kg mass, 100 mm radius is held by a spring of constant 200 N/m at the distance of 50 mm from the centre and rolls on a smooth horizontal plane, as shown in Fig.Q2(b). Find the natural frequency of the system. Use Energy method. **(10 Marks)**

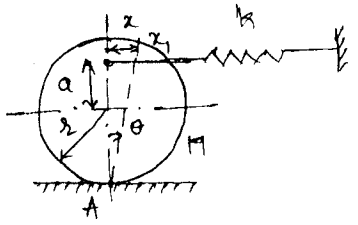

Fig.Q2(b)

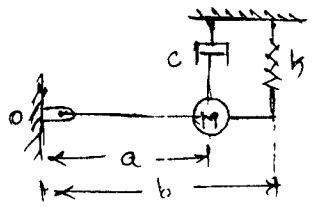

Fig.Q3(c)

3 a. Write a short note on structural damping. **(04 Marks)**

b. Derive the expression of logarithmic decrement. Show that $\delta = \frac{1}{n}\log_e \frac{x_0}{x_n}$, where '$x_0$' is amplitude at particular maximum and 'x_n' is amplitude after 'n' cycles. **(08 Marks)**

c. Determine suitable expression for equation of motion of the damped vibratory system as shown in Fig.Q3(c). Find the critical damping coefficient, when a = 0.10 m, b = 0.13 m, k = 4900 N/m and M = 1.5 kg. **(08 Marks)**

4 a. A vehicle driven on a rough road as shown in Fig.Q4(a). It is assumed that the vehicle is constrained to one degree of freedom in vertical direction. Roughness of the road surface is directly transmitted to the suspension system of the vehicle i.e. the spring constant of tyres is infinite. The tyres do not have the road surface. Mass of the vehicle when loaded is 1000 kg and 250 kg when is empty. The spring constant is 400 kN/m. The damping factor is 0.5, when the vehicle is fully loaded. The speed is 90 km/hr and the road surface varies sinusoidally with a wavelength of 5 m of an amplitude of 'Y' meter. Determine the amplitude ratio of the vehicle when fully loaded and empty. **(10 Marks)**

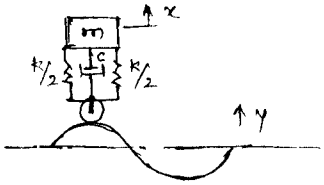

Fig.Q4(a)

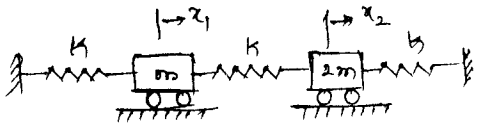

Fig.Q6(b)

b. A mass of 100 kg been mounted on a spring dashpot system having spring stiffness of 19600 N/m and damping coefficient of 100 N.sec/m. The mass is acted upon by harmonic force of 39 N at the undamped natural frequency of the system. Determine
(i) Amplitude of vibration of the mass. (ii) Phase difference between force and displacement (iii) Force transmissibility ratio. **(10 Marks)**

PART – B

5 a. What do you understand by seismic instrument? Explain the theory of seismic instrument giving the conditions under which the instrument can be used as an accelerometer and as vibrometer. **(10 Marks)**

b. An accelerometer with a damped natural frequency of vibration of 160 Hz has a suspended mass of 0.02 kg. When it is mounted on an engine, which is undergoing an acceleration of 10 m/sec^2 at an operating speed of 6500 rpm, the acceleration records in the instrument is 9.75 m/sec^2. Determine damping constant and spring stiffness of the accelerometer. **(10 Marks)**

6 a. Explain the following :
(i) Semi-definite system (ii) Coordinate coupling (iii) Vibration absorber **(12 Marks)**

b. Use Lagrange's equation to find the natural frequency and amplitude ratio of the system shown in FigQ6(b). **(08 Marks)**

7 a. Write a note on compensated suspension system. **(08 Marks)**

b. An engine weighing 1000 N including reciprocattory parts is mounted on springs. The weights of reciprocating parts is 22 N and the stroke is 90 mm. The engine speed is 720 rpm.
(i) Neglecting damping, find the stiffness of the springs, so that the force transmitted to the foundation is 5% of the amplitude force.
(ii) If under actual working condition the damping reduces the amplitude of successive vibration by 25%. Determine the force transmitted at 720 rpm. **(12 Marks)**

8 Using Holzer method find the natural frequencies of the system as shown in Fig.Q8. Assume $m_1 = m_2 = m_3 = 1$ kg and $k_1 = k_2 = k_3 = 1$ N/m. **(20 Marks)**

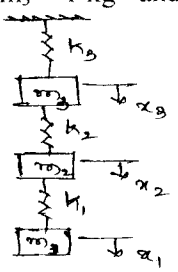

Fig.Q8

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