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10ME72

Seventh Semester B.E. Degree Examination, June/July 2018
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Derive an expression for workdone by a harmonic force. **(08 Marks)**

b. Explain beats phenomenon and discuss the importance of beats. **(04 Marks)**

c. Determine the algebraic sum of the harmonic motions given by $x_1 = 3\sin\left(\omega t + \frac{\pi}{3}\right)$ and $x_2 = 5\sin\left(\omega t + \frac{2\pi}{3}\right)$ analytically as well as graphically. **(08 Marks)**

2 a. Figure Q2 (a) shows a cylinder of mass m and radius r rolls without slipping on a cylindrical surface of radius R. Determine using energy method, (i) Differential equation of motion (ii) Natural frequency of oscillation. **(10 Marks)**

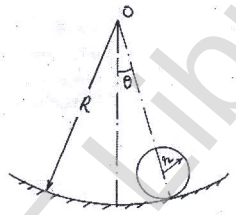

Fig. Q2 (a)

b. Determine the natural frequency of spring mass system by considering the mass of the spring into account. **(10 Marks)**

3 a. The mass of the spring mass dashpot system is given an initial velocity of ω_n (from equilibrium position), where ω_n is the undamped natural frequency of the system. Find the equation of motion for the system when $\xi = 2$. **(10 Marks)**

b. Determine the value of C such that the system shown in Fig. Q3 (b) is critically damped, if m = 10 kg and K = 10,000 N/m. **(05 Marks)**

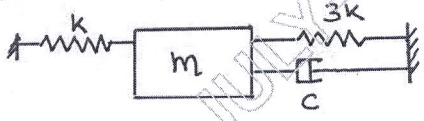

Fig. Q3 (b)

c. Show that logarithmic decrement $\delta = \frac{1}{n}\ln\left(\frac{x_0}{x_n}\right)$ where x_0 is the initial amplitude and x_n is the amplitude after n cycles. **(05 Marks)**

4 a. A 50 kg fan has a rotating unbalance of magnitude 0.1 kgm. The fan is mounted on the free end of a Cantilever beam of length 1.2 m. Find the steady state amplitude of the fan when it operates at 1000 rpm. The Young's modulus of elasticity of the Cantilever beam material is 210 GPa and moment of inertia is 1.3×10^{-6} m^4. The beam is specially treated to add viscous damping of $\xi = 0.08$. **(10 Marks)**

b. An air compressor of 450 kg operates at a constant speed of 1750 rpm. The reciprocating part is 10 kg and Crank radius is 100 mm. Specify the spring for the mounting such that only 20% of the unbalanced force is transmitted to the foundation when (i) damping ratio $\xi = 0$ and (ii) damping ratio $\xi = 0.15$. **(10 Marks)**

PART – B

5 a. A commercial vibration pick up has a damped natural frequency of 4.5 Hz and a damping ratio 0.75. What is the range of impressed frequency at which the amplitude can be read directly from the pick up with an error not exceeding 2% of the actual amplitude? **(10 Marks)**

b. The rotor of mass 9 kg is placed at the center of a 25 mm diameter steel shaft 40 cm between bearings. Determine

(i) The critical speed of shaft.

(ii) The amplitude of vibration of the rotor at a speed of 3600 rpm, if the eccentricity is 0.15 mm and

(iii) The vibratory force transmitted to the bearings at this speed.

Assume the shaft to be simply supported and neglect the weight of the shaft. Take $E = 2.1 \times 10^{11} N/m^2$. **(10 Marks)**

6 a. Find the natural frequencies of the system shown in Fig. Q6 (a). **(10 Marks)**

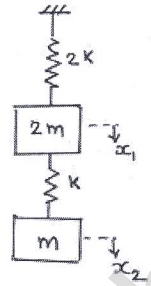

Fig. Q6 (a)

b. Find the natural frequencies of the system shown in Fig. Q6 (b). Assume that there is no slip between the cord and the cylinder. Give K_1 = 60 N/m, K_2 = 40 N/m, m = 2 kg and M = 10 kg. **(10 Marks)**

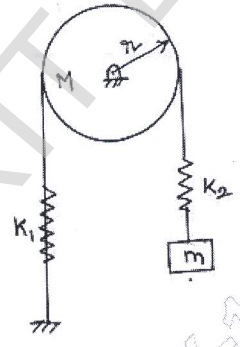

Fig. Q6 (b)

7 a. State and prove Maxwells reciprocal theorem. **(08 Marks)**

b. Find the lowest natural frequency of vibration for the system shown in Fig. Q7 (b) by Rayleighs method. Take $E = 1.96 \times 10^{11} N/m^2$, $I = 4 \times 10^{-7} m^4$, m_1 = 100 kg and m_2 = 50 kg. **(12 Marks)**

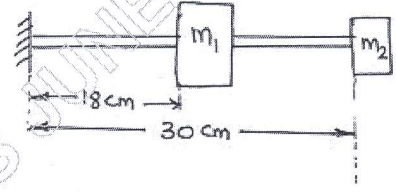

Fig. Q7 (b)

8 a. Sketch and explain the arrangement for experimental modal analysis. **(08 Marks)**

b. Explain the following: (i) Breakdown maintenance (ii) Preventive maintenance (iii) Condition based maintenance. **(09 Marks)**

c. List the various techniques for machine condition monitoring. **(03 Marks)**

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