

Enrollment No./Seat No.:

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**Bachelor of Engineering - SEMESTER - VI EXAMINATION - WINTER 2025**

**Subject Code: 3160621**

**Date: 25-11-2025**

**Subject Name: Earthquake Engineering**

**Time: 02:30 PM TO 05:00 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: 1893-2016 Part-1, IS: 13920-2016, is permitted.**

	<b>Marks</b>
<b>Q.1 (a)</b> Explain the following terms in Brief: (i) Meizoseismal and Ioseismal (ii) Focus of an Earthquake (iii) Seismograph	<b>03</b>
<b>(b)</b> Differentiate: (i) Magnitude and Intensity of an Earthquake (ii) Body Waves and Surface waves	<b>04</b>
<b>(c)</b> Explain the earthquake resistant Design Philosophy and provide four virtues of a good earthquake resistant design.	<b>07</b>
<b>Q.2 (a)</b> "Can your house sustain an Earthquake having an magnitude of 8.0 on Richter Scale?" Answer this question giving suitable explanation.	<b>03</b>
<b>(b)</b> "Frequency of a spring-mass system will decrease with the increase in mass of the system". State whether is statement is True or False giving proper justification. Also calculate the frequency of a spring mass system in Hertz if the mass of the system is 2 tonnes and stiffness is 200 N/mm.	<b>04</b>
<b>(c)</b> Derive the equation of motion for displacement at any given time for damped free vibration of an SDOF system.	<b>07</b>
<b>OR</b>	
<b>(c)</b> A free vibration test was performed on a single storey one bay portal frame having a mass of 200 kg, by displacing it horizontally and suddenly released. The initial displacement was observed to be 1.52 mm and after three cycles the displacement was recorded to be 0.371 mm. The time taken to finish three cycles of vibration was 0.285 second. Determine the stiffness 'k' and damping coefficient 'c' of the portal frame.	<b>07</b>
<b>Q.3 (a)</b> Explain in detail with examples Rigid Diaphragm and Flexible Diaphragm.	<b>03</b>
<b>(b)</b> Explain in detail; (i) Soft Storey and Weak Storey (ii) Mass Irregularity and Stiffness Irregularity	<b>04</b>

- (c) A 6.8 kg mass is suspended by a linear spring. The mass receives an impact resulting in motion with no initial displacement but with an initial velocity. The natural period of system was measured to be 0.25 sec, and the displacement amplitude of 50mm. Find (a) the spring constant for the system, (b) the initial velocity imparted on the mass and displacement of the system at  $t = 0.63$  sec considering an undamped system. 07

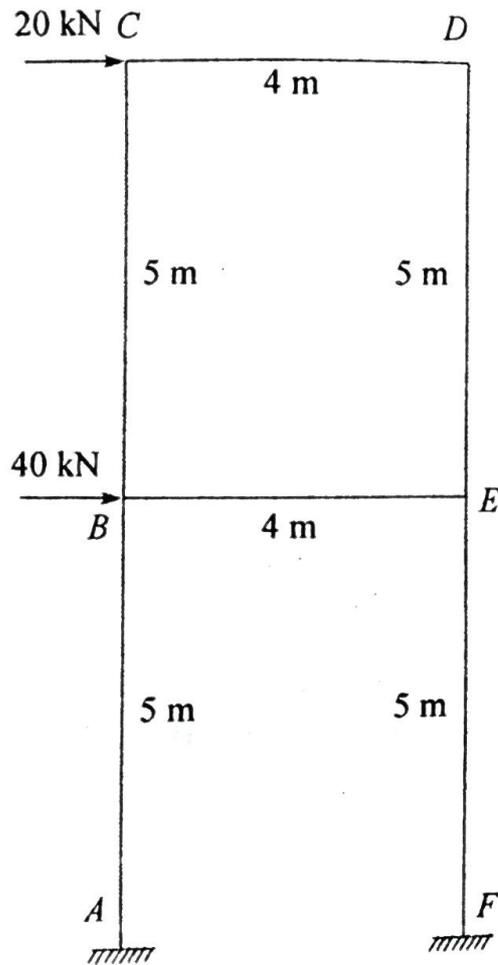
OR

- (a) "Can you build an earthquake proof building?" Answer the question with proper justifications 03
- (b) Explain the role of Base isolation and Dampers installed in structures. In which type of structures, base isolation will be ineffective and why? 04
- (c) Formulate the governing equation of motion for undamped vibrations for a three storey structure having mass of  $m_1$ ,  $m_2$ , &  $m_3$  and storey stiffness of  $k_1$ ,  $k_2$ , &  $k_3$  for first, second, and third storey respectively. 07
- Q.4 (a) Explain the concept of ductility and describe the measures used to make RCC structures more ductile? 03
- (b) Describe confined masonry structures and discuss why they perform better than normal brick masonry buildings. 04
- (c) Describe in detail about the various methods prescribed by IS: 1893-2016 for elastic analysis of structures to evaluate the design lateral forces during an earthquake. Also give the suitability of each method for different types of structures. 07

OR

- (a) Write a short note on the possible damages to RC buildings in earthquake-prone urban regions. 03
- (b) Explain with neat sketches the various construction features that can be adopted to improve the earthquake resistance of brick masonry structures. 04
- (c) A 5-storey RCC structure located in Bhopal has storey height of 3.5m and built up area of  $350 \text{ m}^2$ . The dead weight on each floors including partitions and structural members can be considered as 375 kN and 415 kN for terrace. Consider a live load of  $3.5 \text{ kN/m}^2$  on each floor and  $1.5 \text{ kN/m}^2$  for terrace. Assuming the structure is used as a Shopping Center, having foundation on medium soil and provisions of IS: 13920-2016 have been followed in detailing, evaluate the design lateral forces and base shear for each storey of the structure using equivalent static method as per the provisions of IS: 1893-2016. Mention the clause numbers of the provisions used from IS: 1893-2016. 07
- Q.5 (a) Describe the salient point of difference between ductile detailing and normal reinforced RCC Column. 03
- (b) Differentiate between Passive and Active structural control systems installed in the structures. 04

- (c) Analyze the portal frame shown in Figure-1 using Portal method and draw the BM 07



diagram

OR

- (a) When an RCC building is designed with an intermediate storey having no walls, unlike the storeys above and below, a structural irregularity arises. Identify the type of irregularity caused in such a case and explain the remedial measures recommended by the IS:1893-2016 to mitigate it. 03
- (b) In a ductile detailing design, explain how the shear capacity of beams is ensured against brittle failure. 04
- (c) Compare torsionally coupled and uncoupled systems under lateral load. Explain, with sketches, how torsional irregularity affects structural response. 07

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Enrolment No./Seat No \_\_\_\_\_

## GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3160621

Date:05-12-2024

Subject Name:Earthquake Engineering

Time:02:30 PM TO 05:00 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.

	Marks
<b>Q.1</b> (a) Explain Ductility and Flexibility	<b>03</b>
(b) Discuss the need of seismic zones in India	<b>04</b>
(c) Define (i) isoseismal (ii) soft storey (iii) epicenter (iv) magnitude (v) resonance (vi) seismogram (vii) Intensity	<b>07</b>
<b>Q.2</b> (a) Explain ‘Rigid diaphragm’ and ‘Flexible diaphragm’.	<b>03</b>
(b) Distinguish between ‘centre of mass’ and ‘centre of stiffness’.	<b>04</b>
(c) Enlist the various seismic waves and explain about all.	<b>07</b>
<b>OR</b>	
(c) A spring mass model consists of 6 kg mass and spring of stiffness 3 N/mm was tested for viscous damped vibration. The test recorded two consecutive amplitude is 1.5 cm and 1.2 cm respectively. Determine (i) natural frequency of undamped system (ii) logarithmic decrement (iii) damping ratio (iv) damping coefficient (v) damped natural frequency of system.	<b>07</b>
<b>Q.3</b> (a) Explain crack repair by epoxy injection grouting.	<b>03</b>
(b) Write a brief note on ‘Beam Jacketing’.	<b>04</b>
(c) What is soil liquefaction? Explain theory of liquefaction in detail.	<b>07</b>
<b>OR</b>	
<b>Q.3</b> (a) Define repair, restoration and retrofitting of structures.	<b>03</b>
(b) Discuss various dampers used for energy dissipation.	<b>04</b>
(c) Explain torsionally coupled and torsionally uncoupled system.	<b>07</b>
<b>Q.4</b> (a) What is base isolation? Explain concept of base isolation in structures.	<b>03</b>
(b) How design eccentricity is calculated as per IS 1893(1) – 2002.	<b>04</b>
(c) Explain effect of structural irregularities under lateral loading.	<b>07</b>
<b>OR</b>	
<b>Q.4</b> (a) Calculate the base shear for a five storey hospital building having special moment resisting frame (SMRF) located in Ahmedabad on medium soil with following data using seismic coefficient method.	<b>07</b>

(i) No. of bay in x and y-direction = 4 (ii) Width of each bay = 5m (iii) Thickness of slab =150 mm (iv) Storey height = 3 m (v) Size of beam and column = 300 mm x 450 mm (vi) Amount of damping = 10 % of critical damping (vii) Live load = 4 kN/m<sup>2</sup> Assume any additional data if required and neglect the weight of the infill wall panels

(b) Calculate the lateral forces at each floor level of hospital building of Q.1 (a) **07**  
using seismic coefficient method.

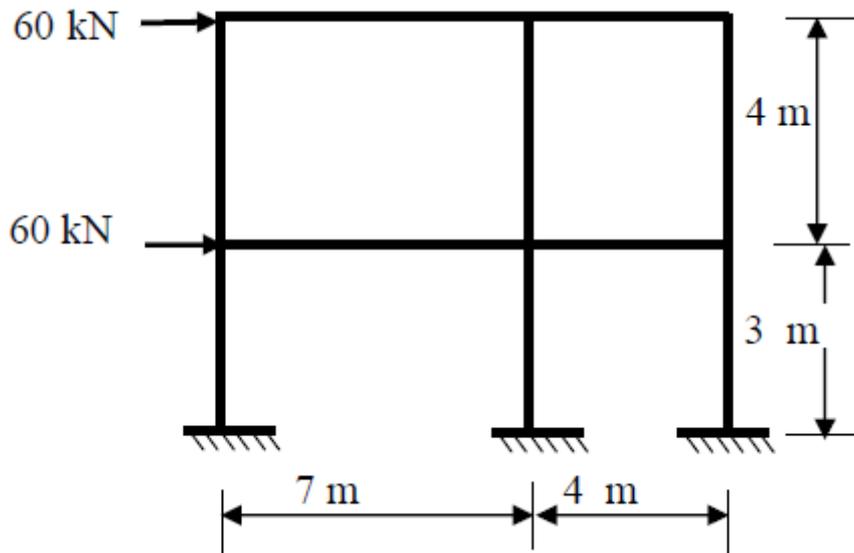
**Q.5 (a)** Discuss, “How Architectural Features Affect Buildings During Earthquakes?” **07**

(b) Explain the earthquake resistance feature of masonry structures **07**

**OR**

**Q.5 (a)** Enlist different approximate methods used for lateral load analysis. Analyse the frame shown in the figure - 1 using an appropriate approximate method and construct Bending Moment, Shear Force and Axial Force diagrams. All columns are of same cross section 300 x 300 mm . Assume appropriate data if necessary. **07**

(b) How we can make Buildings Ductile for Good Seismic Performance? **07**



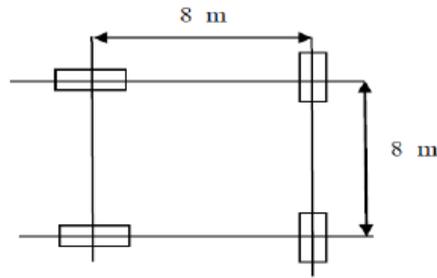
**Figure -1**

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**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VI (NEW) EXAMINATION – WINTER 2023****Subject Code:3160621****Date:13-12-2023****Subject Name:Earthquake Engineering****Time:02:30 PM TO 05:00 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
<b>Q.1</b>	(a) Define Following terms: (1) Weak Story (2) Epicenter (3) Damping.	<b>03</b>
	(b) Differentiate between the following: (1) Magnitude & Intensity (2) Rayleigh Waves and Love waves	<b>04</b>
	(c) What are the four virtues of earthquake resistant design. Explain any one in detail.	<b>07</b>
<b>Q.2</b>	(a) What are the known causes of earthquake?	<b>03</b>
	(b) Discuss the strong column – weak beam concept.	<b>04</b>
	(c) Differentiate between static and dynamic analysis for earthquake loading. Explain the procedure of Seismic Coefficient Method method as per Indian Standards.	<b>07</b>
<b>OR</b>		
	(c) Derive the motion equation for the forced damped vibration?	<b>07</b>
<b>Q.3</b>	(a) Differentiate the following terms 1. Storey drift and storey shear 2. Importance factor and response reduction factor	<b>03</b>
	(b) Give details of expected damages by Earthquake in structures with 1. Short columns, 2. Building frames without shear panels, 3. Floating columns, 4. Unsymmetrical plan	<b>04</b>
	(c) A vibrating system consisting of a mass of 50 kg and a spring of stiffness $4 \times 40^4$ N/m is viscously damped. The ratio of two consecutive amplitudes is 20:18. Determine the natural frequency of undamped system. Also determine the damping ratio and damped natural frequency.	<b>07</b>
<b>OR</b>		
<b>Q.3</b>	(a) Explain base isolation techniques in details.	<b>03</b>
	(b) How design eccentricity is calculated as per IS: 1893 (1) -2016?	<b>04</b>
	(c) The properties mass m, stiffness k, and natural frequency $\omega$ of an undamped SDOF system are to be determined by a harmonic excitation test. At an excitation frequency of 4 Hz the response tends to increase without bound. Then, a weight W of 22 N is attached to the mass m, the resonance occurred at 3 Hz. Determine the dynamic properties of the system.	<b>07</b>
<b>Q.4</b>	(a) Explain Rigid diaphragm in detail.	<b>03</b>
	(b) Locate the center of mass and center of stiffness for the <b>Fig-1</b> . All column sizes are 350 mm x 650 mm.	<b>04</b>

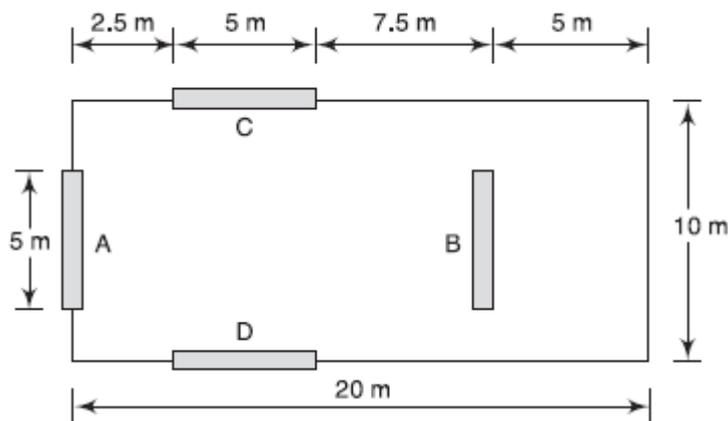


**Fig 1**

- (c) Determine the frequency and design seismic coefficient for an ordinary masonry shear wall in a school building at Allahabad, for the following data. Roof load  $P = 15 \text{ kN/m}$ ; Height of wall  $h = 3.0 \text{ m}$ ; Width of wall  $b = 0.2 \text{ m}$ ; Unit weight of wall  $w = 19.2 \text{ kN/m}^3$  Soil is medium. 07

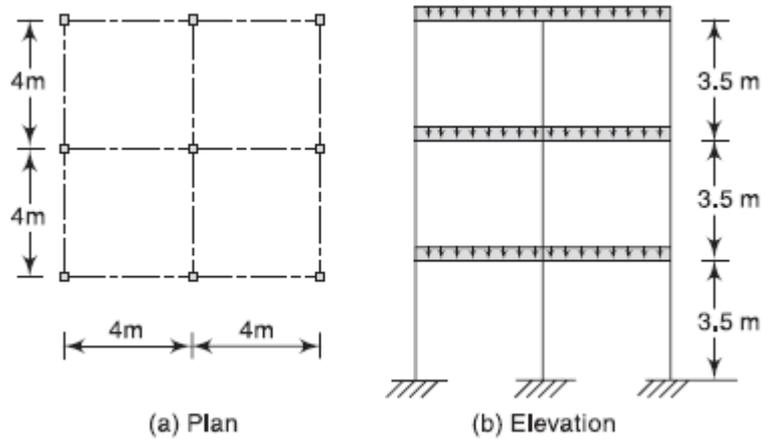
**OR**

- Q.4** (a) Enlist required conditions for liquefaction. Also suggest remedial measures for the same. 03
- (b) Explain various irregularities found in the civil engineering structures from earthquake point of view. 04
- (c) Explain ductile detailing of Column as per Indian standard 13920 (2016) with neat sketches. 07
- Q.5** (a) Differentiate between the following: (1) Seismograph & Seismogram (2) Inter-plate & Intra-plate earthquakes. 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. 2**. It has some gravity columns that are not considered for analysis. All four walls are in M25 grade concrete, 200 thick and 5 m long. Storey height is 4.0 m. Floor consists of cast-in-situ reinforced concrete. Design shear force on the building is 200 kN in either direction. Evaluate design lateral forces on different shear walls using the torsion provisions of IS 1893 (Part 1) 2016. 07



**Fig. 2**  
**OR**

- Q.5** (a) Explain the importance of ductility. 03
- (b) Explain with neat sketches the techniques of Column Jacketing. 04
- (c) The plan and elevation of a three-storey RCC Community Hall is shown in **Fig. 3**. 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  $10 \text{ kN/m}^2$  and the floors are to cater to an IL of  $3 \text{ kN/m}^2$ . Determine the design seismic loads on the structure by static analysis. 07



**Fig. 3**

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**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-VI(NEW) EXAMINATION – WINTER 2022****Subject Code:3160621****Date:17-12-2022****Subject Name:Earthquake Engineering****Time:02:30 PM TO 05:00 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.

	<b>Marks</b>
<b>Q.1 (a)</b> What are the known causes of earthquake?	<b>03</b>
<b>(b)</b> Enlist various IS codes applicable to earthquake engineering.	<b>04</b>
<b>(c)</b> Elaborate on the seismic waves developed during earthquake and its effects on structure.	<b>07</b>
<b>Q.2 (a)</b> Differentiate between static loading and dynamic loading.	<b>03</b>
<b>(b)</b> Write short note on mathematical modeling.	<b>04</b>
<b>(c)</b> Derive the motion equation for the free damped vibration.	<b>07</b>
<b>OR</b>	
<b>(c)</b> A SDOF vibrating system is consisting of a mass = 160 kg, spring stiffness = 160 N/m, and $c = 30$ N-sec/m. determine (i) Natural frequency of damped vibration (ii) Damping ratio (iii) logarithmic decrement (iv) Ratio of two successive amplitudes.	<b>07</b>
<b>Q.3 (a)</b> Differentiate the following terms	<b>03</b>
1. Storey drift and storey shear	
2. Importance factor and response reduction factor	
<b>(b)</b> Give details of expected damages by Earthquake in structures with 1. Short columns, 2. Building frames without shear panels, 3. Floating columns, 4. Unsymmetrical plan	<b>04</b>
<b>(c)</b> List the four virtues of good earthquake resistance design and describe in detail.	<b>07</b>
<b>OR</b>	
<b>Q.3 (a)</b> Write zone factor [Z] values as per IS 1893-part I.	<b>03</b>
<b>(b)</b> Explain soft storey & discuss its performance of soft storey building in past earthquakes. How will you avoid soft storey?	<b>04</b>

- (c) Explain the step wise procedure to find the base shear of multistory building with seismic coefficient method with codal provisions. **07**

- Q.4** (a) List assumptions made in Cantilever method of lateral load analysis. **03**  
(b) How torsionally couple system is differing from torsionally uncouple system? Discuss it with neat sketches. **04**  
(c) Discuss in detail the concepts of the ductile detailing in Beams as per IS: 13920. Write clear codal provisions. **07**

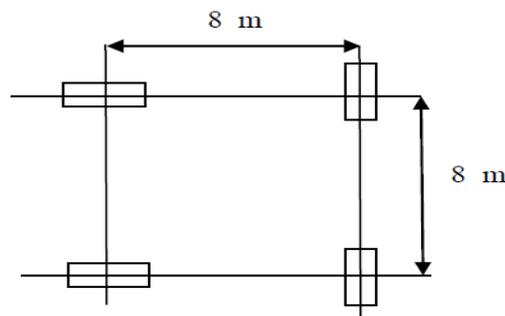
**OR**

- Q.4** (a) Explain repair, restoration and retrofitting. **03**  
(b) Describe importance of shear wall in multistoried Buildings **04**  
(c) Explain Earthquake Resistant Design Philosophy. Differentiate between Earthquake Proof Design and Earthquake Resistant Design. **07**

- Q.5** (a) Explain how ductile design is helpful for better earthquake resistance. **03**  
(b) Define following **04**  
(1) Magnitude of Earthquake (2) Intensity  
(3) Focus (4) Epicenter  
(c) Explain the concept of base isolation. Discuss its suitability. **07**

**OR**

- Q.5** (a) Enlist required conditions for liquefaction. Also suggest remedial measures for the same. **03**  
(b) Explain with neat sketches the techniques of Column Jacketing. **04**  
(c) Locate the center of mass and center of stiffness for the Fig-1. All column sizes are 350 mm x 650 mm. **07**



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