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

CLASS: BTECH **SEMESTER : V/ADD**
BRANCH: MECHANICAL ENGINEERING **SESSION : MO/2025**

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 cylinder of mass m and mass moment of inertia J_0 is free to roll without slipping but is restrained by two springs of stiffnesses k_1 and k_2, as shown in Fig. Q.1(a). Derive the equation of motion within the framework of Newtonian or Lagrangian Mechanics and find its natural frequency. Also, find the value of a that maximizes the natural frequency of vibration.	[5]	1	4

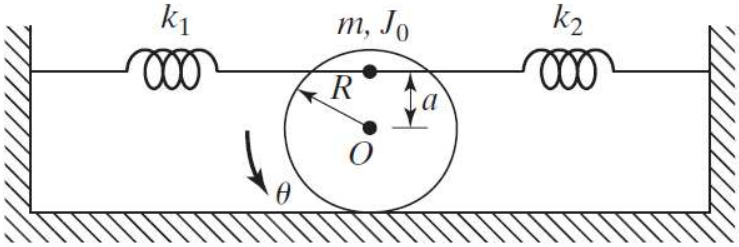

Fig. Q.1(a)

Q.1(b)	Consider a spring-mass system with k = 4000 N/m and m = 10 kg subjected to a harmonic force $F(t)$ = 400 cos(10t) N. Find the total response of the system under the initial conditions of x_0 = 0.1 m and $\dot{x}_0$ = 0.	[5]	1	3
Q.2(a)	Find the natural frequencies and mode shapes of the 2-DOF torsional system shown in Fig. Q.2(a) for $J_1 = J_0$, $J_2 = 2J_0$, $k_{t1} = k_{t2} = k_t$.	[6]	2	3

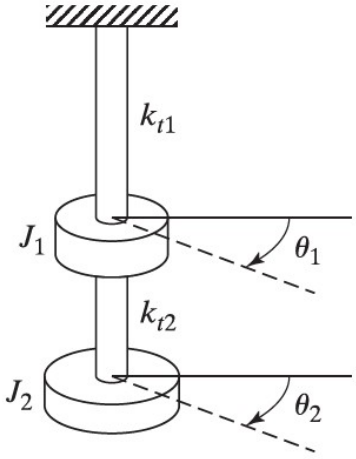

Fig. Q.2(a)

Q.2(b)	Either considering the 2-DOF system of Q.2(a) or considering any other 2-DOF vibrating system, write short notes on orthogonality of vibrating modes.	[4]	2	2

PTO

Q.3(a)	Find the natural frequencies and mode shapes of the system shown in Fig. Q.3(a) for $k_1 = k_2 = k_3 = k_4 = k$, $m_1 = 2m$, $m_2 = 3m$, and $m_3 = 2m$.	[5]	3	3

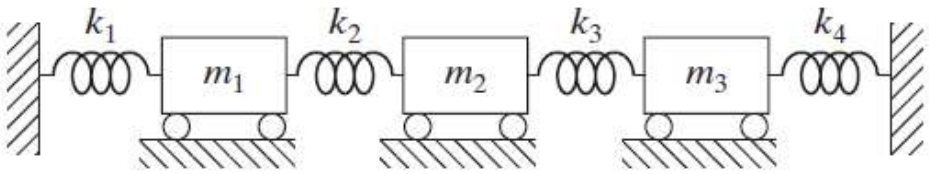

Fig. Q.3(a)

Q.3(b)	Employing the Dunkerley's method, determine the fundamental frequency of a uniform cantilever beam of total mass M with a concentrated lumped mass M at the end as shown in Fig. Q.3(b).	[5]	3	3

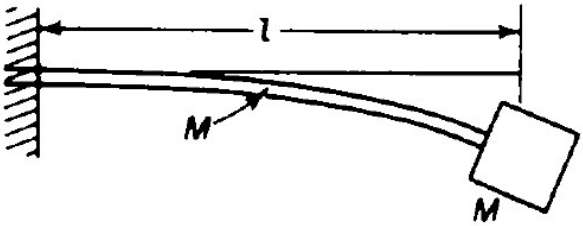

Fig. Q.3(b)

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.	[7]	4	4
Q.4(b)	Using the expression of the generalized natural frequency derived in Q.4(a), determine the tension T required in order to have fundamental frequency of 10 Hz if the string has length l = 2 m and mass per unit length ρ = 0.4 kg/m.	[3]	4	3
Q.5(a)	Explain the working principle of piezoelectric transducer (accelerometer).	[5]	5	2
Q.5(b)	Consider a typical acceleration-time response of a vibrating machine frame captured through an accelerometer. Is the time-response sufficient for getting useful information about the vibration characteristics or does it need to be transformed into some other form? Justify your answer through proper explanation and suitable diagrams.	[5]	5	2

::::::20/11/2025::::::M