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10ME72

Seventh Semester B.E. Degree Examination, Aug./Sept.2020

Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. A harmonic motion is given by $x(t) = 10\sin\left(30t - \frac{\pi}{3}\right)$ mm where 't' is in seconds and phase angle in radians. Find:
(i) Frequency and the period of motion
(ii) The maximum displacement, velocity and acceleration. **(05 Marks)**

b. If there is a non-zero number of such that $\phi(tty) = \phi(t)$. What is the type of motion $\phi(t)$? State its most important characteristic? **(03 Marks)**

c. Saw tooth periodic motion of a follower operated by a cam is shown in Fig.Q1(c). Represent the motion by a harmonic series. The cam rotates uniformly at 60 rpm and the lift of the follower is 25 mm.

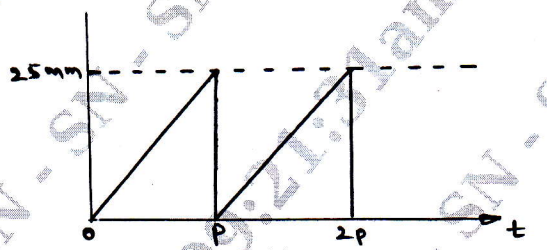

Fig.Q1(c) **(12 Marks)**

2 a. Obtain natural frequency of spring-mass system by energy method. **(06 Marks)**

b. A pendulum consists of a stiff weightless rod of length 'l' carrying a mass 'm' on its end as shown in Fig.Q2(b). Two springs each of stiffness 'K' are attached to the rod at a distance 'a' from the upper end. Determine the frequency for small oscillations.

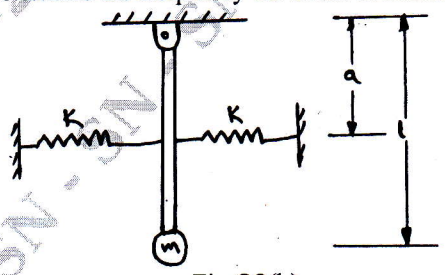

Fig.Q2(b) **(10 Marks)**

c. Obtain the natural frequency of a cantilever beam of length 'l' with a mass 'm' attached to its end. **(04 Marks)**

3 a. Draw damping response curve (x – t) for over, under and critically damped systems. **(04 Marks)**

b. For the system shown in Fig.Q3(b). The characteristic of the dashpot is such that when a constant force of 49 N is applied to the piston its velocity is found to be constant at 0.12 m/sec.
   (i) Determine the value of C.
   (ii) Would you expect the complete system to be periodic or aperiodic.

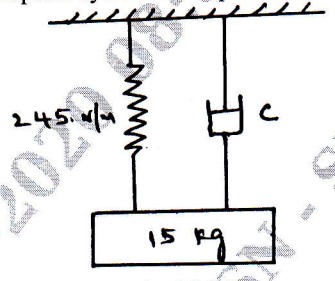

Fig.Q3(b) **(06 Marks)**

c. Free vibration records of 1 tonne machine mounted on an isolator is shown in Fig.Q3(c). Identify the type of isolator and its characteristics i.e. the spring.

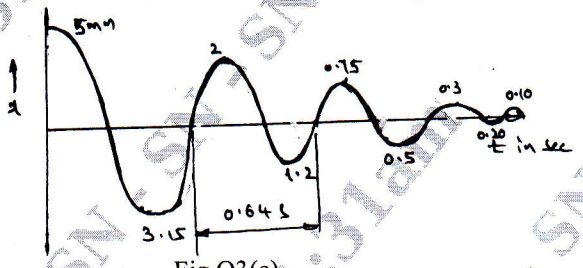

Fig.Q3(c) **(10 Marks)**

4 a. The sketch shown in Fig.Q4(a) is the vector representation of forced vibration with damping. Name the vectors.

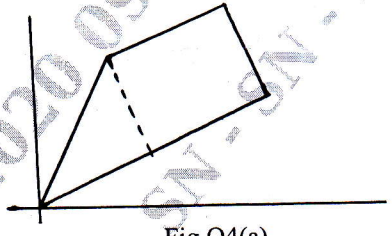

Fig.Q4(a) **(04 Marks)**

b. A trailer has 1000 kg mass when fully loaded and 250 kg when empty. The spring of the suspension is 350 kN/m. The damping factor is 0.5 when the trailer is fully loaded. The speed is 100 km/hr. The road varies sinusoidally with a wave length of 5m. Determine the amplitude ratio of the trailer when fully loaded and empty. **(12 Marks)**

c. Write a short note on vibration isolation. **(04 Marks)**

PART – B

5 a. A rotor of mass 4 kg is mounted on 1 cm diameter shaft at a point 10 cm from one end. The 25 cm long shaft is supported by bearings. Calculate the critical speed. If the centre of gravity of the disc is 0.03 mm away from the geometric centre of rotor, find the deflection of the shaft when its speed of rotation is 5000 rpm. Take $E = 1.96 \times 10^{11}$ N/m^2. Find the critical speed when the rotor is mounted midway on the shaft. **(12 Marks)**

b. With a sketch and Z/Y versus W/W_n diagram, explain the principle of vibrometer. **(08 Marks)**

6 a. Find the natural frequencies of the system shown in Fig.Q6(a). Assume that there is no slip between the cord and cylinder.

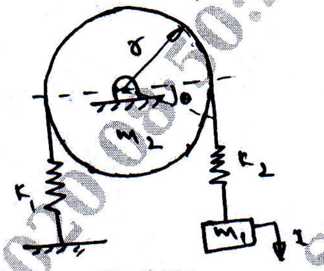

Fig.Q6(a)

(14 Marks)

b. Explain the principle of working of a dynamic vibration absorber. (06 Marks)

7 Using Holzer method to find the natural frequency of the system shown in Fig.Q7. Assume $m_1 = m_2 = m_3 = 1$ kg and $k_1 = k_2 = k_3 = 1$ N/m.

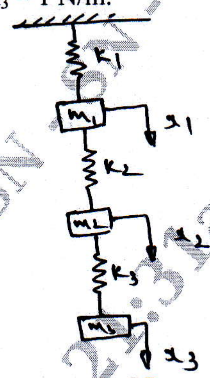

Fig.Q7

(20 Marks)

8 Write short notes on:

a. Signal analysis
b. Dynamic testing of machines
c. Experimental modal analysis
d. Machine condition monitoring and diagnosis (20 Marks)

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