Exam Date & Time: 06-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

MECHANICAL VIBRATION [MME 4043]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions. Section Duration: 180 mins

Answer all questions.
Missing data if any can be assumed with proper reasoning.

1a) Prove that for a compound pendulum of an undamped single-degree-of-freedom system the natural frequency is given in rad/sec as

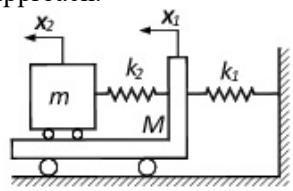
$$\omega_n = \sqrt{\frac{g\,h}{k^2 + h^2}}$$

(4)

1b) Explain the following:
i) Overdamping
ii)Critical damping
iii) Underdamping
(3)

1c) When a system was subjected to damped vibration test the measured frequency was 10 hz. When the same system was subjected to constant excitation force, the measured peak frequency was 9.6 hz. Then what is the natural frequency and damping factor of the system? (3)

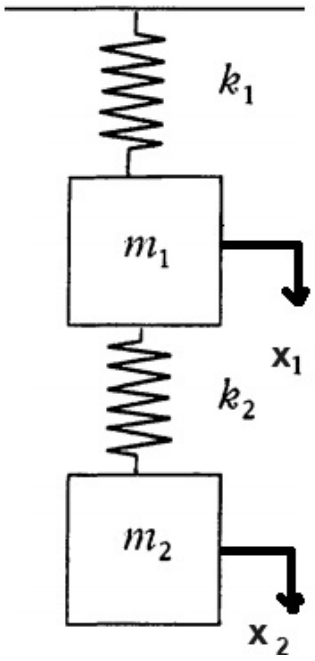
2a) Derive the differential equation dof motion of the system shown below using Lagrange's equation approach.



(4)

2b) Two degrees of freedom of the vibrating system is shown below. Evaluate, (4)
i) The two natural frequencies of vibration.
ii) Ratio of amplitudes of motion of m_1 and m_2 for the two modes of vibration.

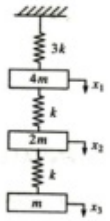
Given: m_1 = 2 kg; m_2 =1 kg; k_1 =40N/m and k_2 = 20 N/m.



2c) Locate the nodes for each mode of vibration for the quetsion Q2b). (2)

3a) State and prove Maxwell's reciprocal theorem. (3)

3b) Using the matrix iteration method, estimate the lowest natural frequency for the system shown below.

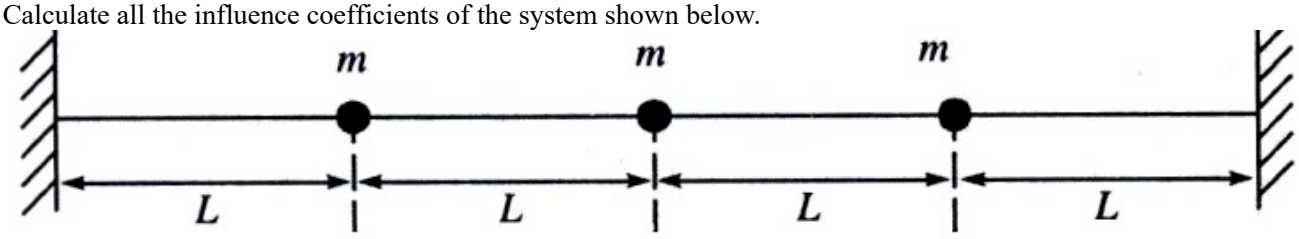


(5)

3c) Differentiate between free and forced vibrations. (2)

4a) A U tube manometer has a uniform box of cross section **A**. If a column of length *l* and density ß is set into motion,evaluate the frequency of the resulting motion. (3)

4b) Calculate all the influence coefficients of the system shown below.



(5)

4c) Explain dynamic vibration absorber. (2)

5a) The expression $4\ddot{x} + 1.2\,\dot{x} + 100\,x = 1.2\,Sin\,10\,t$

represnts a single degree of freedom system. Calculate the following:
i) Damped natural frequency of the system.
ii) Peak amplitude.
iii) Frequency at peak amplitude.
iv) Amplitude at resonance. (4)

5b) If a cylinder of mass ***m*** as shown below rolls over the surface without slipping, determine the equilibrium of motion and the natural frequency for small oscillations. (3)

5c) A single cylinder vertical petrol engine of total mass 320 kg is mounted upon a steel chasis frame and causes a vertical ststic deflection of 0.2 cms. The reciprocating parts of the engine have a mass of 24 kg and moves through a vertical stroke of 15 cms with simple harmonic motion. ***'e'*** can beconsidered to be half the stroke length. A dashpot is provided, the damping resistance of whcih is directly proportional to the velocity and amounts to 490 N at 0.3 m/sec. Determine the following: (3)
i) Speed of driving shaft at which resonance will occur.
ii) Amplitude of steady state forced vibrations when driving shaft of the engine rotates at 480 rpm.

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