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10AE65

Sixth Semester B.E. Degree Examination, Feb./Mar. 2022
Theory of Vibrations

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following terms:
(i) Longitudinal vibration (ii) Torsional vibration (iii) Resonance
(iv) Simple harmonic motion (v) Time period. **(10 Marks)**

b. Periodic motion in time domain is given by $x(t) = -20t + 2$ for $0 \le t \le 0.2$. Obtain Fourier's series equation in frequency domain. **(10 Marks)**

2 a. Determine the natural frequency of a spring mass system where the mass of the spring is also to be taken in to account. **(10 Marks)**

b. The solution to the differential equation for single degree freedom motion is given by $x = X\cos(100t + \phi)$ with initial condition $\dot{x}_{(0)} = 1250$ mm/sec and $x_{(0)} = 0.25$ mm, find the values of X and ϕ and express the given equation in the form $x = A\sin\omega_n t + B\cos\omega_n t$. **(10 Marks)**

3 a. A door 200 cm high, 75 cm wide and 4 cm thick and weighing 35 kg is fitted with an automobile door closer. The door opens against a spring with a modulus of 1 kg-cm/radian. If the door is opened 90° and released, how long will it take the door to be within 1° of closing? Assume the return spring of the door to be critically damped. **(10 Marks)**

b. Derive an expression for logarithmic decrement of an under damped system. **(06 Marks)**

c. What is damping? Mention different types of damping. **(04 Marks)**

4 a. With usual notation derive an expression for maximum displacement for a forced vibration of undamped single degree freedom system. **(10 Marks)**

b. A machine of a total mass 68kg mounted on springs of stiffness K = 11,000 N/cm, with an assumed damping factor ξ = 0.2. A piston within the machine has a mass of 2kg has a reciprocating motion with stroke 7.5cm and a speed of 3000rpm. Assuming the motion of piston to be SHM. Determine:

i) Amplitude.
ii) Phase angle with respect to exciting force.
iii) Transmissibility and force transmitted to foundation.
iv) Phase angle of transmitted force with respect to exciting force. **(10 Marks)**

PART – B

5 a. Explain the working of a seismic instrument with a neat sketch. State the conditions for which the instrument functions as : i) Vibrometer ii) Accelerometer. **(08 Marks)**

b. A rotor has a mass of 15kg and is mounted at a distance 300 from right hand support on a 20mm diameter horizontal shaft supported at the ends by two bearings. The bearings are 80cm apart. The shaft routes at 2400 rpm. If the centre of mass of the rotor is 0.11mm away from the geometric centre of the rotor due to a certain manufacturing inaccuracies, find the amplitude of the steady state vibration and the dynamic force transmitted to each bearing. Take E = 200GPa. **(12 Marks)**

6 a. Explain the following :
i) Modes of vibration
ii) Co-ordinate coupling
iii) Vibration absorber **(06 Marks)**

b. Find the natural frequency and amplitude ratio for the system shown in Fig Q6(b). Take $m_1 = 10kg$, $m_2 = 15kg$ and $k = 320$ N/m.

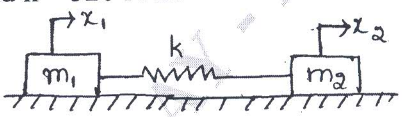

Fig Q6(b) **(14 Marks)**

7 a. Derive the general solution of a torsional vibration of rods. **(10 Marks)**

b. Derive suitable mathematical expression for longitudinal vibration of rod of uniform cross section. **(10 Marks)**

8 Find the natural frequency of the system shown in Fig. Q8 by Holzer's method. Assume $m_1 = m_2 = m_3 = 1\,kg$ and $k_1 = k_2 = k_3 = 1\,N/m$. **(20 Marks)**

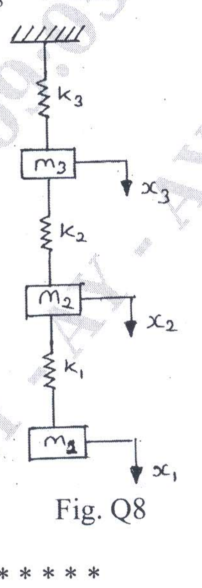

Fig. Q8

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