Exam.Code:0942
Sub. Code: 7060

1058

B.E. (Mechanical Engineering)
Sixth Semester
MEC-603: Mechanical Vibrations

Time allowed: 3 Hours Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part. Assume suitable data wherever necessary.

x-x-x

Question 1: Answer the following

(a) Define the number of degrees of freedom of a vibrating system.
(b) How do you add two harmonic motions having different frequencies?
(c) Suggest a method for determining the damping constant of a highly damped vibrating system that uses viscous damping.
(d) What assumptions are made in finding the natural frequency of a single-degree-of-freedom system using the energy method?
(e) What is critical damping, and what is its importance?

2 marks each=10 marks

Part A (All questions carry 10 marks each)

Question 2: Three springs and a mass are attached to a rigid, weightless bar PQ as shown in Fig. 1 2 Find the natural frequency of vibration and response of the system. Assume initial displacement as 'x' and initial velocity as 'v'.

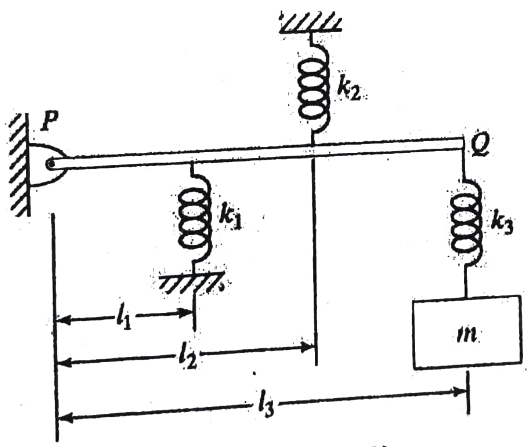

Fig. 1 (Question 2)

Question 3: Derive the equation of motion and find the steady-state response of the system shown in Fig. 2 for rotational motion about the hinge O for the following data: $k = 5000$ N/m, $l = 1$ m, $c = 1000$ N-s/m, $m = 10$ kg, $M_o = 100$ N-m, speed = 1000 rpm.

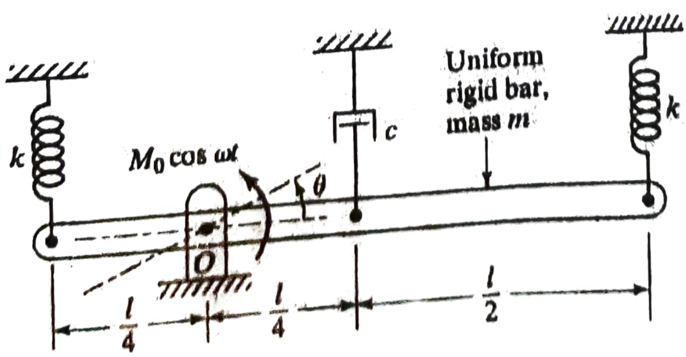

Fig. 2 (Question 3)

Question 4: Determine the steady-state response of the bar under a harmonic force, applied at the middle of the bar, as shown in the Fig. 3.

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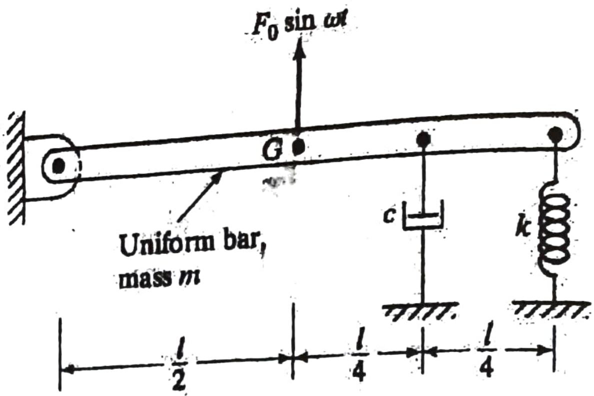

Fig. 3 (Question 4)

Part B (All questions carry 10 marks each)

Question 5: A two-mass system consists of a piston of mass m_1, connected by two elastic springs, that moves inside a tube as shown in Fig. 4. A pendulum of length l and end mass m_2 is connected to the piston. Derive the equations of motion of the system in terms of x_1 (t) and u(t). (b) Derive the equations of motion of the system in terms of the x_1 (t) and x_2 (t). (c) Find the natural frequencies of vibration of the system.

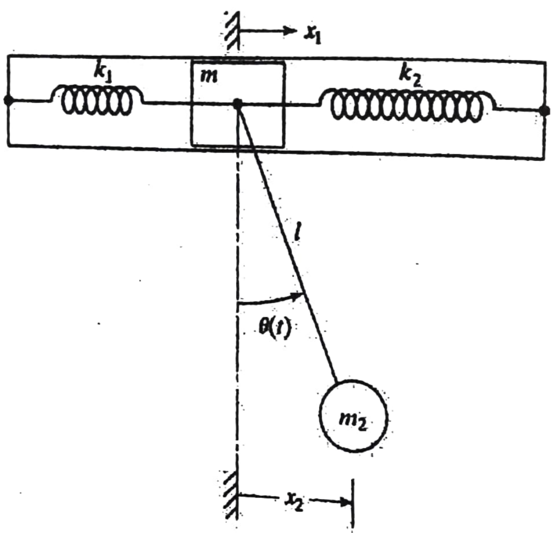

Fig 4 (Question 5)

Question 6: The mass matrix and eigen vectors of a vibrating system is given by

$$[m] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad \begin{Bmatrix} 1 \\ -1 \\ 1 \end{Bmatrix}, \quad \begin{Bmatrix} 1 \\ 1 \\ 1 \end{Bmatrix}, \quad \text{and} \quad \begin{Bmatrix} 0 \\ 1 \\ 2 \end{Bmatrix}$$

Find the [m]-orthonormal modal matrix of the system.

Question 7: Derive equations of motion and solve the governing free vibration of a string with both ends fixed.

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