BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH | **SEMESTER : V**
BRANCH: MECHANICAL | **SESSION : MO/2024**

SUBJECT: ME303 MECHANICAL VIBRATION

TIME: 3 Hours | **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	A spring-mass-damper system is subjected to a forced excitation as shown in Figure 1. For steady-state solution, derive the expression of amplitude and phase difference of the system in terms of frequency and damping ratio.	[5]	1	6

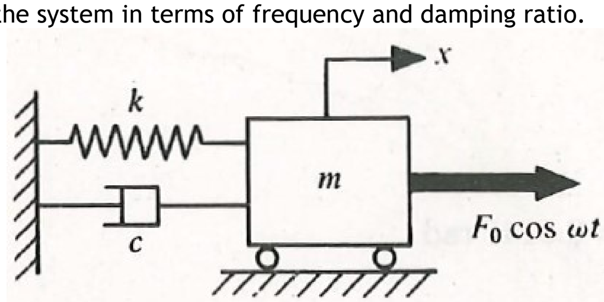

Figure 1

Q.1(b)	A machine of mass 110 kg is mounted on an elastic foundation of stiffness 2X10^6 N/m. The machine is subjected to a harmonic force of F(t) = 1500 cos(150t) N. The steady-state amplitude of the machine is measured as 1.9 mm. Determine the damping ratio of the foundation?	[5]	1, 5	3
Q.2(a)	Derive Lagrange's equation for a conservative multi degree of freedom system.	[5]	2	6
Q.2(b)	Using Lagrange's method, determine the equation of motion for the 3-DOF system shown in Figure 2.	[5]	2	3

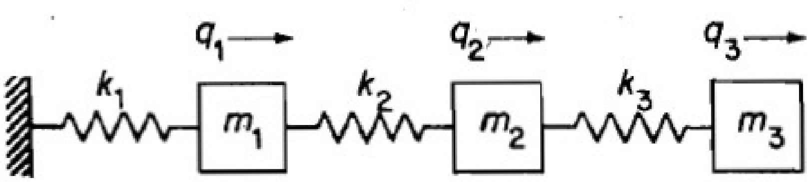

Figure 2

Q.3(a)	For a three degree of freedom spring-mass system, the mass and flexibility matrix in some suitable units are	[5]	1,2,3,5	3

$$[m] = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{ and } [a] = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.5 & 1.5 & 1.5 \\ 0.5 & 1.5 & 2.5 \end{bmatrix},$$

respectively. Starting with a suitable set of normalized amplitude of the masses, determine the normalized eigenvector obtained after the second iteration of the matrix iteration procedure, which is used to determine the natural frequency of the system.

PTO

Q.3(b)	Using Dunkerley's method, determine the natural frequency of the system shown in Figure 3. Take m_1 = 1 kg, m_2 = 2 kg, m_3 = 3 kg, k_1 = 100 N/m, k_2 = 100 N/m, k_3 = 200 N/m.	[5]	2,3,5	3

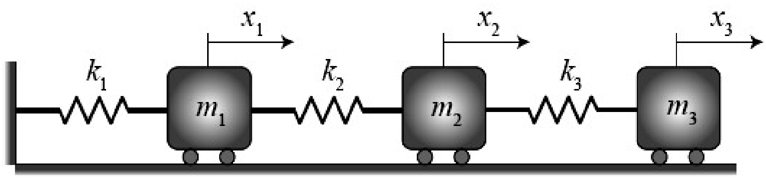

Figure 3

Q.4(a)	Derive the generalized natural frequency of lateral vibration of a string subjected to tension *T* and fixed at both ends. The string has length *L* and mass per unit length ρ.	[5]	1,4,5	6
Q.4(b)	The string of a musical instrument is fixed at both ends and has a length 2 m, diameter 0.5 mm, and density 7800 kg/m^3. Determine the tension required in order to have a fundamental frequency of 5 Hz.	[5]	4,5	3
Q.5(a)	Discuss the working principle of different frequency measuring instruments used in engineering systems.	[5]	5	2
Q.5(b)	Discuss the working principle of different vibration exciters used in engineering systems	[5]	5	2

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