BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION SP/2025)

CLASS: BTECH | **SEMESTER : VI/ADD**
BRANCH: CIVIL & ENVIRONMENTAL ENGINEERING | **SESSION : SP/2025**

SUBJECT: CE412 STRUCTURAL DYNAMICS

TIME: 02 Hours | **FULL MARKS: 25**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

			CO	BL
Q.1(a)	Define degrees of freedom (DOF) of a system.	[2]	1	K2
Q.1(b)	Prove that for an un-damped free vibration, the total energy of the system remains conserved. Consider initial displacement as x_0 and initial velocity as $\dot{x_0}$.	[3]	1	K2,K3
Q.2(a)	Calculate the critical damping of a SDOF system with mass m = 10 kg and stiffness K = 180 N/m.	[2]	1	K3,K4
Q.2(b)	Determine the expression of time-dependent displacement of critically damped SDOF system with initial displacement of x_0 and initial velocity $\dot{x_0}$. The generic is given as $x(t) = (C_0 + C_1\, t)e^{-\omega t}$ where ω is the natural frequency of the system. Plot the displacement vs time graph for the same.	[3]	1	K2,K3
Q.3(a)	Draw the variation of the ratio of natural time-period to damped time- period (T/T_D) of an under-damped SDOF system with the damping ratio ζ.	[2]	1	K2,K3
Q.3(b)	The amplitude of free vibration of an under-damped SDOF system is reduced by 50% after 12 oscillations. Determine the damping ratio ζ.	[3]	2	K4
Q.4(a)	The steady state displacement of under-damped SDOF system under harmonic excitation $P_0\, Sin(\omega_r t)$ is given by $$x(t) = \frac{P_0}{K}\frac{1}{[(1-r^2)^2 + (2r\zeta)^2]^{0.5}} Sin(\omega_r t - \phi)$$ Prove that the resonance frequency for displacement of the system is $\omega_r = \omega_n(1-2\zeta^2)^{0.5}$, where ω_n and ζ are the natural frequency and damping coefficient of the system respectively. $r = \omega_r/\omega_n$	[2]	2	K3,K4
Q.4(b)	Determine the value of dynamic magnification factor R_D for the above system at resonance.	[3]	2	K4
Q.5(a)	Draw the variation of dynamic magnification factor ($R_d = \lvert\frac{x(t)}{\Delta_{st}}\rvert$) with the frequency ratio ($r = \omega_r/\omega_n$) for an under-damped SDOF system subjected to harmonic excitation.	[2]	2	K3
Q.5(b)	Describe the half-power band width method for the determination of the damping coefficient of an under-damped SDOF system.	[3]	2	K2,K3

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