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18AE56

Fifth Semester B.E. Degree Examination, July/August 2022
Theory of Vibrations

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Discuss the types of vibration. **(08 Marks)**

b. Represent the periodic motion given in the following Fig.Q.1(b) by harmonic series. **(12 Marks)**

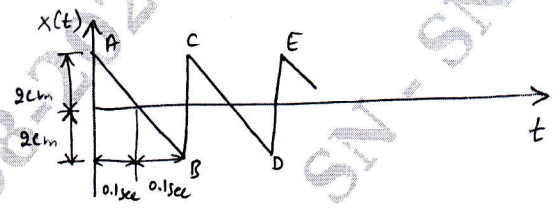


Fig.Q.1(b)

OR

2 a. Add the following harmonic motions and check the solution graphically:
$x_1 = 2\cos(wt + 0.5)$
$x_2 = 5\sin(wt + 1.0)$. **(08 Marks)**

b. Find the Fourier series expansion for the impact force generated by the forging hammer shown in Fig.Q.2(b). **(12 Marks)**

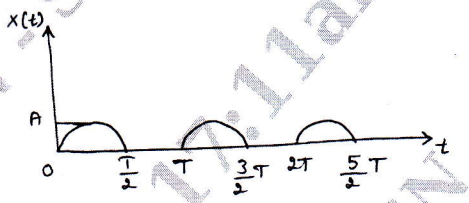


Fig.Q.2(b)

Module-2

3 a. Determine equivalent stiffness of spring combinations:
i) Springs in series ii) Springs in parallel. **(08 Marks)**

b. An oscillating system with a natural frequency of 3.98Hz starts with an initial displacement of $x_0 = 10$mm an initial velocity of $\dot{x}_0 = 125\text{mm/sec}$. Calculate all the vibratory parameters involved and the time taken to reach the first peak. **(12 Marks)**

OR

4 a. Derive differential equation of damped free vibration. **(10 Marks)**

b. A spring-mass-dashpot system is given an initial velocity of XW_n where W_n is the undamped natural frequency of the system. Find the equation of motion for the system when
i) $\xi = 2.5$ ii) $\xi = 1$ iii) $\xi = 0.5$. **(10 Marks)**

Module-3

5 a. Discuss the necessity of vibration isolation. **(06 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 150cos 50tN is applied at the mass with vertical direction. Find the amplitude of forced vibration. What is its value at resonance? **(14 Marks)**

OR

6 a. With neat figure, explain construction and working of
i) Vibrometer ii) Fullarton tachometer. **(10 Marks)**

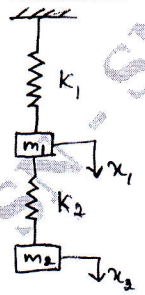
b. An accelerometer with a damped natural frequency of vibration of 160Hz has a suspended mass of 0.02kg. When it is mounted on an engine, which is undergoing an acceleration of 10m/sec^2 at an operating speed of 6500rpm, the acceleration recorded in the instrument is 9.75m/sec^2, determine damping constant and the spring stiffness of the accelerometer. **(10 Marks)**

Module-4

7 a. Derive expression for displacements in two degree of freedom system subjected to free vibration interms of initial conditions. **(10 Marks)**

b. A two degrees of freedom vibrating system as shown in below 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. **(10 Marks)**

Fig.Q.7(b)

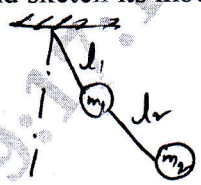


OR

8 a. Derive expression for equivalent length in geared system. **(10 Marks)**

b. With respect to below Fig.Q.8(b) assume $l_1 = l$ and $l_2 = 2l$, $m_1 = m_2 = m$. Obtain the natural frequencies of the double pendulum and sketch its mode shapes. **(10 Marks)**

Fig.Q.8(b)

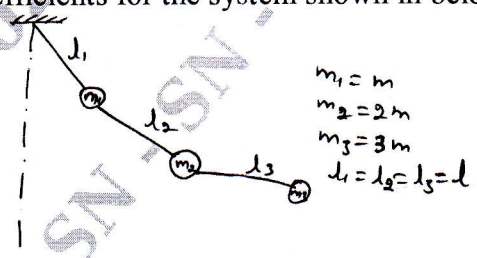


Module-5

9 a. State and prove Maxwell reciprocal theorem. **(06 Marks)**

b. Determine the influence coefficients for the system shown in below Fig.Q.9(b). **(14 Marks)**

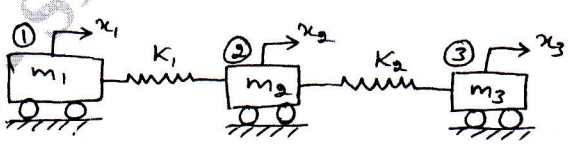
Fig.Q.9(b)



OR

10 Determine the natural frequency and the mode shape of the system shown in below Fig.Q.10 by Holzer's method. **(20 Marks)**

Fig.Q.10



$m_1 = 2kg$; $m_2 = 4kg$; $m_3 = 2kg$; $k_1 = 5N/m$; $k_2 = 10N/m$

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