FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF

CIVIL ENGINEERING

Marwadi University
Marwadi Chandarana Group

Earthquake Engineering

01CI0618

Objective of the Course:

- To Develop an understanding to SDOF and MDOF structural system subjected to vibration.
- To apply the principles of structural dynamics and earthquake-resistant design in RC structures
- To Understand the ductile detailing of the building using IS: 13920
- To identify the lateral forces generated in the structure due to earthquake.

Credit Earned: 04

Prerequisite: Applied Differential Equations, Basics of Geology, Structural Analysis

Students learning outcomes:

After successful completion of the course, it is expected that students will be able to,

1. Apply the concept of seismology, liquefaction, and structural control systems for preparedness against earthquakes.
2. Apply the planning and design requirements for earthquake-resistant features in RCC and Masonry structures, as per relevant IS codes.
3. Calculate the response of Single and Multi-Degree of Freedom systems.
4. Analyze structural frames considering lateral force distribution.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	IA (M)	CSE (I)	Viva (V)	Term Work (TW)	
03	00	02	04	50	30	20	25	25	150

Detailed Syllabus

Sr No.	Title of the unit	Number of hours
1	**Engineering Seismology**	**03**
	1.1 Interior of Earth, plate tectonics, faults, consequences of earthquake, Basic parameters of earthquake, magnitude &	

	intensity, scales, Seismic zones of India, damages caused during past earthquakes (worldwide).	
2	**Structural Dynamics**	**14**
	2.1 Static load v/s Dynamic load (force control and displacement control), Lumped mass model, Simplified single degree of freedom system, mathematical modelling of buildings, natural frequency, Time period resonance v/s increased response.	02
	2.2 Responses of buildings to different types of vibrations like free and forced, damped and un-damped vibration, Response of the building to earthquake ground motion.	08
	2.3 Response to multi-degree (maximum three) of freedom systems up to mode shapes, Response Spectrum Method.	04
3	**Design Philosophy**	**12**
	3.1 Philosophy of earthquake resistant design, earthquake proof v/s earthquake resistant design, four virtues of earthquake resistant structures (strength, stiffness, ductility and configuration), seismic structural configuration,	06
	3.2 Introduction to Earthquake Resistant Features of un-reinforced & reinforced masonry Structure, Confined Masonry.	02
	3.3 Introduction to IS: 1893-2016 (Part I). Seismic Analysis Methods, Seismic Coefficient Method – base shear and its distribution along height.	04
4	**Lateral Load Distribution**	**08**
	4.1 Rigid diaphragm, Flexible Diaphragm, Center of mass and stiffness, Uniform and Non-Uniform mass distribution, Torsionally couple and uncoupled system,	02
	4.2 Lateral load distribution in floors with columns or shear walls	06
5	**Ductile Detailing**	**02**
	5.1 Concepts of Detailing of various structural components as per IS: 13920 provisions.	02
6	**Special Topics**	**03**
	6.1 Soil liquefaction, Structural controls system, Structural dampers, base isolation, Seismic strengthening.	03
	Total	**42**

List of Experiments:

Sr. No	Topic name	No. of Hours
1	Spring Mass Model	2
2	Mode shape of 3 storey building	4
3	Response of structure with and without shear wall and bracing system	2
4	Response of building with re-entrant corner	2
5	Behaviour of structure under pounding	2
6	Liquefaction potential of clayey & sandy soil	2

List of Tutorials

Sr. No	Topic name	No. of Hours
1	Calculate the response of free undamped and damped vibration.	2
2	Calculate base shear using Seismic coefficient method.	4
3	Calculate base shear using Response Spectrum Method	2
4	Calculate the lateral load in various lateral load resisting element according to its centre of mass and stiffness.	4
5	Prepare the structural drawing of the different elements by considering the provisions of Ductile Detailing.	2

Suggested Theory Distribution

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve an effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
5%	20%	30%	25%	10%	10%

Instructional Method and Pedagogy:

1. At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
2. Lectures will be taken in class room with the use of multi-media presentations, white board– mix of both.
3. Attendance is compulsory in lectures and laboratory which carries a 5% component of the overall evaluation.
4. Minimum two internal exams will be conducted and average of two will be considered as a part of continuous evaluation
5. Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval. It carries a weightage of 5%.
6. Surprise tests/Quizzes will be conducted which carries 5% component of the overall evaluation.
7. The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.

Recommended Study Material

1. Shrikhande, Manish., & Agrawal, Pankaj., Earthquake Resistant Design of Structures, PHI Publication, New Delhi, 2010.
2. Duggal, S. K., Earthquake resistance design of structures; Oxford University Press, New Delhi, 2010.
3. Chopra, A. K., Dynamics of Structures: theory and applications to earthquake engineering, Pearson Education, New Delhi, 2012.
4. Clough, R. W., & Penzien, Joseph; Dynamics of structures, MacGraw Hill, 2010.
5. Mario, Paz., Structural Dynamics: theory and computation, CBS Publishers & Distributors Pvt. Ltd, 2004.
6. Kramer, Steven., "Geotechnical Earthquake Engineering", Pearson Education, 2013.
7. Biggs; John., "Introduction to Structural Dynamics" Tata MacGraw Hill Education, 2012.
8. S S Rao; "Mechanical Vibration"; Pearson, New Delhi, 2010.
9. C V R Murthy - Earthquake Tips, NICEE, IITK-BMTPC.
10. IITK-GSDMA EQ26 – V -3.0 Design Example of a Six Storey Building

IS Codes:

1. Criteria for earthquake resistant design General provision & Building - IS: 1893 (Part I)- 2016
2. Code of Practice for Ductile Detailing of RC Structures - IS: 13920 (2016).
3. Code of Practice for earthquake resistant design & Construction of buildings – IS 4326 (2013).
4. Guide lines for Improving Earthquake Resistance low strength masonry buildings - IS 13828 (1993)

Web Links

1. https://www.nicee.org/EQTips.php
2. www.nicee.org
3. www.eeri.org
4. www.gsdma.org
5. www.ndma.gov.in
6. www.nptel.iitm.ac.in/courses