CBCS SCHEME

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18RA743

Seventh Semester B.Tech. Degree Examination, Dec.2023/Jan.2024
Mechanical Vibrations

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. What is Vibrations? Enumerate the causes and effects of vibration. **(10 Marks)**

b. What is SHM? Explain the principle of super position applied to SHM. **(10 Marks)**

OR

2 a. Add the following harmonics analytically:
$x_1 = 3 \sin (wt + 30°)$
$x_2 = 4 \cos (wt + 10°)$. **(10 Marks)**

b. Fig.Q.2(b) shows a spring mass system. Determine spring stiffness and natural frequency of vibration of the system. **(10 Marks)**

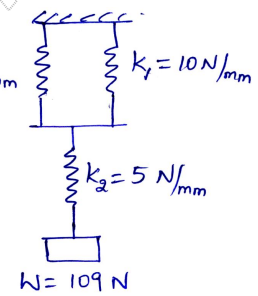

Fig.Q.2(b)

Module-2

3 a. Set up the differential equation for a spring mass damper system and obtain complete solution for the critically damped condition. **(10 Marks)**

b. A damped spring mass system has m = 10kg, k = 10N/mm and c = 0.1N-s/mm. Obtain the equation for the displacement of the mass. **(10 Marks)**

OR

4 a. The measurement on a mechanical vibrating system shows that the mass of 10kg and that the springs can be combined to give an equal spring stiffness 5N/mm. If the vibrating system have a dashpot attached which exerts a force of 40N when the mass have a unit velocity of 1m/s. Determine:
i) Critical damping coefficient
ii) Damping factor
iii) Logarithmic decrement
iv) Ratio of any two consecutive amplitudes. **(10 Marks)**

b. The mass of a single degree damped vibrating system is 7.5kg makes 24 free oscillation in 14 secs, when distributed from its equilibrium position. The amplitude of vibration reduced to 0.25 of its initial value after 5 oscillations. Determine:
i) Stiffness of spring
ii) Log decrement
iii) Damping factor. **(10 Marks)**

Module-3

5 a. Define transmissibility and magnification factor. Derive the equations for the same. **(10 Marks)**

b. A mass of 10kg suspended from one end of helical spring, the other end is fixed. The stiffness of spring is 10N/mm. The viscous damping causes the amplitude to decrease $1/10^{th}$ of initial value in four complete oscillations. If a periodic force of 150 cos 50t N is applied at the mass with vertical direction. Find the amplitude of forced vibration. What is its value at resonance? **(10 Marks)**

OR

6 a. A machine of total mass 17kg is mounted on springs having stiffness k = 11,000N/cm. A piston within the machine has a mass of 2kg has a reciprocating motion with stroke 7.5cm and speed 6000rpm. Assuming the motion to be SHM. Determine:

i) Amplitude of machine
ii) Transmissibility
iii) Force transmitted to the ground

Take Z = 0.2. **(10 Marks)**

b. Show that providing damping in vibration isolation is not useful when the frequency ratio is more than 1.414 or $\sqrt{2}$. **(10 Marks)**

Module-4

7 a. For the system shown in Fig.Q.7(a)

i) Derive the equation of motion
ii) Set up frequency equation and obtain natural frequencies of the system.

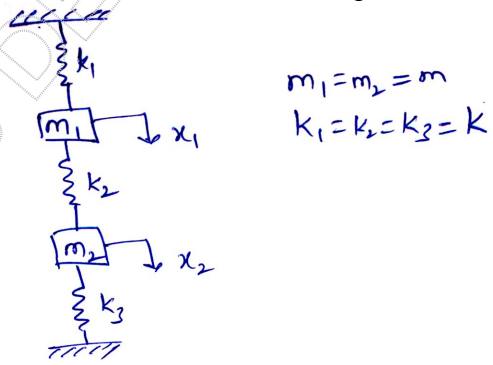

Fig.Q.7(a)

(10 Marks)

b. A two degrees of freedom vibrating system is shown in Fig.Q.7(b). Determine: i) The two natural frequencies of vibrations ii) Ratio of amplitudes of motion of m_1 and m_2 for the two modes of vibration iii) Modal vector and modal shapes iv) Locate the nodes for each mode of vibration. Given m_1 = 2kg, m_2 = 1kg, k_1 = 40N/m and k_2 = 20N/m. **(10 Marks)**

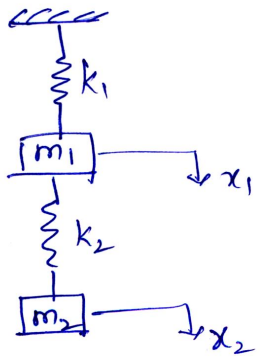

Fig.Q.7(b)

OR

8 Fig.Q.8 shows a spring mass system. If the mass m_1 is displaced 20mm from its static equilibrium position and released, determine the resulting displacements $x_1(t)$ and $x_2(t)$ of the masses. Given $k_1 = k_2 = k_3 = k$ and $m_1 = m_2$. **(20 Marks)**

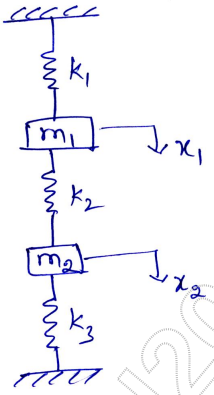

Fig.Q.8

Module-5

9 a. Explain Maxwell reciprocal theorem. **(10 Marks)**

b. What are influence coefficients? Write a note on orthogonality principle? **(10 Marks)**

OR

10 a. Briefly explain Dunkerley's method. **(10 Marks)**

b. Find the lowest natural frequency of vibration for the system shown in Fig.Q.10(b) by Rayleigh's method. $E = 1.96 \times 10^{11} N/m^2$ $I = 4 \times 10^{-7} m^4$. **(10 Marks)**

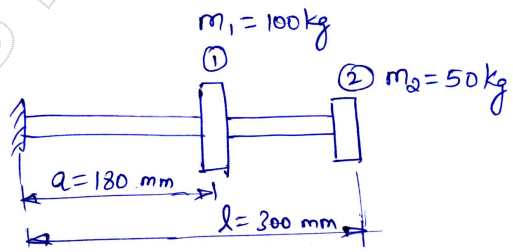

Fig.Q.10(b)

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