B.E. Semester: VIII

Department of Civil Engineering

Subject Name: Earthquake and Wind Engineering (CV802-N)

Course Category: Program Course Core (PCC)

A. Objectives of the Course:

- To provide a coherent development to the students for the courses in sector of earthquake engineering and wind engineering
- To give an experience in the implementation of engineering concepts those are applied in field of earthquake engineering and wind engineering
- To involve the application of scientific and technological principles of planning, analysis, design of buildings according to earthquake design philosophy
- Students will get the experience of analysis of RC frame structures using old and revised version of IS 1893, IS 13920 and IS 875 Part 3 and thus they will understand the differences in both version of IS standards
- Students will learn the calculations of wind forces on industrial roof truss

B. Teaching & Evaluation Scheme:

Teaching Scheme				Credit	Evaluation Scheme					Total Marks
L hrs	T hrs	P hrs	Total Hrs		Theory		IE	CIA	Pra/Viva	
					Hrs	Marks	Marks	Marks	Marks	
3	0	2	5	4	3	70	30	20	30	150

C. Detailed Syllabus:

1. Introduction to Dynamic Loads:

Static Load v/s Dynamic Load, Types of Dynamic Forces with time vs displacement graph

<u>Earthquake Engineering</u>

2. Basics of Seismology:

Earth and its interior, Plate Tectonics, Convection Currents, The Earth quake, Inter Plate Earthquake (Convergent Boundaries, Divergent Boundaries and Transform Boundaries), Intra Plate Earthquake (Faults and Types of Faults), Seismic Waves, Basic Terminology, Measuring Units and Instruments

3. Behaviour of Structures during Earthquake and Earthquake Resistant Features:

Introduction to Inertia Forces in Structures,

Behaviour of Brick Masonry Structures – Behaviour of Brick Masonry Walls, Box Action, Different types of Bands, Types of Mortar

Behaviour of Stone Masonry Structures – Behaviour of Stone Masonry Walls, Earthquake Resistant Features of Stone Masonry Structures

Behaviour of RC Structures: Load Transfer Path, Strength Hierarchy, Centre of Mass and Centre of Stiffness, Importance of Beam Column Joints, Importance of Stiffness and Ductility (Capacity Design Concept) in Structures,

Effect of:Short Column, Soft Storey, Weak Storey Improper Detailing, Masonry Infill Walls, Eccentricity, Pounding, Floating Columns, Flexibility and Setbacks,

Earthquake Resistant Features of RC Structures, Earthquake Design Philosophy

4. Fundamentals of Earthquake Vibrations of Structures:

Equation of Motion (By Newton's Law and By D'Alembert's Principle), Degrees of Freedom, Simplified Single Degree of Freedom, Mathematical Modeling, Equation of Motion for Free Vibration for Damped and Un-damped System (Single Degree of Freedom System), Equation of Motion for Forced Vibration for Damped and Un damped System (Single Degree of Freedom System), Logarithmic Decrement

5. Analysis of Structures for Earthquake:

Introduction of IS 1893: 2002 and2016, Introduction to Methods of Lateral Load Analysis (Linear Static, Linear Dynamic, Non Linear Static, Non Linear Dynamic), Analysis of RC Building by Linear Static Method (Seismic Coefficient Method) as per IS 1893: 2016 (Part I)

6. Special Topics:

Introduction to Soil Liquefaction and Structural Controls, Ductile Detailing IS 13920: 2016

Wind Engineering

7. Behaviour of Structures during Wind and Wind Resistant Features:

Behaviour of RC Structures, Wind Bracing, Flexibility and Stiffness

8. Wind Load Analysis on Structures:

Introduction of IS 875 (Part - 3): 1987 and 2016, Introduction to methods of Wind Load Analysis, Analysis of RC Frame Structure and Truss by Static Method using IS 875 (Part - 3): 1987 and 2016

D. Lesson Planning:

Unit No	Title of the Unit	Minimum Hours	Weightage (%)
1	Introduction to Dynamic Loads	01	02
2	Basics of Seismology	02	04
3	Behaviour of Structures during Earthquake and Earthquake Resistant Features	12	27
4	Fundamentals of Earthquake Vibrations of Structures	12	27
5	Analysis of Structures for Earthquake	06	15
6	Special Topics	03	06
7	Behaviour of Structures during Wind and Wind Resistant Features	02	04
8	Wind Load Analysis on Structures	07	15
	Total:	45	100

E. Assignments:

- Minimum 6 questions from each sub topics
- Presentation on EQ Tips

- Drawing Sheets for Ductile Detailing in A3 size Graph Papers
- Minimum 20 Examples from the topic Fundamentals of Earthquake Vibrations of Structures
- 2 Examples for Static Analysis of RC Frame for EQ Load
- 2 Examples for Static Analysis of RC Frame and Steel Truss for Wind Forces
- Presentation Comparison of Old and Revised Codes IS 1893, IS 13920 and IS 875 (Part 3)
- Presentation on Past Major Earthquakes
- Model Preparation for Practical on Shake Table

F. Instructional Method and Pedagogy (Continuous Internal Assessment Scheme CIA):

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lecture may be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lectures, practical and Tutorial which carries 05 Marks.
- At regular intervals assignments is given. In all, a student should submit all assignments of 05 marks each.
- Classroom participation and involvement in solving the problems in Tutorial rooms carries 05 Marks.
- Viva Voce will be conducted at the end of the semester of 05 Marks.
- One internal exam of 30 marks is conducted as a part of Mid Semester evaluation.

G. Students Learning Outcomes:

On the successful completion of this course

- The students will gain an experience in the implementation of Earthquake Engineering on engineering concepts which are applied in field Structural Engineering.
- The students will be able to identify the behaviour and modes of failure in brick masonry, stone masonry and RC framed building and thus will be able to design earthquake resistant features in the buildings

- The students will learn to calculate member response of single degree of freedom system under dynamic earthquake force for free and forced vibration
- The students will learn to calculate static earthquake forces in RC buildings using IS 1893 – 2016
- The students will learn to calculate static earthquake forces using IS 1893 – 2016
- The students will be able to identify the behaviour and modes of failure in brick masonry, stone masonry and RC framed building and thus will be able to design wind resistant features in the buildings
- The students will learn to calculate static wind forces in RC buildings using IS 875 – 2016 (Part – III)

H. Recommended Study Materials:

a. Text book & Reference Books:

1. Earthquake Resistant Design of Structures by PankajAgarwal& Manish Shrikhande, PHI Publications
2. Manish Shrikhande&PankajAgrawal; Earthquake Resistant Design of Structures, PHI Publication, New Delhi
3. S. K. Duggal; Earthquake Resistance Design of Structures; Oxford University Press, New Delhi
4. A. K. Chopra; Dynamics of Structures, Pearson, New Delhi
5. Clough &Penzin; Dynamics of Structures
6. Park &Pauly; Behavior of R.C Structures
7. John M. Biggs; Introduction to Structural Dynamics
8. S S Rao; Mechanical Vibration; Pearson, New Delhi
9. IITK-bmtpc, Earthquake Tips "Learning Earthquake Design and Construction" by C.V.R.Murthy, Building Material and Technology Promotion Council
10. IITK – GSDMA EQ 26 – V- 3.0 Design Example of a Six Storey Building
11. Structural Dynamics: Concepts and Applications, Busby, Henry R., author.; Staab, George H

b. Web Materials:

1. http://www.cdeep.iitk.ac.in/nptel
2. http://www.nptel.iitm.ac.in

c. Indian Codes of Practice:

1. IS: 1893 (Part-I) 2002, 2016 Criteria for Earthquake Resistant Design General Provision to Building
2. IS: 13920 (1993 and 2016), Code of Practice for Ductile Detailing of RC Structures
3. IS: 4326 (1993), Code of Practice for Earthquake Resistant Design and Construction of Buildings
4. IS: 13827 (1993), Improving Earthquake Resistance of Earthen Buildings
5. IS: 13828 (1993), Guide lines for Improving Earthquake Resistance of low Strength Masonry Buildings