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10ME72

Seventh Semester B.E. Degree Examination, June/July 2014
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Add the following harmonic motions analytically and check the solution graphically:
$x_1 = 4 \cos (wt + 10°)$
$x_2 = 6 \sin (wt + 60°)$. **(10 Marks)**

b. Develop the Fourier series for the curve shown in Fig.Q.1(b). **(10 Marks)**

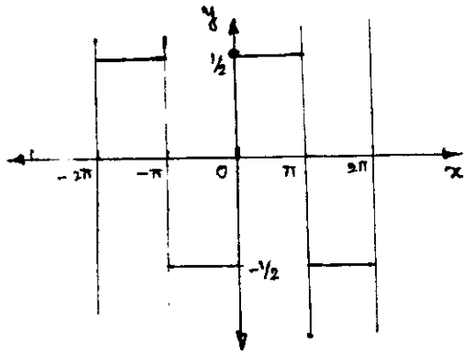

Fig.Q.1(b)

2 a. Explain the energy method of finding natural frequency of a spring-mass system. **(08 Marks)**

b. Find the natural frequency of the spring controlled simple pendulum shown in Fig.Q.2(b). Neglect the mass of the rod. **(06 Marks)**

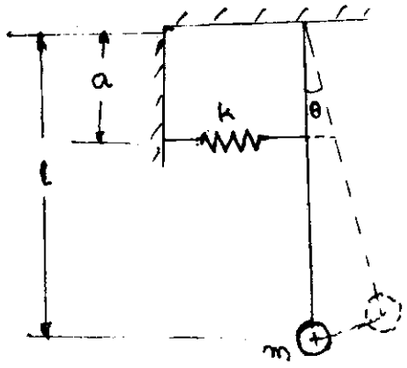

Fig.Q.2(b)

c. For the system shown in Fig.Q.2(c) find mass m if the system has a natural frequency of 10Hz.
Take $k_1 = 2$ N/mm
$k_2 = 1.5$ N/mm
$k_3 = 3$ N/mm
$k_4 = k_5 = 0.5$ N/mm. **(06 Marks)**

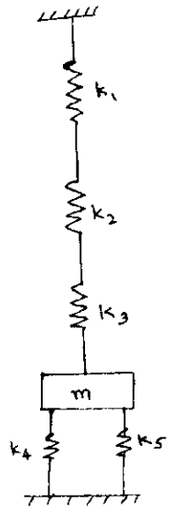

Fig.Q.2(c)

3 a. Show that the ratio of successive amplitudes of mass in a underdamped, viscously damped spring-mass system is given by
$\frac{x_0}{x_1} = e^{\delta}$ where $\delta = \frac{2\pi\xi}{\sqrt{1-\xi^2}}$. **(10 Marks)**

b. A machine of mass 20kg is mounted on a spring and dashpot. The spring stiffness is 10 N/mm and damping is 0.15 N/mm/s. If the mass is initially at rest and a velocity of 100 mm/s is imported to it, determine: i) displacement and velocity of mass as a function of time; ii) displacement and velocity when time is equal to one second. **(10 Marks)**

4 a. Derive an expression for steady state amplitude of vibration of mass in a spring-mass-damper system when the mass is subjected to harmonic excitation. Also find the phase angle between the mass and excitation. **(10 Marks)**

b. A vibratory body of mass 150kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000rpm. If the damping factor is 0.3, determine:
i) Amplitude of vibration and phase angle.
ii) Transmissibility ratio and
iii) Force transmitted to the foundation. **(10 Marks)**

PART – B

5 a. Explain the principle of working of
i) Vibrometer (seismometer) ; ii) Accelerometer. **(10 Marks)**

b. A rotor of mass 9.5kg is mounted on a 12mm horizontal steel shaft midway between bearings that are 0.6m apart. The mass centre of the disc is 6mm from its geometric centre. If the damping factor is 0.1 and the shaft rotates at 690 rpm, determine the maximum stress in the shaft and compare it with the dead load stress in the shaft. For steel shaft take $E = 1.96 \times 10^{11}$ N/m^2. **(10 Marks)**

6 a. Explain the principles of dynamic vibration absorber. Derive the necessary equations. **(10 Marks)**

b. For the system shown in Fig.Q.6(b) find the natural frequencies and amplitude ratios. Given $m_1 = 10kg$, $m_2 = 15kg$ and $k = 320$ N/m. **(10 Marks)**

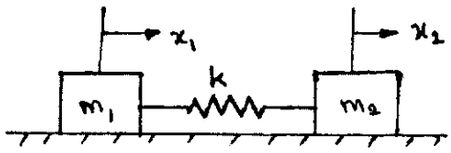

Fig.Q.6(b)

7 a. Find the first natural frequency and draw the mode shape for the system shown in Fig.Q.7(a) by matrix iteration method. Take $k_1 = k_2 = k_3 = k$ and $m_1 = m_2 = m_3 = m$. **(10 Marks)**

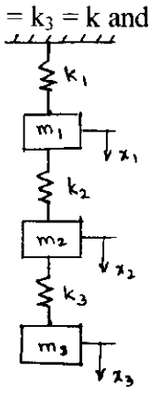

Fig.Q.7(a)

b. Using Stodola's method, determine the lowest natural frequency of the torsional system shown in Fig.Q7(b). **(10 Marks)**

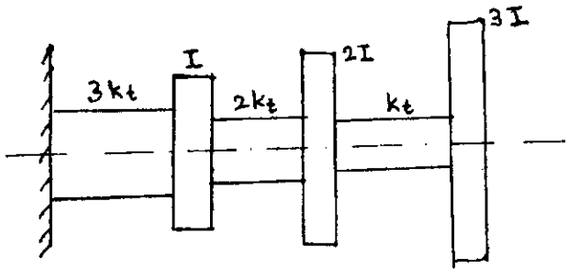

Fig.Q7(b)

8 a. Explain the role of i) Exciter; ii) Transducer; iii) Signal conditioner and iv) Analyzer, used in experimental modal analysis. **(10 Marks)**

b. Describe the three types of maintenance schemes given below:
   i) Breakdown maintenance.
   ii) Preventive maintenance.
   iii) Condition-based maintenance. **(06 Marks)**

c. Explain briefly the following methods of condition monitoring:
   i) Wear debris monitoring.
   ii) Vibration analysis. **(04 Marks)**

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