



BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 10.03.2021

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : CE G615
Course Title : Earthquake Engineering
Instructor-in-Charge : Ravi Kant Mittal

1. Course Description:

Earthquake Engineering course is mainly aimed to provide procedures and design provisions to be considered for earthquake resistant design of different structural components. The course deals with various aspects of seismic design, detailing and construction of buildings, bridge, tanks, chimneys, retaining structures. Earthquake codes and their provisions are to be studied in-depth.

2. Scope and Objective of the Course: Earthquakes are one of the most destructive forces that nature unleashes on earth. Since earthquakes are so far unpreventable and unpredictable, the only course open to us is to design and construct the structure in such a manner that the loss of property and life is minimized. Objective of the course is to know the various aspects in the analysis, design and detailing in order to produce safe and economical EQ resistant structures.

3. Text Books:

- T1. Agarwal, P. and Shrikhande, M. (2006), "Earthquake Resistant Design of Structures" Prentice-Hall of India.
T2. Jain, A. K. (2016), "Dynamics of Structures with MATLAB Applications" Pearson India Education services Pvt. Ltd.

4. Reference Books:

- R1. Duggal, S. K. (2013), "Earthquake Resistant Design of Structures" Oxford University Press.
R2. Saran, S. (2012), "Analysis and design of foundations and retaining structures subjected to seismic loads" I K Lee Publishers.
R3. Kramer S.L. (1996), "Geotechnical Earthquake Engineering" Pearson Education.
R4. Subramanian, N. (2013), "Design of Concrete Structures" Oxford Univ. Press.
R5. IS: 1893(All parts), 4326, 13827, 13828, 13920, 13938, 16700 and other relevant BIS and International, codes

5. Course Plan:

Module	Lecture Session	No of Lec.	Ref. to Ch.	Learning Outcome
Introduction to EQ Engineering	Importance and scope of the course, seismic hazard mitigation.	1	1T1.	EQ resistant design concept and economy
Engineering seismology	Causes of earthquake, seismic waves, magnitude and intensity, Seismic hazard in India and development of seismic zoning map.	2	1,2,T1; Notes	Understanding the basic introduction to seismology and the importance of associated concepts



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Site Characterization	EQ ground motion parameters, dynamic soil properties, and local site effects. Liquefaction of soils.	2	3,4,5,T1; 2R2.	Determining site characteristics and seismic Hazard.
Introduction to Earthquake Resistant Design	EQ resistant design philosophy, basic principles of EQ resistant design, load combination, regular and irregular buildings, Codal provisions of IS: 1893- 2016 (Part-1) for multi-storeyed buildings.	4	IS:1893-Part1; 12, 14,15, T1; 12, T2; 5, R1.	Understanding basic EQ resistant design philosophy and the codal provisions related to it.
Earthquake analysis of Structures	EQ analysis of buildings using equivalent lateral load analysis based on approximate fundamental natural period of buildings. Response spectra of IS1893-part1.	1	8, 12 T2.	EQ analysis using equivalent lateral load analysis
	Mode Superposition method, Modal combination rules using absolute sum, SRSS and CQC method. Time history method of analysis for EQ analysis of multistory buildings.	3	16,18 T1; 12 T2; IS:1893-Part1.	Determination of EQ forces using dynamic analysis
Seismic Soil-Structure Interaction (SSI)	Soil-Structure Interaction (SSI) effects and the effect of its inclusion in seismic analysis of buildings, chimney, stack like structure, Guideline in International code of practice related to SSI	3	IS1893-part4-2015and notes	EQ analysis considering SSI.
EQ resistant analysis and design of Chimneys and other Stack like structures	Seismic design aspects of chimneys, stack like structures etc., IS 1893-part4 guidelines	3	Ch11, T2, IS1893Part 4.	Understanding the guidelines for EQ resistant design of Chimneys
Design of non-structural members	Seismic analysis and design of non-structural members, case histories	2	10-R1. IS:16700 (2017)	Basic introduction to seismic design of non-structural members
Non-Engineered Structures	EQ resistant guidelines and provisions for non-engineered buildings, Improving EQ resistance of earthen, stone masonry, buildings.	3	6, R1; IS:4326; IS:13827; IS:13828.	Earthquake resistant design of non-engineered construction
Seismic Liquefaction	Phenomena of liquefaction and Factors Affecting Liquefaction, Various methods of evaluation of liquefaction. Anti-liquefaction measure. Code of practice.	3	2,R2; 9,12, R3;Lec. Notes.	Evaluation of liquefaction and Remedial measure
Seismic Design of Foundations	Dynamic bearing capacity and Seismic design of shallow, Codal provisions.	2	4R2;Lec. Notes.	Seismic analysis & design consideration for shallow foundation
	Seismic design of deep foundations. Lateral load, moment and displacement due to earthquake, . Plies in liquefiable soil. Codal provisions.	2	5R2;Lec. Notes.	Seismic analysis & design consideration for deep foundation
EQ resistant design of Retaining Walls	Seismic earth pressure, c- ϕ soils, Displacement based seismic design consideration for retaining structures.	3	IS-1893 Part-3; 3,7,8,9,10R2; 11,R3.	Seismic Analysis and design of retaining structures
EQ resistant design of bridges	Principles of seismic design of bridges, hydrodynamic pressure,	3	IS-1893 Part-3; 7, 10,11,R3.	Provisions forEQ resistant design of bridges



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EQ resistant design of Water tanks	Seismic analysis and design of water/ liquid storage tanks	3	IS1893- Part 2 and Part 4.	Understanding the guidelines for seismic design of Water tanks
Ductile Detailing of Structures and members	Causes of failure of RCC structures, case studies. Concept of ductility, design and detailing of Beams, columns, joints as per 13920, strong columns and weak beams concept.	4	20,T1; 8,R1;IS:13920; Ch13, R4.	Seismic design and ductile detailing of various elements and structures
Seismic Retrofit and Isolation	General Introduction to seismic retrofitting of super-structural and sub-structural elements, Base isolation, energy dissipation devices	2	13, 14, T2Lec. Notes	Insight on the seismic retrofitting measures, seismic protection recent advancement

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid Sem. Test	90 minutes	25%		Close Book
Literature review, seminar and project		20%	Continuous	OB
Term paper		10%	Continuous	OB
Assignment (during class or take home)		10%	Continuous	OB
Comprehensive Examination	120 minutes	35%		Close Book

7. Chamber Consultation Hour: To be announced in the class.

8. Notices: Notices will be sent to your BITS email id only.

9. Make-up Policy: Make will be given for genuine cases only.

10. Note (if any): Reading assignments will be given as and when necessary.

Instructor-in-charge

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