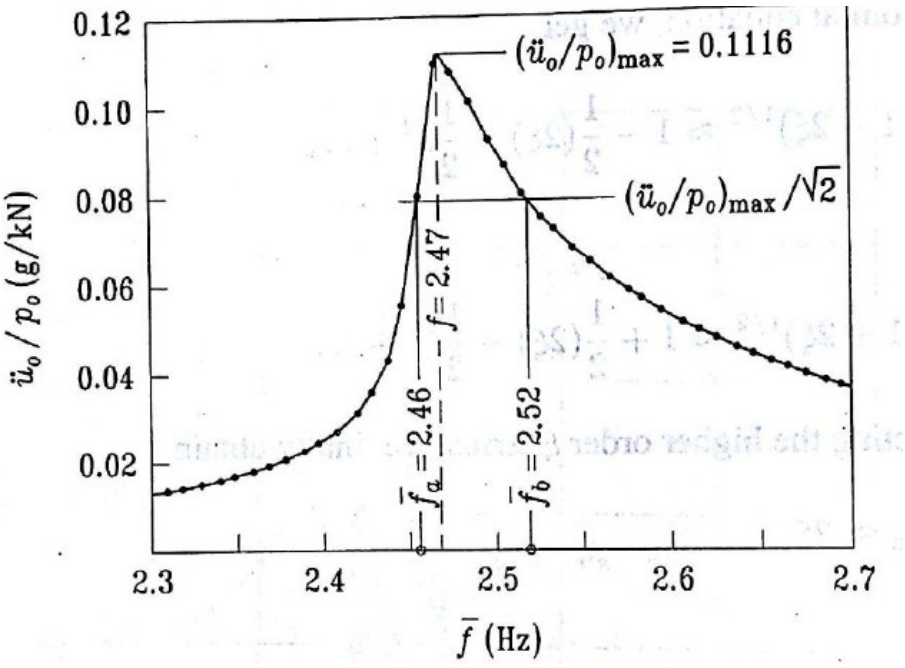
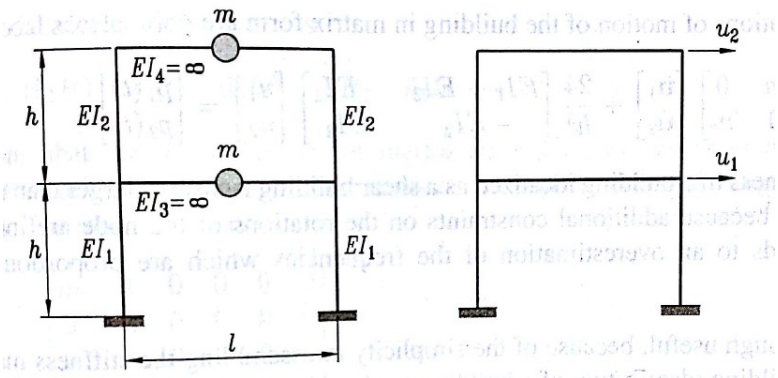
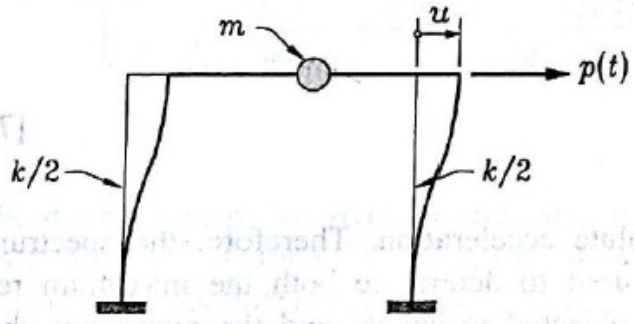
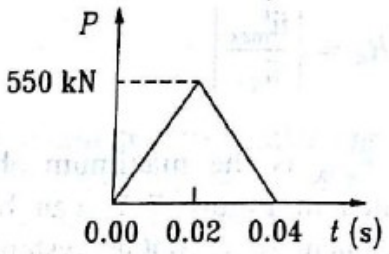
Name: Enrolment No:	UPES

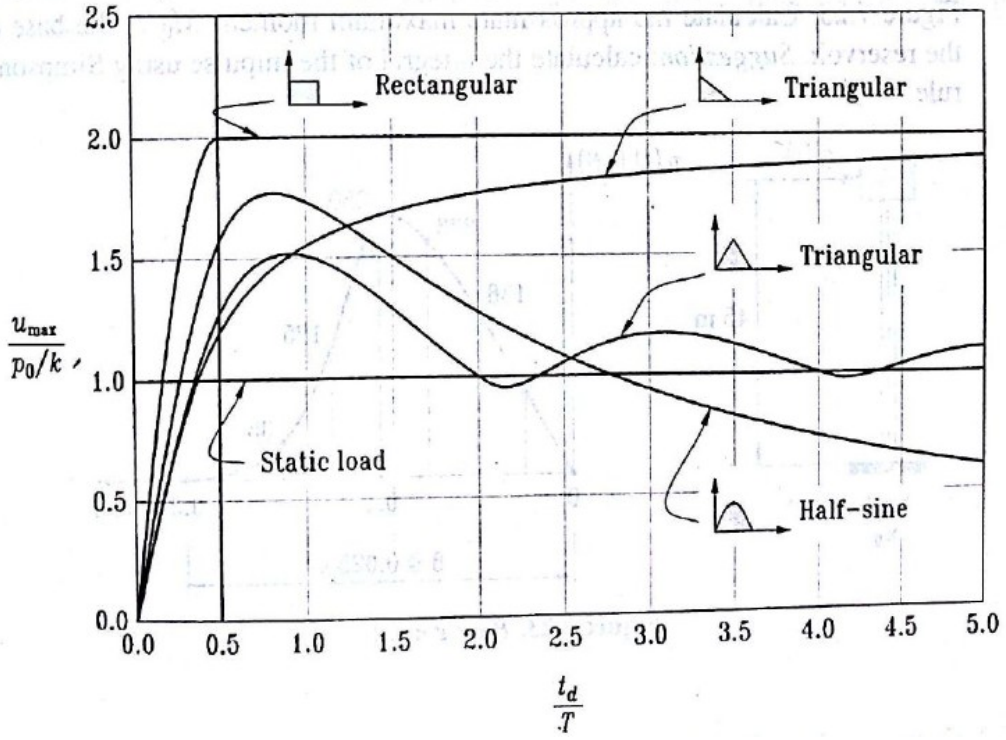
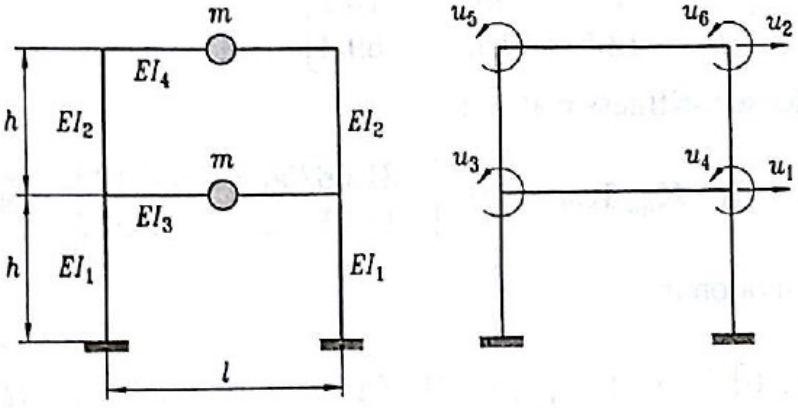
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

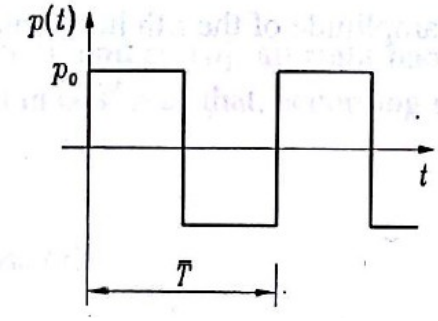
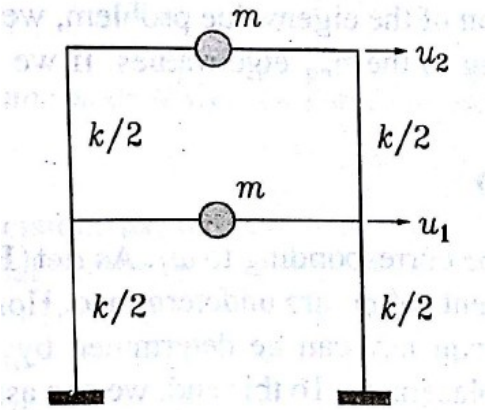
Course: STRUCTURAL DYNAMICS - CIVL 7006 **Semester: I**
Programme: B TECH IN CIVIL ENGINEERING
Time: 03 hrs. **Max. Marks: 100**
Instructions: ATTEMPT **ALL QUESTION** IN **SECTION A**, **ANY FOUR** QUESTION IN **SECTION B** AND **ANY TWO** QUESTION **SECTION C**

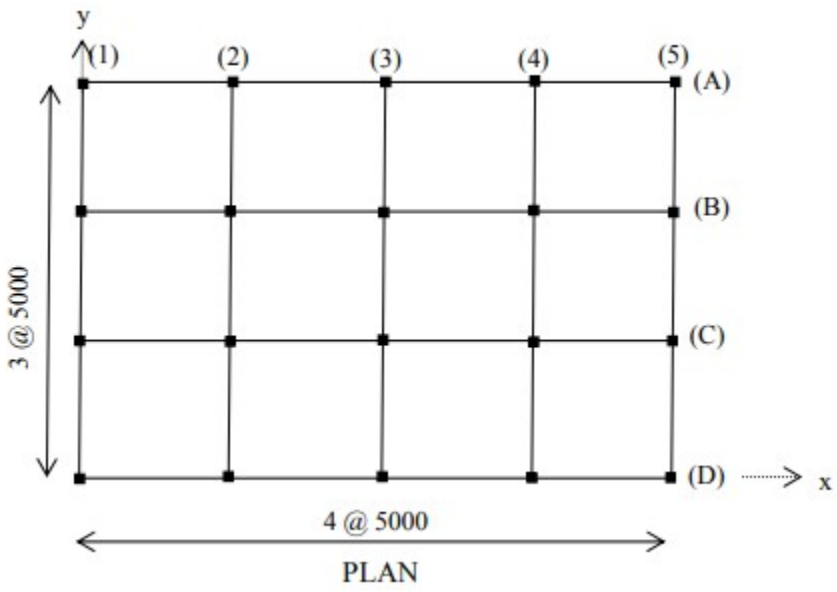
SECTION A

S. No.		Marks	CO
Q1	The amplitude curve for acceleration per unit force was obtained for a two story high performance concrete structure in vicinity of the first resonance using forced vibration test with an eccentric mass shaker. Calculate the damping ratio of the structure.  	5	CO3
Q2	Explain D 'Alembert principle with a SDOF system. Also, write the dynamic equilibrium equation for forced vibration equation for damped system.	5	CO1
Q3	Differentiate between dynamic degree of freedom and static degree of freedom.	5	CO1 CO2
Q4	Write the equation of motion of the two story building shown in figure considering beams to be rigid axially and flexurally and columns to be axially rigid not flexurally as shown in figure.	5	CO2

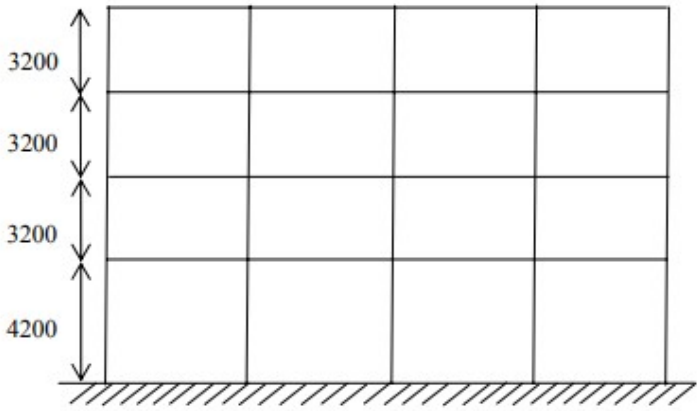
			
	SECTION B		
Q5	A rotating machine having a total mass of 200 kg is supported by four isolator on a rigid floor. The total stiffness of the isolators is 1000 x 10^3 N/m. When operating, the machine generates a vertical harmonic force with an amplitude of 450 N at a rotation frequency of 50 Hz. Assuming that the damping is $\zeta = 0.20$, check that the amplitude of motion does not exceed the allowable amplitude of 0.03 mm and that the force that is transmitted to the floor does not exceed the allowable force of 50 N.	**10**	**CO1**
Q6	The single story building shown in figure is subjected to a load generated by an explosion that can be represented by a lateral force applied the roof level, with indicated time variation. The total lateral stiffness of the building is 2500 kN/ m and the total mass of the roof is 17500 kg. Calculate the maximum roof displacement and the maximum base shear for the building.  	**10**	**CO3** **CO1**

			
Q7	Write the equation of motion in y direction of the structure shown in figure after performing a static condensation of the stiffness matrix to eliminate the rotational degree of freedom. Consider l_x = 4 m, l_y = 5 m, h = 3 m. The columns are identical and their flexural stiffness are $EI_1 = EI_2 = 10.125 \times 10^6$ N m^2. The beams identical and their flexural stiffness are $EI_3 = EI_4 = 20.250 \times 10^6$ N m^2. The mass concentrated at each floor is m = 20000 kg and the dynamic loads applied to DOFs u_1 and u_2 are p_1 (t) and p_2 (t). 	**10**	**CO3** **CO2**
Q8	What is the relationship between dynamic displacement response factor R_d, dynamic velocity response factor R_v and dynamic displacement response factor R_a? What is a tri- partite plot? Draw a qualitative tri- partite plot. Write the expression for displacement resonant angular frequency ω_{rd}, velocity resonant angular frequency ω_{rv}	**10**	**CO4**

	and displacement resonant angular frequency ω_{ra}.		
Q9	Draw the Fourier series for the square wave force function shown in figure till three expression for odd and even terms. 	**10**	**CO1**
	SECTION-C		
Q10	Calculate the vibration frequencies of the structure illustrated in figure. The floor mass m = 20000 kg and lateral storey stiffness k = 18 X 10^6 N/m. Calculate the mode shapes of the structure shown in figure and draw the mode shapes. 	**20**	**CO2** **CO3** **CO4**
Q11	Consider a four-storey reinforced concrete office building shown in figure. The building is located in Shillong (seismic zone V). The soil conditions are medium stiff and the entire building is supported on a raft foundation. The R. C. frames are infilled with brick-masonry. The lumped weight due to dead loads is 12 kN/m^2 on floors and 10 kN/m^2 on the roof. The floors are to cater for a live load of 4 kN/m^2 on floors and 1.5 kN/m^2 on the roof. Determine storey shear on the structure by Dynamic Method (Mode Method) as per IS 1893.	**20**	**CO2** **CO3** **CO4**



PLAN



ELEVATION

Natural Period (sec)	Mode 1	Mode 2	Mode 3
	0.860	0.265	0.145
	Mode Shape		
Roof	1.000	1.000	1.000
3rd Floor	0.904	0.216	-0.831
2nd Floor	0.716	-0.701	-0.574
1st Floor	0.441	-0.921	1.016

Q12	Derive the expression of free response of damped system and **plot** the qualitative response diagram for subcritical, supercritical and critical response. If the mass of system is "m", stiffness "k" and damping ratio "ζ".		**CO1**