

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

CLASS: MTECH
BRANCH: CIVIL AND ENVIRONMENTAL ENGINEERING

SEMESTER: II
SESSION: SP/2025

SUBJECT: CE503 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

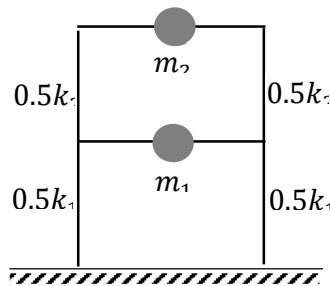
TIME: 3 Hours

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 handbook/Graph paper etc. to be supplied to the candidates in the examination hall.

		CO	BL
Q.1(a) Discuss the wave propagation characteristics of seismic waves in the event of earthquake.	[5]	1	K1,K2,K3
Q.1(b) Define (a) return period, (b) maximum credible earthquake (MCE) and (c) design basis earthquake (DBE). Write down the steps involved in probabilistic seismic hazard analysis (PSHA).	[5]	1	K2
Q.2(a) Define degree of freedom and natural time period of a dynamic system. A SDOF system has the mass $m = 5 \text{ kg}$ and stiffness $k = 180 \text{ N/m}$. Determine the critical damping (C_{cr}) of the system. $\zeta = 1$	[5]	2	K2,K3
Q.2(b) Prove that the total energy (PE + KE) of an undamped SDOF system remains constant throughout the duration of oscillation.	[5]	2	K1,K2
Q.3(a) What is Rayleigh Quotient? The matrix $A = \begin{bmatrix} 4 & -2 & 0 \\ -2 & 2 & -2 \\ 0 & -2 & 2 \end{bmatrix}$ has one Eigen vector $\phi = \begin{pmatrix} -0.802 \\ -0.445 \\ 1.000 \end{pmatrix}$. Determine the Eigen value (λ) corresponding to the Eigen vector ϕ	[5]	3	K1,K2,K3
Q.3(b) Write down three different base-isolation methods used in earthquake-resistant structures. What is passive and active base isolation techniques.	[5]	5	K2,K3,K4,K5
Q.4(a)			



Determine the base shear on the MDOF system as shown in the figure below by using response spectrum analysis. The properties of the MDOF is given as; $m_1 = 6000 \text{ kg}$, $m_2 = 4000 \text{ kg}$, $k_1 = k_2 = 12.0 \times 10^6 \frac{\text{N}}{\text{m}}$. Use the SRSS (square root of summation of square) combination rule for the modal superposition of the base shears. The response spectrum is given as

$$\frac{S_a}{g} = \begin{cases} 1 + 15T & \text{for } 0 < T < 0.1 \text{ s} \\ 2.5 & \text{for } 0.1 \text{ s} < T < 0.55 \text{ s} \\ \frac{1.36}{T} & \text{for } 0.55 \text{ s} < T < 4.0 \text{ s} \\ 0.34 & \text{for } T > 4.0 \text{ s} \end{cases}$$

Q.5(a) A damped SDF system has the following properties: $m = 0.2533$ kg, $k = 10$ N/m, and $\zeta = 0.05$. The SDF system is subjected to an external load of $P(t) = P_0 \sin(\bar{\omega} t)$; $P_0 = 10$ kN, $\bar{\omega} = 5.236 \frac{\text{rad}}{\text{s}}$. Determine the displacement ($u_{t=0.3}$) and velocity ($\dot{u}_{t=0.3}$) of the SDF system at $t = 0.3$ s. Use the central difference method with a time interval of $\Delta t = 0.1$ s. The initial displacement and velocity are given as $u_{t=0} = 0$ and $\dot{u}_{t=0} = 0$. [10] 3 K3,K4,K5

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