BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

FIRST SEMESTER 2023-24

DE G611 DYNAMICS AND VIBRATION

Mid-Semester Examination (Regular) (Closed Book+ Open Book)

Date: 11.10.2023 Maximum Marks: 25 (Weightage 25%) Time: 90 min.

PART –A (Closed Book) (15 Marks)

Q1. Using Lagrange's equation derive the equation of motion for system shown in the Fig. Q1. Write down the equation in Matrix form **[5]**

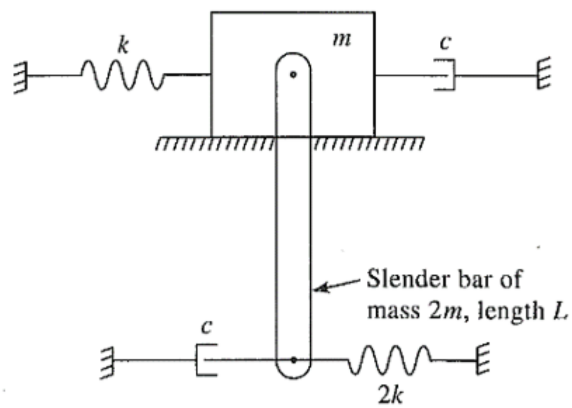

Fig. Q1

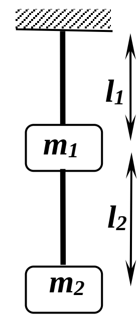

Fig: Q2

Q2. Two discrete masses m_1 and m_2 are axially loaded on elastic steel wires as shown in Fig. Q2. Derive the equations of motion for the system. The length of the wires are l_1= 30 cm and l_2= 40 cm and diameter of the wire is 1 mm. If the masses are $m_1=30kg$ and $m_2=50kg$ find out the natural frequencies and corresponding mode shapes. {E_{steel}=200 GPa} **[5]**

Q3. Determine the approximate fundamental frequency by using Rayleigh's method & Dunkerley's equation for the system shown in Fig. Q3. **[5]**

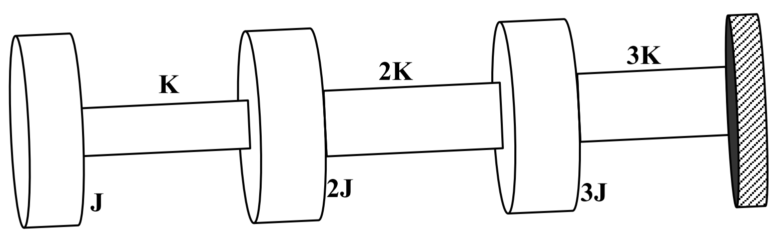

Fig. Q3

PART –B (Open Book) (10 Marks)

Q1. Consider a undamped linear spring-mass system governed by Equation of motion

$$m\ddot{x} + kx = F\cos^2\omega t$$

With parameter, m = 1 kg, k = 400 N/m, F = 100 N, ω = 5 rad/s and initial displacement $x(0)$ = 10 mm, and initial velocity $\dot{x}(0)$ = 0.1 m/s , Derive the total displacement response of mass 'm' in terms of time. Also find the displacement and velocity of mass 'm' after 2 second. **[5]**

Hint: **Total response means sum of free and forced vibration response**

Q2. A mass spring discrete system shown in Figure Q2. The first natural frequency of the system is $\omega_1 = 0.438\sqrt{k/m}$ and corresponding mode shape vectors is [1.00 1.539 1.904]. **[5]**

(i) Write down system matrices for the system

(ii) Determine normal mode shape vector for first natural frequency

(iii) Find the dynamic matrix for finding second natural frequency by **matrix deflation method.**

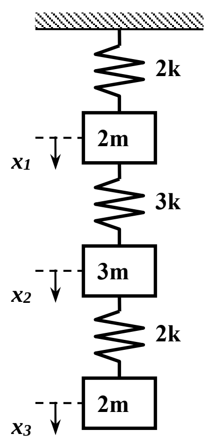

Figure Q2