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06ME62

Sixth Semester B.E. Degree Examination, December 2010
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. Define : i) Degrees of freedom ; ii) Simple harmonic motion. **(04 Marks)**

b. Explain : i) Types of vibrations ; ii) Beats phenomenon. **(08 Marks)**

c. 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 period of motion ; ii) Maximum displacement, velocity and acceleration. **(08 Marks)**

2 a. The ratio K/m of a spring-mass system is given as 4.0. If the mass is deflected 20 mm down, measured from its equilibrium position, and given an upward velocity of 80 mm/s, determine its amplitude and maximum acceleration. **(10 Marks)**

b. Find the time period of small vibrations of an inverted pendulum and spring-mass system shown in Fig.Q.2(b). The pendulum is vertical in the equilibrium position. Is there any limitation on the value of 'K'? Discuss. **(10 Marks)**

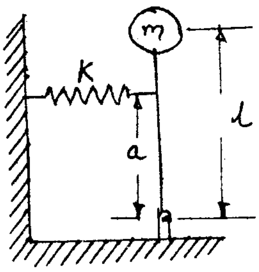

Fig.Q.2(b).

3 a. Derive an expression for oscillatory motion of a spring-mass-damper system, given the initial conditions as $x = x_0$ at $t = 0$ and $\dot{x} = 0$ at $t = 0$. **(10 Marks)**

b. A machine weighing 7.6 kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three parallel springs each of stiffness 1 N/mm and it is found that the amplitude of vibration diminishes form 38.4 mm to 6.4 mm in two complete oscillations. Assume that the damping force varies proportionately with velocity. Determine :
i) The resistance of the dashpot at unit velocity ; ii) The ratio of frequency of damped vibration to frequency of undamped vibration ; iii) The periodic time of the damped vibration. **(10 Marks)**

4 a. A reciprocating pump, 200 kg, is driven through a belt by an electric motor at 3000 rpm. The pump is mounted on isolators with total stiffness of 5 MN/m and damping of 3.125 kN-s/m. Determine the vibrating amplitude of the pump at the running speed due to fundamental harmonic force of excitation, 1kN. Also determine the maximum vibratory amplitude when the pump is switched 'ON' and the motor speed passes through resonant condition. **(10 Marks)**

b. Define displacement and transmissibility. Deduce an expression for the same. Sketch or plot its vibration with frequency ratio for different amounts of damping. **(10 Marks)**

PART – B

5 a. Derive an expression for the deflection of the shaft mounted with a disc at the centre, when the centre of gravity of the disc is displaced from the geometric centre by a distance 'e'. Neglect the effect of air damping and the mass of the shaft. Also, show that the critical speed of the shaft is equal to the natural frequency of lateral vibration of the shaft. **(10 Marks)**

b. A device used to measure torsional acceleration consists of a ring having a moment of inertia of 0.049 kg-m^2 connected to a shaft by a spiral spring having a scale of 0.98 N-m/rad, and a viscous damper having a constant of 0.11 N-m-sec/rad. When the shaft vibrates with a frequency of 15 cpm, the relative amplitude between the ring and the shaft is found to be 2^o. What is the maximum acceleration of the shaft? **(10 Marks)**

6 a. Write notes on :
   i) Generalized and principal co-ordinates
   ii) Normal mode of vibration. **(06 Marks)**

b. Determine the natural frequency and normal modes of vibration for the system shown in Fig.Q.6(b). Also determine the response of the system when $x_1(0) = 1$, $\dot{x}_1(0) = 0$, $x_2(0) = 0$, $\dot{x}_2(0) = 0$ **(14 Marks)**

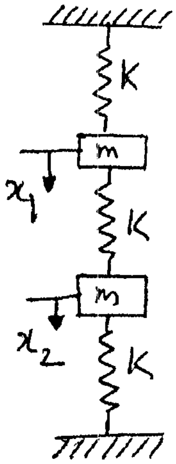

Fig.Q.6(b).

7 a. The differential equation of motion for the longitudinal vibration of uniform bar is $\frac{\partial^2 u}{\partial x^2} = \frac{1}{a^2}\frac{\partial^2 u}{\partial t^2}$, where $a^2 = \frac{E}{\rho}$, E is the Young's modulus, ρ is the density of the material. Obtain the general solution to this equation. Also derive an expression for free longitudinal vibration, when the bar is fixed at one end and free at the other. **(12 Marks)**

b. State and prove Maxwell's reciprocal theorem. **(08 Marks)**

8 Use Holzer's method to determine the first three natural frequencies for torsional vibration of four-degree-of-freedom system as shown in Fig.Q.8. **(20 Marks)**

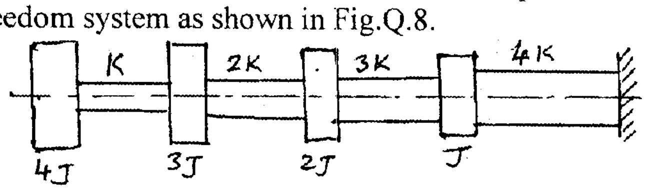

Fig.Q.8

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