

GUJARAT TECHNOLOGICAL UNIVERSITY

BE (CIVIL & INFRASTRUCTURE ENGINEERING) DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

SUBJECT CODE: 2184010

8th Semester

Type of course: Elective Subject

Prerequisite: Mechanics of solids, Fundamentals of Structural Analysis, Advanced Structural Analysis, Design of Reinforced Concrete Structures.

Course Objectives: Students should be able:

- To understand basic analogy of earthquake and its effects on structures.
- To estimate earthquake loadings on structures.
- To understand the concepts of earthquake resistant structures,
- To understand earthquake resistant systems for structures.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE	PA(M)	Viva	PA (I)		
3	2	0	5	70	30	30	20	150

Contents:

Sr. No.	Topics	Hrs.	% Weightage
1	Engineering Seismology: Causes of Earthquakes and Seismic Waves, Measurement of Earthquakes and Measurement parameters, Influence of Nature of Soil on Intensity of Earthquake, Response of structure, Load Transfer Path and Elements, features of earthquake resistant structure as per IS 1893 (Part I), IS: 875 (Part V) and prediction of earthquake loads (Seismic Coefficient Method), base shear, distribution of loads along the height of building, Capacity based design approach, Performance based design approach, Response reduction factors	10	25
2	Fundamentals of Earthquake Vibrations of buildings: Kinetics and Kinematics, Static load v/s Dynamic load (force control and displacement control), idealization of structures (SDOF & MDOF systems), mathematical modelling of buildings, Dynamic	12	30

Sr. No.	Topics	Hrs.	% Weightage
	Properties of building (natural frequency, time period, damping, stiffness, etc.), mode shapes and modal analysis, resonance v/s increased response, damped and un-damped vibration, response of building to earthquake ground motion, Response to multi degree (maximum three) of freedom systems.		
3	Earthquake Resistant Design of RC Buildings: Lateral Loads on Buildings: Lateral Load Distribution (SDOF): Rigid diaphragm effect, centers of mass and stiffness, torsionally coupled and uncoupled system. Lateral Load Analysis: Analysis of frames using approximate methods like portal & cantilever methods. Design of RC buildings: Preliminary data, loading data, analysis of structural frames, load combinations, design of structural frames (maximum of 4 storeys).	10	25
4	Ductile Detailing: Introduction; Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Concepts of Detailing of various structural components as per IS: 13920 provisions.	4	10
5	Special Topics: Base Isolation, Confined Masonry, Soil liquefaction, Basics of soil structure interaction, Seismic strengthening. Structural Controls: Passive Structure control system, Active structure control system, semi active structure control system, isolation systems and various dampers.	4	10
		40	100

Course Learning Outcomes:

After learning the course the students should be able to:

1. Determine the response of SDOF & MDOF structural system subjected to vibration including earthquake.
2. Apply the concept of Earthquake Resistant Design & concept of lateral load distribution on buildings.
3. Determine the lateral forces generated in the structure due to earthquake.
4. Apply the concept of ductile detailing in RC structures.

Term Work:

Term work shall consist of laboratory works and following:

1. At least 25 problems based on the syllabus of Earthquake engineering which are uniformly distributed & graded from each of the topic.
2. Seminar/project assigned by the faculty member.

Design based Problems (DP)/Open Ended Problem: (This may be considered as a part of term work)

1. Preparation of the canvas of site visit of real life structures to understand the irregularities and ductile detailing with Photographs.
2. Model preparation to understand the behavior of structures under earthquake forces.

Texts Books: NIL**Reference Books:**

1. Manish Shrikhande & Pankaj Agrawal; Earthquake resistant design of structures, PHI Publication, New Delhi.
2. S.K. Duggal; Earthquake resistance design of structures; Oxford University Press, New Delhi.
3. A.K. Chopra; Dynamics of structures, Pearson, New Delhi.
4. Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992.
5. Park & Pauly; Behaviour of RC structure.
6. John M. Biggs; Introduction to Structural Dynamics.
7. C V R Murthy - Earthquake Tips, NICEE.
8. IITK-GSDMA EQ26 – V -3.0 Design Example of a Six Storey Building.
9. S.S. Rao; Mechanical Vibration; Pearson, New Delhi.
10. IS Codes:
 - a. Criteria for earthquake resistant design General provision & Building - IS: 1893 (Part I).
 - b. Code of Practice for Ductile Detailing of RC Structures - IS: 13920.
 - c. Code of Practice for earthquake resistant design & Construction of buildings – IS 4326.
 - d. Improving Earthquake Resistance of Earthen Buildings - IS 13827.
 - e. Guide lines for Improving Earthquake Resistance low strength masonry buildings - IS 13828.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N	E Level	C
10	15	20	20	25	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above

List of Open Source Software/learning website:

1. www.nicee.org
2. www.eeri.org
3. www.gsdma.org
4. www.ndma.gov.in
5. <http://www.nptel.ac.in/>

Active Learning Assignments:

Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.