Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - VI EXAMINATION - SUMMER 2025

Subject Code: 3160621 **Date: 30-05-2025**

Subject Name: Earthquake Engineering

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions

1. Attempt all questions.

2. Make suitable assumptions wherever necessary.

3. Figures to the right indicate full marks.

4. Simple and non-programmable scientific calculators are allowed.

5. Use of IS-1893-Part 1(2016), IS 13920 (2016), IS 4326(2013), IS 13827 (R2006), IS 13828 (R2008) IS 875 Part I-V are permitted.

			Marks
Q.1	**(a)**	Define Following terms : (1) Isoseismal (2) Hypocentre (3) Aftershocks	**03**
	(b)	(i) **Differentiate** between Magnitude & Intensity of earthquake. (ii) **Discuss** the physical significance of MSK 7 Intensity earthquake.	**04**
	(c)	Explain the four virtues of earthquake resistant design.	**07**
Q.2	**(a)**	Describe importance of shear wall in multistoried Buildings	**03**
	(b)	Write short notes on the following: (i) Strong Ground Motion; (ii) Modified Mercalli Scale	**04**
	(c)	Determine the free vibration response of an SDOF system shown in **Fig. 1** at time t = 0.20 s for the following data: Natural circular frequency ω= 12 rad/s; Damping factor ξ = 0.15; Initial velocity (0) = 10 cm/s Initial displacement x(0) = 5 cm	**07**

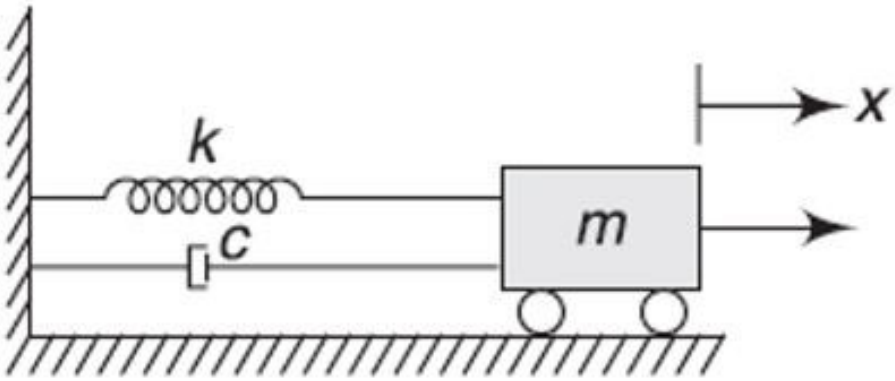


Fig. 1

OR

	(c)	In an experiment on a certain structure modelled as an SDOF system, the amplitude of free vibration decreased from 10 mm to 4 mm. If the logarithmic decrement was 0.1018 and undamped natural frequency is 40 rad/s, determine the damping ratio, damped period, and number of cycles completed.	**07**

Q.3 **(a)** **State** the reasons for the poor performance of masonry buildings in seismic areas. **03**

(b) Explain with neat sketches the techniques of Column Jacketing. **04**

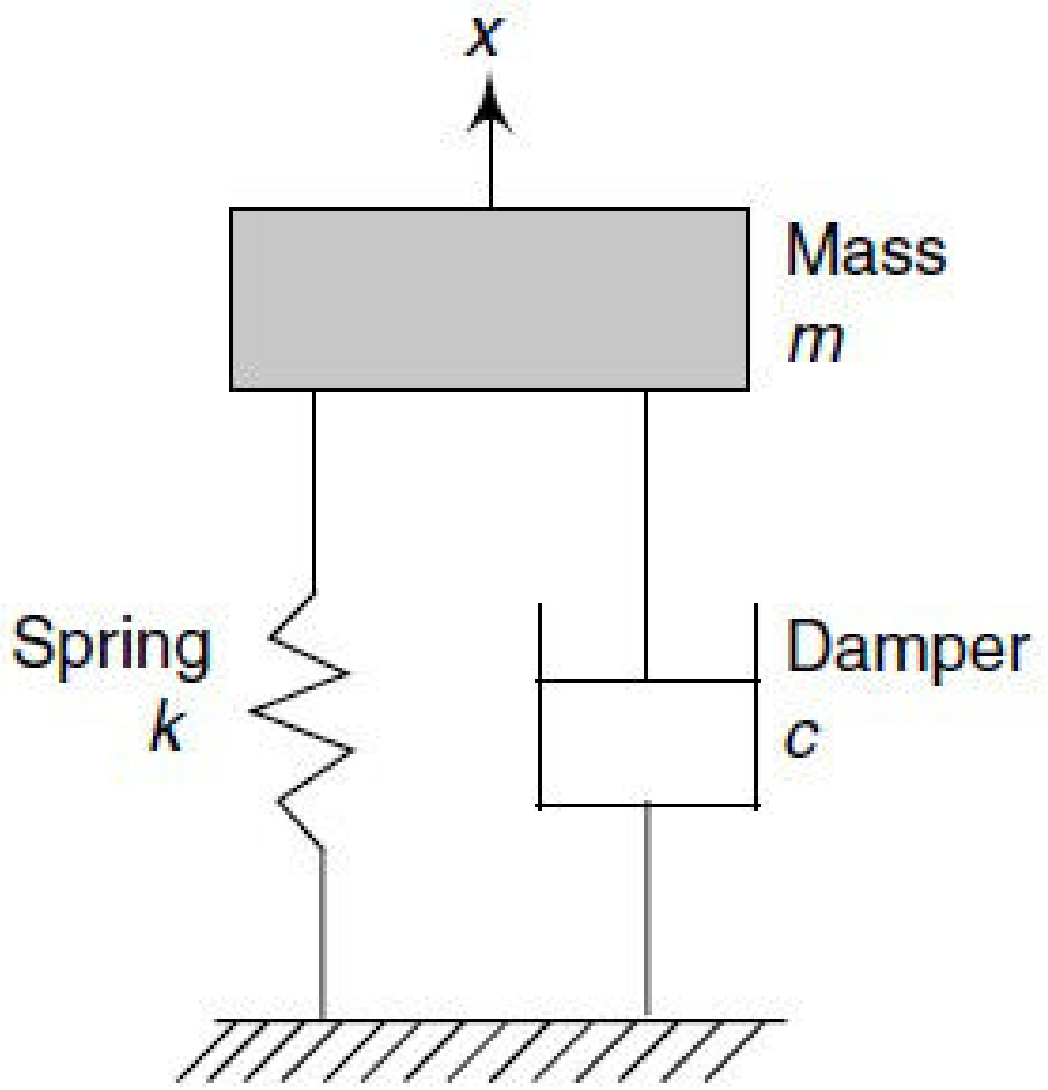
(c) A mass of 0.07 kg is suspended from a spring of stiffness 45 N/m. The mass is pulled downwards by 15 mm from its equilibrium position and then released.The upward velocity observed was 25 mm/s. Determine the maximum velocity,maximum acceleration, and the phase angle. **07**

OR

(a) Differentiate the following terms **03**
(i) Storey drift and storey shear
(ii) Importance factor and response reduction factor

(b) **Enlist** required conditions for liquefaction. Also suggest remedial measures for the same. **04**

(c) An SDOF system is modelled as shown in Fig. 2. It has the following properties.Mass, m = 2 kg; Stiffness, k = 15,000 N/m; Coefficient of damping, c = 45 N/m/s. Determine the natural circular frequency, damping factor, and damped frequency of the system shown in Fig. 2 Write the equation of free response for determining the time history response of the system. **07**



Q.4 **(a)** **How** design eccentricity is calculated as per IS: 1893 (1) -2016? **03**

(b) List assumptions made in Cantilever method of lateral load analysis. **04**

(c) Consider a simple one-storey building having two shear walls in each direction as shown in **Fig. 3**. It has some gravity columns that are not considered for analysis. All four walls are in M25 grade concrete, 200 thick and 4 m long. Storey height is 4.5 m. Floor consists of cast-in-situ reinforced concrete. Design shear force on the building is 100 kN in either direction. Evaluate design lateral forces on different shear walls using the torsion provisions of IS 1893 (Part 1) 2016. **07**

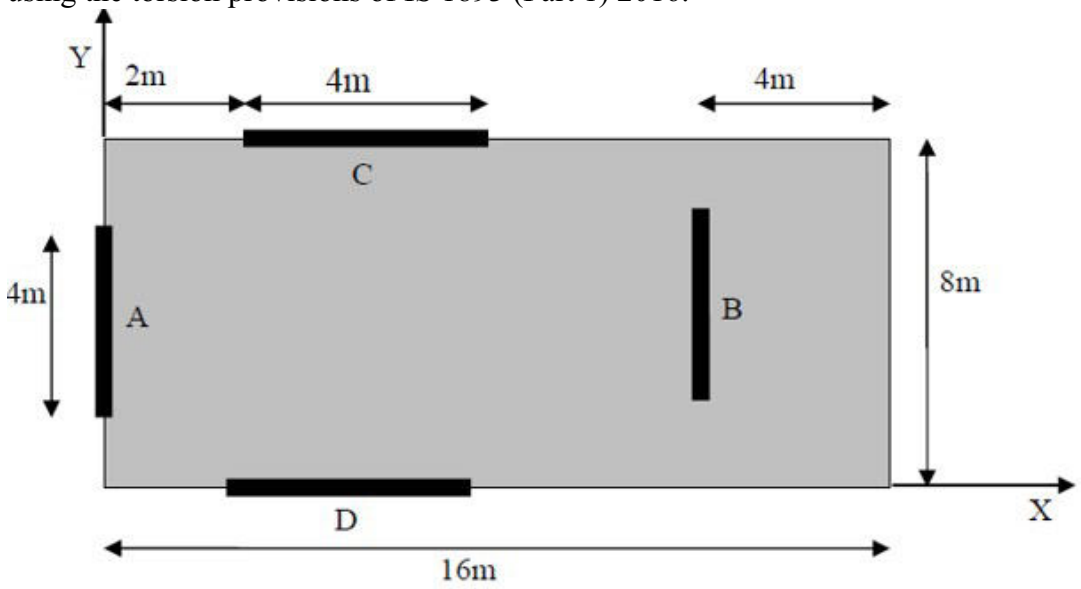


Fig. 3

OR

(a) Explain various irregularities found in the civil engineering structures from earthquake point of view. **03**

(b) Locate the center of mass and center of stiffness for the **Fig-4**. All column sizes are 350 mm x 650 mm. **04**

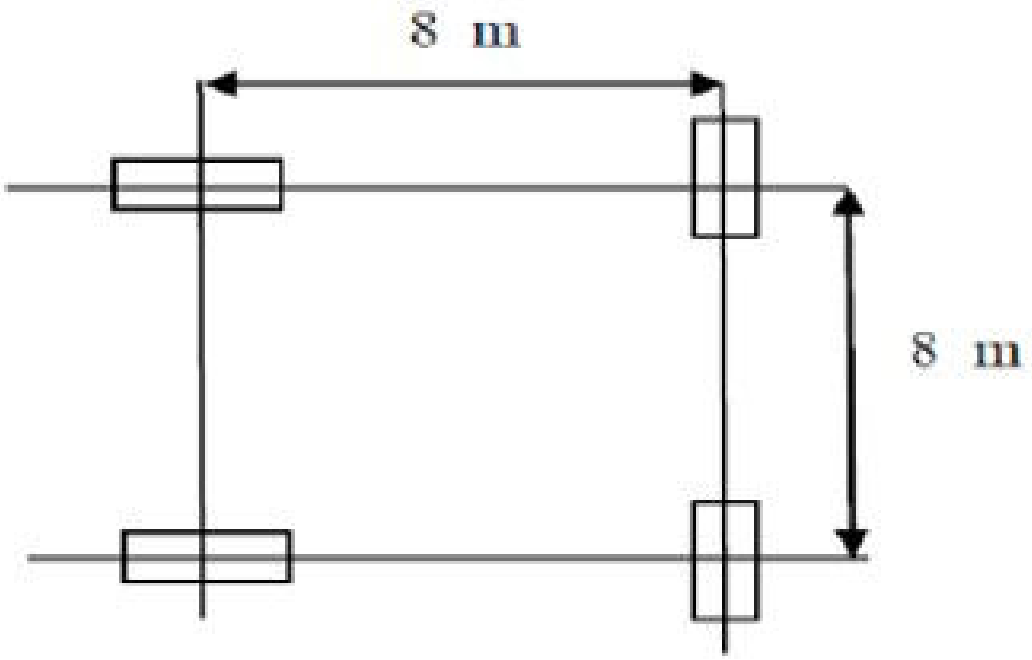


Fig 4

(c) Explain ductile detailing of beam as per Indian standard 13920 (2016) with neat sketches. **07**

Q.5 **(a)** Explain Rigid diaphragm in detail. **03**

(b) **Explain** base isolation techniques in details. **04**

(c) The plan and elevation of a three-storey RCC Community Hall is shown in **Fig. 5**. The building is located in seismic zone V. The type of soil encountered is medium stiff and it is proposed to design the building with a special moment resisting frame. The intensity of DL is 10 kN/m^2 and the floors are to cater to an IL of 3 kN/m^2. Determine the design seismic loads on the structure by Seismic Coefficient Method. **07**

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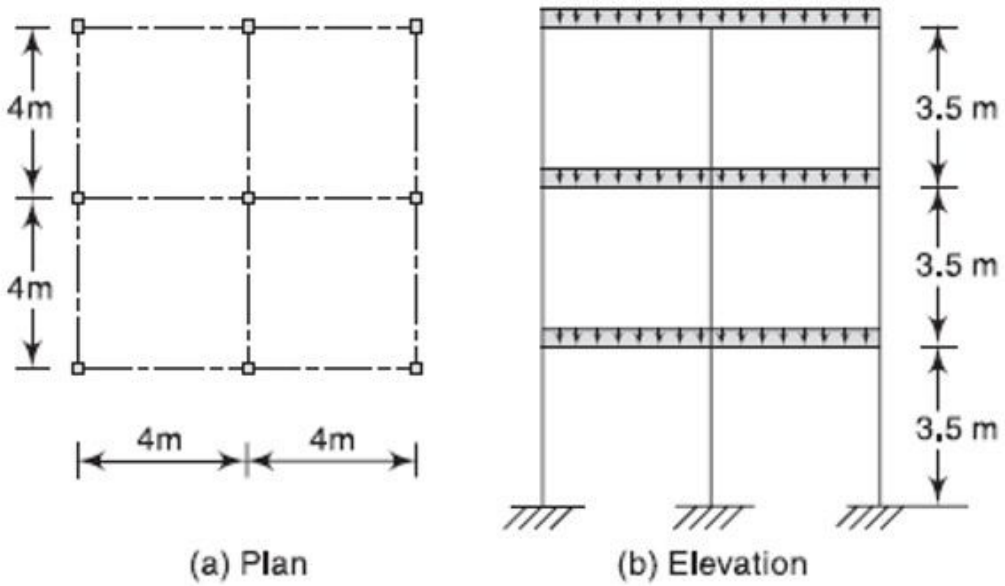

Fig. 5

OR

(a) Explain the importance of ductility. **03**

(b) Explain the procedure of Response spectrum method as per Indian Standards. **04**

(c) Consider a four-storey reinforced concrete office building shown in Fig. 6. 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 12kN/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 and1.5 kN/m^2 on the roof. Determine design seismic load on the structure as per IS 1893-Part 1 (2016). **07**

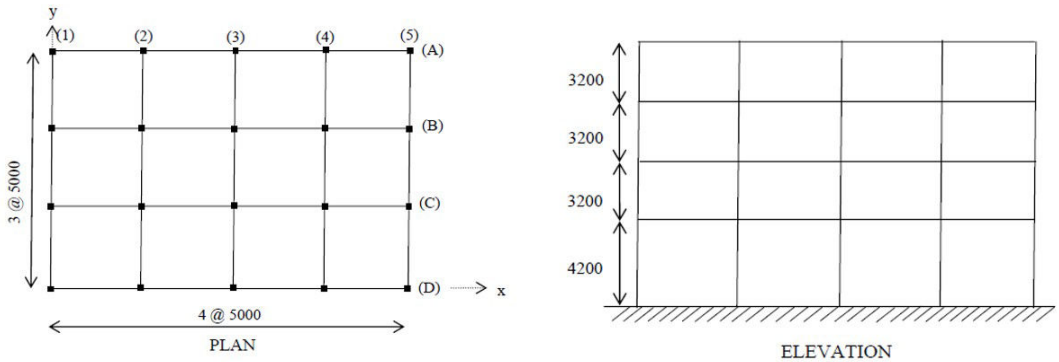

Fig 6

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2024

Subject Code:3160621 Date:24-05-2024

Subject Name:Earthquake Engineering

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS-1893-Part 1(2016), IS 13920 (2016), IS 4326(2013), IS 13827 (R2006), IS 13828 (R2008) IS 875 Part I-V are permitted.**

			MARKS
Q.1	**(a)**	What are the known causes of earthquake? Explain in terms of Plate Tectonic theory.	**03**
	(b)	(i) Differentiate between Magnitude & Intensity of earthquake. (ii) Discuss the significance of MSK 9 Intensity earthquake.	**04**
	(c)	Explain the Philosophy of earthquake resistant design. Give four virtue of good earthquake resistant design.	**07**
Q.2	**(a)**	Define Following terms: (1) Soft storey (2) Centre of Rigidity (3) Ductility	**03**
	(b)	What is regular and irregular building according to IS 1893. Describe any two vertical irregularities with neat sketches.	**04**
	(c)	In an experiment on a certain structure modelled as an SDOF system, the amplitude of free vibration decreased from 10 mm to 4 mm. If the logarithmic decrement was 0.1018 and undamped natural frequency is 40 rad/s, determine the damping ratio, damped period, and number of cycles completed.	**07**
		OR	
	(c)	Write the equation of motion for damped forced vibration and derive the expressions for the displacement.	**07**
Q.3	**(a)**	Differentiate the following terms 1. Storey drift and storey shear 2. Importance factor and response reduction factor	**03**
	(b)	Enlist required conditions for liquefaction. Also suggest remedial measures for the same.	**04**
	(c)	Differentiate between static and dynamic analysis for earthquake loading. Explain the procedure of Response spectrum method as per Indian Standards.	**07**
		OR	
Q.3	**(a)**	Differentiate the flexible and Rigid Diaphragm.	**03**
	(b)	Explain with neat sketches the techniques of Column Jacketing.	**04**
	(c)	Determine the free vibration response of an SDOF system shown in Fig. 1 at time t = 0.20 s for the following data: Natural circular frequency ω= 12 rad/s; Damping factor ξ = 0.15; Initial velocity $\dot{x}$ (0) = 10 cm/s Initial displacement x(0) = 5 cm	**07**

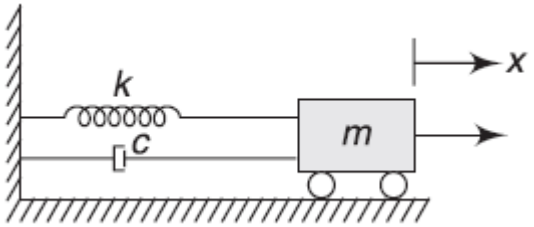

Fig. 1

Q.4 **(a)** State the reasons for the poor performance of masonry buildings in seismic areas. **04**

(b) A three storeyed public building is shown in Fig 2. Consider that the service block is separately provided with no structural connection with this building. Consider 230 mm thick peripheral walls throughout the height of the building with 0.9m high parapet at terrace. Determine the seismic weights of the building components and determine the base shear. Also check whether equivalent static method of earthquake analysis can be applied and if yes, calculate the earthquake forces at all levels. **10**

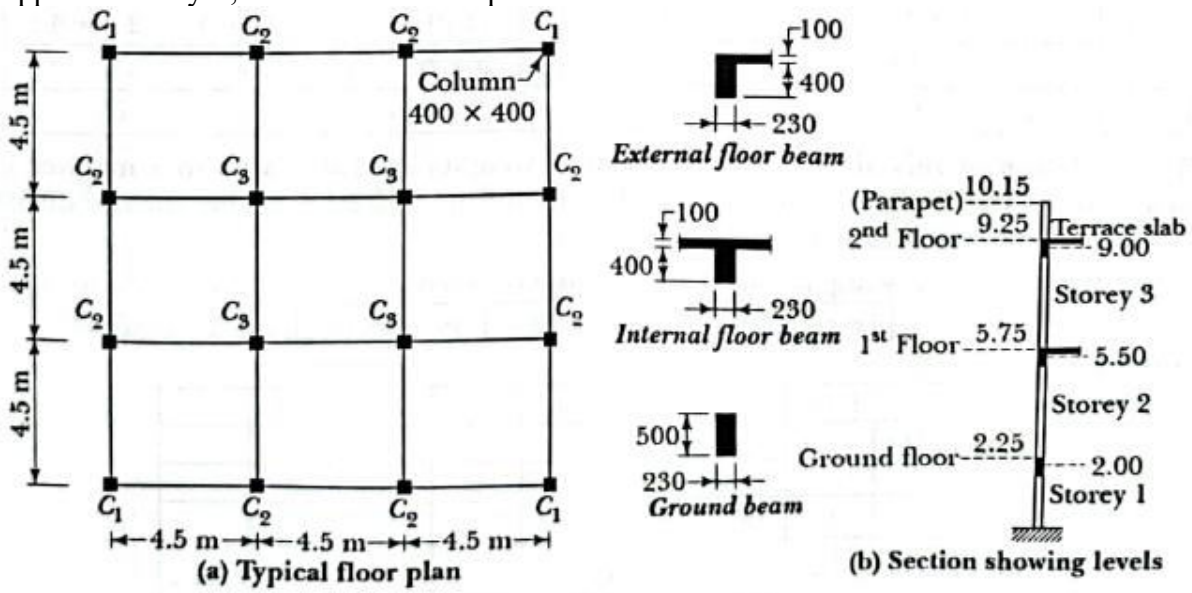

Fig. 2

OR

Q.4 **(a)** How design eccentricity is calculated as per IS: 1893 (1) -2016? **04**

(b) A typical floor plan of an intermediate storey of multi-storeyed building is shown in Fig. 3. Floor masses acting on various columns are also shown in the same figure. All columns have 500 mm X 500 mm size and cast in M25 grade concrete. The floor is subjected to seismic load of 480 kN in the principal directions. The floor height is 5 m. Determine (i) Center of Mass and Center of Gravity; (ii) accidental eccentricities and torsion induced in floor. **10**

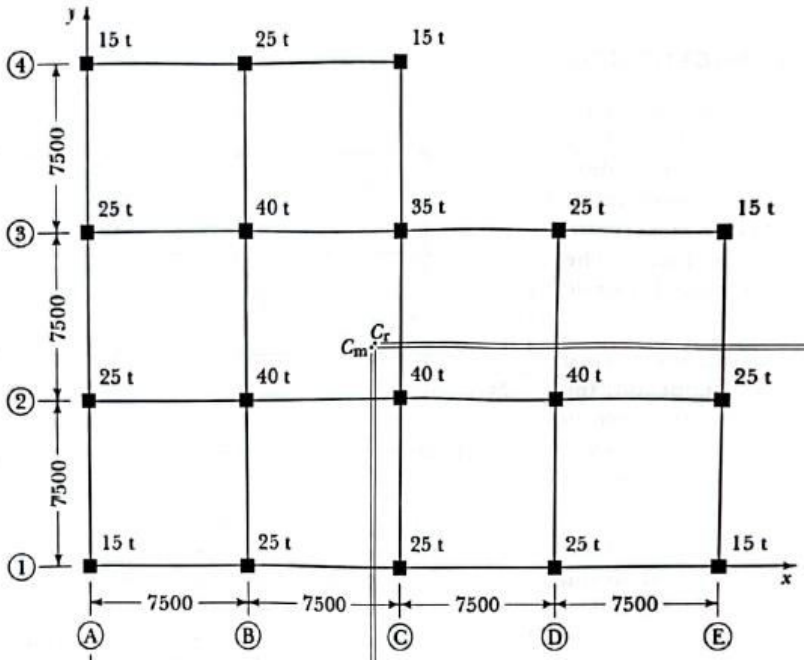

Fig. 3

Q.5 **(a)** Write short note on Logarithmic Decrement. **03**

(b) Distinguish between centre of mass and centre of stiffness. **04**

(c) What are plate tectonics and how are they related to continental drift and sea floor spreading? **07**

OR

Q.5 **(a)** Give assumptions made in cantilever method of lateral load analysis. **03**

(b) Explain base isolation techniques in details. **04**

(c) Explain importance of various bands in masonry buildings? Support the answer with suitable sketches. **07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2023

Subject Code:3160621 Date:14-07-2023

Subject Name:Earthquake Engineering

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS-1893-Part 1(2016), IS 13920 (2016), IS 4326(2013), IS 13827 (R2006), IS 13828 (R2008) IS 875 Part I-V are permitted.**

			MARKS
Q.1	**(a)**	Define Following terms: (1) Epicenter (2) Focus (3) Critical Damping.	**03**
	(b)	Differentiate between the following: (1) Magnitude & Intensity (2) Body Waves and surface waves	**04**
	(c)	Explain four virtues of earthquake resistant design.	**07**
Q.2	**(a)**	Describe importance of shear wall in multistoried Buildings.	**03**
	(b)	Define Following terms: (1) Soft storey (2) Damping ratio (3) Ductility (4) Centre of Rigidity	**04**
	(c)	Differentiate between static and dynamic analysis for earthquake loading. Explain the procedure of Response spectrum method as per Indian Standards.	**07**
		OR	
	(c)	Explain importance of various bands in masonry buildings? Support the answer with suitable sketches.	**07**
Q.3	**(a)**	Differentiate the following terms 1. Storey drift and storey shear 2. Importance factor and response reduction factor	**03**
	(b)	Explain base isolation techniques in details.	**04**
	(c)	In an experiment on a certain structure modelled as an SDOF system, the amplitude of free vibration decreased from 10 mm to 4 mm. If the logarithmic decrement was 0.1018 and undamped natural frequency is 40 rad/s, determine the damping ratio, damped period, and number of cycles completed.	**07**
		OR	
Q.3	**(a)**	Discuss the strong column – weak beam concept.	**03**
	(b)	Enlist required conditions for liquefaction. Also suggest remedial measures for the same.	**04**
	(c)	Determine the free vibration response of an SDOF system shown in **Fig. 1** at time t = 0.20 s for the following data: Natural circular frequency ω= 12 rad/s; Damping factor ξ = 0.15; Initial velocity $\dot{x}$ (0) = 10 cm/s Initial displacement x(0) = 5 cm	**07**

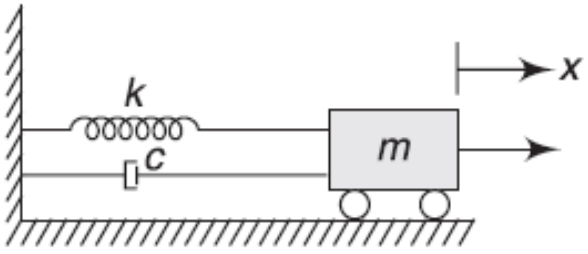

Fig. 1

Q.4 **(a)** Explain Rigid diaphragm in detail. **03**

(b) Distinguish between centre of mass and centre of stiffness. **04**

(c) The plan and elevation of a three-storey RCC Community Hall is shown in **Fig. 2**. The building is located in seismic zone V. The type of soil encountered is medium stiff and it is proposed to design the building with a special moment resisting frame. The intensity of DL is 10 kN/m^2 and the floors are to cater to an IL of 3 kN/m^2. Determine the design seismic loads on the structure by static analysis. **07**

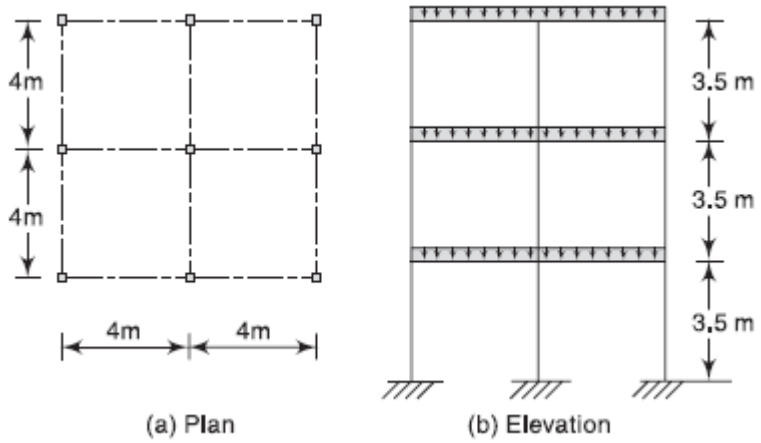

Fig. 2

OR

Q.4 **(a)** How design eccentricity is calculated as per IS: 1893 (1) -2016? **03**

(b) Explain various irregularities found in the civil engineering structures from earthquake point of view. **04**

(c) Explain ductile detailing of beam as per Indian standard 13920 (2016) with neat sketches. **07**

Q.5 **(a)** Write short note on Logarithmic Decrement. **03**

(b) Discuss the capacity design concept in ductile detailing. **04**

(c) Consider a simple one-storey building having two shear walls in each direction as shown in **Fig. 3**. It has some gravity columns that are not considered for analysis. All four walls are in M25 grade concrete, 200 thick and 4 m long. Storey height is 4.5 m. Floor consists of cast-in-situ reinforced concrete. Design shear force on the building is 100 kN in either direction. **07**

Evaluate design lateral forces on different shear walls using the torsion provisions of IS 1893 (Part 1) 2016.

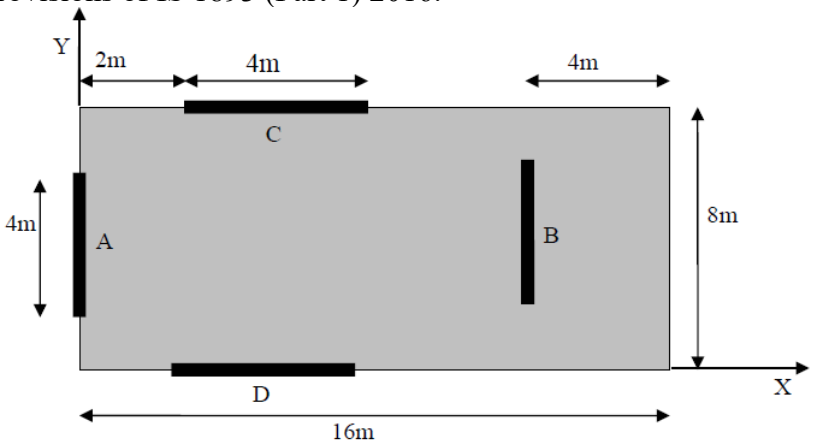

Fig. 3

OR

Q.5 **(a)** Give assumptions made in cantilever method of lateral load analysis. **03**

(b) Explain with neat sketches the techniques of Column Jacketing. **04**

(c) Write the equation of motion for damped free vibration and derive the expressions for the displacement. **07**

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – SUMMER 2022

Subject Code:3160621 Date:10/06/2022

Subject Name:Earthquake Engineering

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS 1893 and IS 13920 is permitted.**

			MARKS
Q.1	**(a)**	Define Following terms: (1) Epicenter (2) Magnitude of Earthquake (3) Resonance.	**03**
	(b)	Differentiate between the following: (1) Magnitude & Intensity (2) Iso – seismal & Meizo – seismal.	**04**
	(c)	Derive the expression of displacement for free vibration of damped SDOF system with usual notations.	**07**
Q.2	**(a)**	Define Following terms: (1) Soft storey (2) Damping ratio (3) Ductility.	**03**
	(b)	Write short note on Short Column Effect.	**04**
	(c)	A spring mass model consists of 18 kg mass and spring of stiffness 25 N/mm was tested for viscous damped vibration. The test recorded two consecutive amplitude is 2.0 cm and 1.5 cm respectively. Determine (i) Natural frequency of un-damped system (ii) Logarithmic decrement (iii) Damping ratio (iv) Damping coefficient (v) Damped natural period.	**07**
		OR	
	(c)	A free vibration test is performed on the single degree-of-freedom system. The mass of the system is 300 kg which is displaced by 3 cm and suddenly released. The time required to complete 15 cycles of oscillations is 5 s. Calculate the stiffness of the system. Write the equation of motion for the system and calculate the displacement after 10 sec. Consider initial velocity as 1 m/sec.	**07**
Q.3	**(a)**	Explain the importance of ductility.	**03**
	(b)	Explain base isolation techniques in details.	**04**
	(c)	Write short note on liquefaction. Explain factors affecting liquefaction.	**07**
		OR	
Q.3	**(a)**	Enlist the different methods of structural control.	**03**
	(b)	Explain how soft storey problems can be eliminated in the existing buildings.	**04**
	(c)	Explain with sketches: Seismic waves and its types.	**07**
Q.4	**(a)**	Explain in detail (1) Rigid diaphragm.	**03**
	(b)	Explain importance of vibration analysis in detail.	**04**
	(c)	Philosophy of earthquake resistant design. Give four virtue of good earthquake resistant design.	**07**
		OR	
Q.4	**(a)**	What is centre of mass and centre of stiffness?	**03**
	(b)	Differentiate between the following: (1) Seismograph & Seismogram	**04**

(2) Inter-plate & Intra-plate earthquakes.

(c) Explain ductile detailing of beam as per Indian standard 13920. **07**

Q.5 **(a)** Enlist various codes of practice along with correct name related to earthquake engineering. **03**

(b) Discuss the capacity design concept in ductile detailing. **04**

(c) A two storied building has lumped floor weights from bottom to top as 95000 N & 78500 N with storey stiffness of 5 x 105 N/m and 4 x 105 N/m respectively. Perform the free vibration analysis & determine natural frequencies and corresponding mode shape coefficients. Also sketch the mode shapes. **07**

OR

Q.5 **(a)** Explain various irregularities found in the civil engineering structures from earthquake point of view. **03**

(b) Write short note on Logarithmic Decrement. **04**

(c) Explain the criteria for earthquake resistant design & detailing of masonry structures. **07**

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