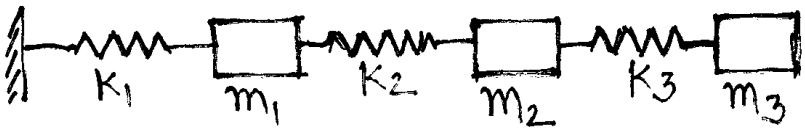
(3 Hours) (Total marks : 80)

N.B.

- Attempt any four questions out six questions.
- Assume suitable data if required with justification. State the assumptions clearly.
- Illustrate answers with sketches if necessary.
- Figures to the right indicate marks.
- Answers to the questions showed be grouped and written together.

Q1. Attempt any four of the following.

1. Derive flexibility influential coefficients for the following spring mass system. (10 marks)



2. Washing machine of mass 50 Kg operates at 1200 rpm. Find maximum stiffness of the isolator that provides 75%isolation in transmitted force. Assume that damping ratio of the isolator is 7%. (10 marks)

Q2 Attempt the following.

1. Write a note on Lindstedt's Perturbation method. (10 marks)

2. Evaluate characteristic features in case of the following defect for vibration health monitoring;

a. loose foot b. cavitation in pumps c. gear teeth failure (10 marks)

Q3 Attempt the following. (20 marks)

1. using modal analysis find free vibration response for the following system;

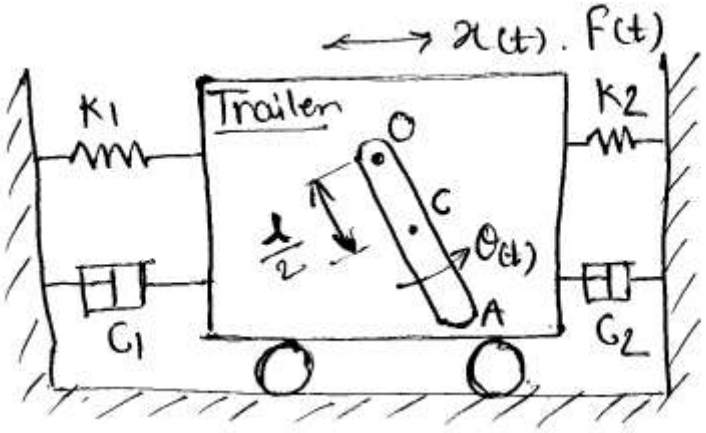
$$\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix} \begin{bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{bmatrix} + \begin{bmatrix} k_1+k_2 & -k_2 \\ -k_2 & k_2+k_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Assume m1: 10 kg; m2: 1kg, k1: 30 N/m, k2: 5 N/m; k3:0 with the following boundary conditions;

$$\vec{x}(t=0) = \begin{bmatrix} x_1(t=0) \\ x_2(t=0) \end{bmatrix} = \begin{bmatrix} 1.0 \\ 0 \end{bmatrix} \quad \vec{\dot{x}}(t=0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Initial displacement Initial velocity

2. Derive equation of motion for the following trailer-compound pendulum system with Lagrange's equation:



OA - Compound pendulum pivoted at O and center of gravity at point 'C'.

Q4 Attempt the following.

1. Explain procedure to obtain natural frequencies of a mechanical component with the experimental method. Elaborate on the following;

a. sensors used and their location b. data analysis (10 marks)

2. Explain use of ISO 10816 and ISO 7919 for evaluation of vibration severity. (10 marks)

Q5 Attempt the following.

1. Solve non linear governing equation of a simple pendulum with one term approximation. (10 marks)

2. Explain the following;
a. cross channel analysis for fault diagnosis
b. orbital analysis for hydrodynamic bearing analysis (10 marks)

Q6 Attempt the following.

1. An accelerometer has suspended mass of 0.01 Kg with damped natural frequency of 150 Hz. When mounted on an engine undergoing an acceleration of 1 g at operating speed of 6000 rpm, the recorded acceleration is 9.5 m/s^2. Find damping consonant and spring stiffness of the accelerometer. (10 marks)

2. Explain semi-active and active control system with instrumentation used to control vibrations in a mechanical system. (10 marks)

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