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10ME72

Seventh Semester B.E. Degree Examination, May 2017
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. If $x_1 = 2\cos(2t + 0.5)$ and $x_2 = 5\sin(2t + 1)$, find
   i) Resultant of x_1 and x_2 analytically and verify the same graphically.
   ii) Time period of resultant motion. **(10 Marks)**

b. $x_1(t)$ and $x_2(t)$ are two harmonic motions of periods T_1 and T_2 respectively. Show that the resultant motion $(x_1 + x_2)$ can be periodic only if two integers m and n can be found such that $mT_1 = nT_2 = T$. **(04 Marks)**

c. For the periodic motion shown in Fig.Q1(c), find:
   i) Fundamental frequency, ω
   ii) The coefficient of $\sin 5\omega t$ of the Fourier's series of this function.

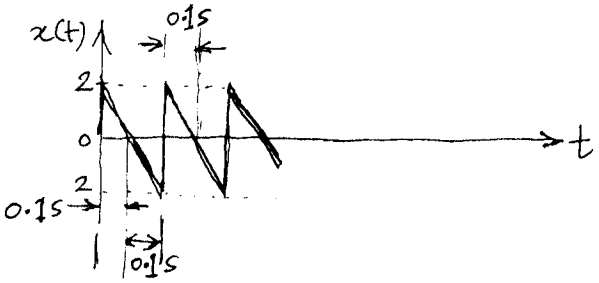

Fig.Q1(c) **(06 Marks)**

2 a. A rim type of flywheel of mass 35 kg having outside and inside diameter of 0.4 m and 0.3 m was allowed to swing as compound pendulum about a knife edge at inner side of the rim. If the measured period of oscillation is 1.22 s, determine the moment of inertia of the flywheel about its geometric axis. **(10 Marks)**

b. A U-tube, open to atmosphere at both ends contains a liquid for a column length 'ℓ'. Find the natural period of oscillation of the liquid column. **(10 Marks)**

3 a. The mass of a spring-mass-dashpot system is given an initial velocity (from the equilibrium position) of $2\omega_n$ m/s where ω_n is undamped natural frequency of the system. Damping ratio of the system is 2. Find an expression for the position of mass at any time. **(10 Marks)**

b. The disc of a torsional pendulum has a moment of inertia of 600 kg-cm^2 and is immersed in a viscous fluid. The brass shaft attached to the disc is light and of diameter 0.1 m and length 0.4 m. For free vibrations, the observed amplitudes on the same side from mean position are 9°, 6° and 4° for successive cycles. Find:
   i) Logarithmic decrement
   ii) Damping coefficient
   iii) Periodic time of vibrations
   (modulus of rigidity of brass = 44 GPa) **(10 Marks)**

4 a. A spring-mass-dashpot system is subjected to a harmonic excitation $F_0 \sin \omega t$. Define 'magnification factor' for this system. Assuming the expression for 'magnification factor', find the value of ω/ω_n When the magnification factor is maximum? **(10 Marks)**

b. Define transmissibility and state the expression for transmissibility. Plot (not to scale) variation of transmissibility with frequency ratio (ω/ω_n) for different damping ratio. For effective transmissibility at high ω/ω_n, machine is attached with a large concrete block. Why? Explain in brief. **(10 Marks)**

PART – B

5 a. Write a brief note seismic instrument along with a neat sketch. **(06 Marks)**

b. Determine the mass 'M' to be placed at the end of reed in order that the reed be in resonance at a frequency of 30 Hz. The steel reed is 50 mm long, 6 mm wide and 0.75 mm thick. Young's modulus of the steel is 196 GPa. **(08 Marks)**

c. A light shaft supported in two bearings at its end, carries a heavy unbalanced rotor at its centre. Under what conditions for undamped system,
i) Rotor rotates with heavy side outwards?
ii) Rotor rotates with light side outwards?
Explain in brief. **(06 Marks)**

6 Obtain the differential equations of motion for the double pendulum (pendulum $\ell_2 - m_2$ attached to pendulum $\ell_1 - m_1$). If $m_1 = m_2 = m$ and $\ell_1 = \ell_2 = \ell$, find: i) natural frequencies, ii) ratio of amplitudes and draw mode shapes. **(20 Marks)**

7 a. Using Dunkerly's method, find the fundamental natural frequency of transverse vibrations for the system shown in Fig.Q7(a).

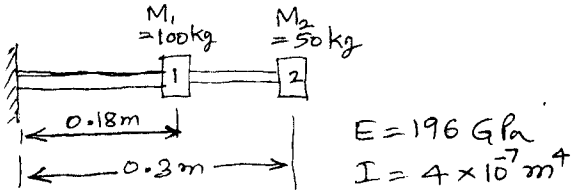

Fig.Q7(a) **(08 Marks)**

b. Find the fundamental natural frequency for the system shown in Fig.Q7(b) by the method of matrix iteration.

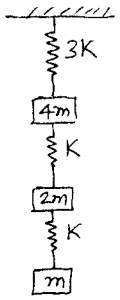

Fig.Q7(b) **(12 Marks)**

8 a. What is the hardware of an equipment necessary for experimental modal analysis? Explain in brief. **(10 Marks)**

b. Explain in brief the various types of machine maintenance techniques. **(10 Marks)**

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