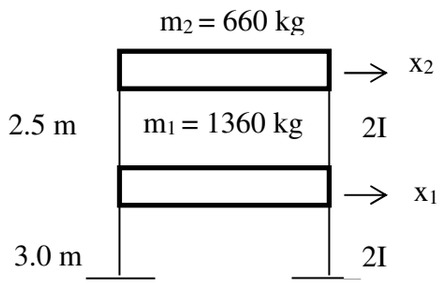
Q.5 i. Discuss briefly about Selection of Degrees of Freedom. **4**

ii. Derive the stiffness equations for a 3-story shear building. **6**

OR iii. Evaluate the natural frequencies and mode shape for the structure shown in fig. below. Assume the support to be fixed at base. **6**



$I = 5 * 10^5$ mm^4

$E = 2.5 * 10^5$ N/mm^2

Q.6 Attempt any two:

i. Differentiate between Magnitude & Intensity **5**

ii. Explain briefly various terminology associated with earthquake through neat sketch. **5**

iii. Write short notes on - **5**

(a) Strong Ground Motion

(b) Seismogram

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Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2022

CE5CS05 Structural Dynamics

Programme: M.Tech. Branch/Specialisation: Structural Engineering

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. Which of the following statements is/are correct? **1**

I. The vibration properties W_n, T_n, f_n depends only on mass and stiffness of the structure.

II. Damped natural period is greater than undamped natural period.

III. In critical damping time taken for the system to come to rest is more compared to time taken for over damping.

(a) 1 (b) 1,2 (c) 2,3 (d) None of these

ii. Calculate damped natural frequency, if a spring mass damper system is subjected to periodic disturbing force of 30 N. Damping coefficient is equal to 0.76 times of critical damping coefficient and undamped natural frequency is 5rad/s. **1**

(a) 5.0 rad/s (b) 6.26 rad/s (c) 3.24 rad/s (d) None of these

iii. A spring mass system (stiffness "k" & mass "m") has natural period of 0.5s. When a 0.5 kg mass is added to the mass "m" the natural period increases by 0.1s. What are the mass "m" and stiffness "k"? **1**

(a) 1.4 kg, 199.45 N/m (b) 1.14 kg, 179.45 N/m

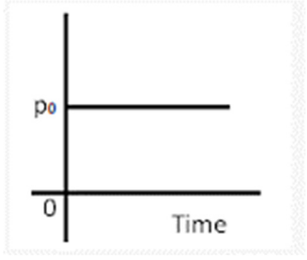
(c) 1.18 kg, 179.45 N/m (d) None of these

iv. The loads that marine structure encounter during wave impacts are- **1**

(a) Impulse Load (b) Static Load

(c) Monotonic load (d) None of these

v. Find the steady state response of an undamped SDOF system subjected to a constant step function as shown below: **1**



The steady state response is given by-

(a) p_0 (1- cos ωt)/k (b) p_0 (1+ cos ωt)/k

(c) p_0 (1- sin ωt)/k (d) None of these

vi. Steady state displacement response of undamped forced vibration using Duhamel's integral for $0 \leq t \leq t_d$: **1**

(a) $x(t) = x_{st}[1 - \frac{t}{t_d} + \frac{1}{\omega t_d} \sin \omega t - \cos \omega t]$

(b) $x(t) = x_{st}[1 + \frac{t}{t_d} + \frac{1}{\omega t_d} sin\, \omega t - cos\, \omega t]$

(c) $x(t) = x_{st}[1 - \frac{t}{t_d} - \frac{1}{\omega t_d} sin\, \omega t - cos\, \omega t]$

(d) None of these

vii. Which of the following is incorrect? **1**

(a) Classical modal analysis is not applicable to structure consisting of subsystems with different level of damping.

(b) Dynamic response of linear systems can be determined by Classical modal analysis.

(c) Classical modal analysis is not applicable to inelastic systems irrespective of damping model.

(d) None of these

viii. Which of the following can be one of the solutions to reduce the amplitude of dynamic displacement of a system with damped forced vibration having frequency ratio β = 10.0? **1**

(a) Add extra mass to the system

(b) Add extra stiffness to the system

(c) Add extra damper to the system

(d) None of these

ix. Which of the following waves has the highest velocity? **1**

(a) S-waves (b) Love waves

(c) P-waves (d) Rayleigh waves

x. The depth of the focus from the epicenter is known as- **1**

(a) Shock depth (b) Epicenter depth

(c) Focal depth (d) Earthquake depth

Q.2 i. Write notes on Half power band width method for evaluation of Damping. **3**

ii. Derive "displacement response" of a SDOF system under "harmonic support motion". Define Transmissibility in terms of displacement and force. Draw neat sketch to show its relation with frequency ratio. **7**

OR iii. Discuss the following – **7**

(a) Lumped Mass Idealization

(b) Dynamic Magnification factor

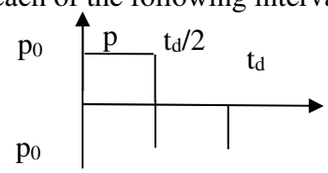
Q.3 i. Define Hamilton Principle. **2**

ii. Determine the response of an undamped SDOF system to the force shown in fig. for each of the following intervals: **8**

(a) $0 \leq t \leq t_d/2$

(b) $t_d/2 \leq t \leq t_d$

(c) $t \geq t_d$



Assume that initial displacement and velocity are zero. $F(t) = P_o$

OR iii. Derive an expression for D'Alembert's principle for the response of SDOF System. **8**

Q.4 i. Write short note on Modal Superposition procedure. **3**

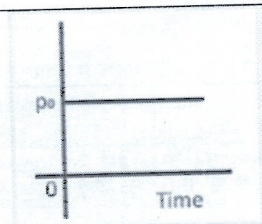
ii. Determine Natural Frequencies of a uniform beam of length 'L' clamped at one end and pinned at other end? **7**

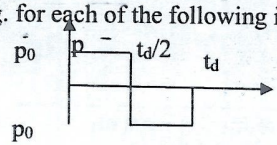
OR iii. Derive an expression for the response of SDOF system subjected to Harmonic excitation. **7**

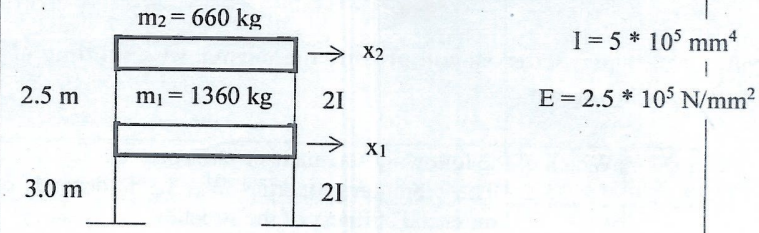
Scheme of Marking

	Faculty of Engineering End Sem (Even) Examination May-2022 Structural Dynamics (T) - CE5CS05 (T)
Programme: M.Tech.	Branch/Specialisation: Structural Engg.

Note: The Paper Setter should provide the answer wise splitting of the marks in the scheme below.

Q.1	i)	Which of the following statements is/are correct? 1. The vibration properties W_n, T_n, f_n depends only on mass and stiffness of the structure. 2. Damped natural period is greater than undamped natural period. 3. In critical damping time taken for the system to come to rest is more compared to time taken for over damping. **b) 1,2**	1
	ii)	Calculate damped natural frequency, if a spring mass damper system is subjected to periodic disturbing force of 30N. Damping coefficient is equal to 0.76 times of critical damping coefficient and undamped natural frequency is 5rad/s. **c) 3.24 rad/s**	1
	iii)	A spring mass system (stiffness "k" & mass "m") has natural period of 0.5s. When a 0.5 kg mass is added to the mass "m" the natural period increases by 0.1s. What are the mass "m" and stiffness "k"? **b) 1.14 kg, 179.45 N/m**	1
	iv)	The loads that marine structure encounter during wave impacts are **a) Impulse Load**	1
	v)	Find the steady state response of an undamped SDOF system subjected to a constant step function as shown below.	1
		 The steady state response is given by- **a) p_0 (1- cos ωt)/k**	
	vi)	Steady state displacement response of undamped forced vibration using Duhamel's integral for $0 \le t \le t_d$ a) $x(t) = x_{st}\left[1 - \frac{t}{t_d} + \frac{1}{\omega t_d}\sin \omega t - \cos \omega t\right]$	1
	vii)	Which of the following is incorrect? **d) None of these**	1
	viii)	Which of the following can be one of the solution to reduce the amplitude of dynamic displacement of a system with damped forced vibration having frequency ratio $\beta = 10.0$? **a) Add extra mass to the system**	1
	ix)	Which of the following waves has the highest velocity? **c)P-waves**	1
	x)	The depth of the focus from the epicenter is known as **c) Focal depth**	1
Q.2	i.	Write notes on Half power band width method for evaluation of Damping. **Sol. Description – 3**	3
	ii.	Derive "displacement response" of a SDOF system under "harmonic support motion". Define Transmissibility in terms of displacement and force. Draw neat sketch to show its relation with frequency ratio. **Sol.** **Derivation of Displacement Response – 3**	7

		Define Transmissibility – 2 **Sketch – 2**	
OR	iii.	Discuss the following – **Sol.** **a) Periodic Loading (Description) – 3.5** **b) Monotonic Loading (Description) – 3.5**	7
Q.3	i.	Define Hamilton Principle? **Sol. Definition – 2**	2
	ii.	Determine the response of an undamped SDOF system to the force shown in fig. for each of the following intervals a) $0 \le t \le t_d/2$ b) $t_d/2 \le t \le t_d$ c) $t \ge t_d$  Assume that initial displacement and velocity are zero. $F(t) = P_o$ **Sol.** **Response – a) – 3** **Response – b) – 3** **Response – c) – 2**	8
OR	iii.	Derive an expression for D'Alembert's principle for the response of SDOF System. Complete principle – 8 marks	8
Q.4	i.	Write short note on Modal Superposition procedure? **Sol. Description – 3** 3 marks	3
	ii.	Determine Natural Frequencies of a uniform beam of length 'L' clamped at one end and pinned at other end? **Sol. Derivation – 7**	7
OR	iii.	Derive an expression for the response of SDOF system subjected to Harmonic excitation? **Sol. Derivation – 7**	7
Q.5	i.	Discuss briefly about Selection of Degrees of Freedom? **Sol. Description – 4**	4

	ii.	Derive the stiffness equations for a 3-story shear building? **Sol. Derivation –** 6 marks	6
OR	iii.	Evaluate the natural frequencies and mode shape for the structure shown in fig. below. Assume the support to be fixed at base.  **Sol. Natural Frequencies – 3** **Mode Shapes – 3**	6
Q.6		Attempt any two:	
	i.	Differentiate between Magnitude & Intensity **Sol. Difference – 5** Each Difference – 1 marks	5
	ii.	Explain briefly various terminology associated with earthquake through neat sketch? **Sol. Description – 3** **Sketch – 2**	5
	iii.	Write short notes on – **Sol.** **a) Strong Ground Motion (Description) – 2.5** **b) Seismogram (Description) - 2.5**	5

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