

B.E. Semester: VIII
Civil Engineering
Subject Name: EARTHQUAKE ENGINEERING (CV801)

A. Course Objective:

- To provide a coherent development to the students for the courses in sector of earthquake engineering
- To present the foundations of many basic engineering concepts related earthquake Engineering
- To give an experience in the implementation of engineering concepts which are applied in field of earthquake engineering
- To involve the application of scientific and technological principles of planning, analysis, design of buildings according to earthquake design philosophy.

B. Teaching /Examination Scheme

Teaching scheme				Total Credit	Evaluation Scheme					Total
L	T	P	Total		Theory		Mid Sem Exam	CIA	Pract/ Tut.	
Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	
03	00	02	05	04	03	70	30	20	30	150

C. Detailed Syllabus:

UNIT-I Introduction to Dynamic Loads

Static Load v/s Dynamic Load, Types of Dynamic forces, Force Control and Displacement Control

UNIT-II 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

UNIT-III Behavior of Structures During Earthquake and Earthquake Resistant Features of Structure

- a) Inertia forces in structures
- b) Behavior of Brick Masonry Structures: Behavior of Brick Masonry Walls, Box Action, Different types of Bands
- c) Behavior of Stone Masonry Structures: Behavior of Stone Masonry Walls, Earthquake Resistant Features of Stone Masonry Structures

- d) Behavior of RC Structures: Load Transfer Path, Strength Hierarchy, Reversal of Stresses, Importance of Beam Column Joints, Importance of Stiffness and Ductility (Capacity Design Concept) in Structures, Effect of Short Column, Effect of Soft Storey, Improper Detailing, Effect of Masonry Infill Walls, Effect of Eccentricity, Effect of Pounding, Effect of Floating Columns, Effect of Flexibility and Effects of Setbacks, Earthquake Resistant Features of RC Structures
- e) Earthquake Design Philosophy

UNIT IV 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

UNIT V Earthquake Load Analysis on Structures

Introduction to methods of Earthquake Load Analysis (Linear Static, Linear Dynamic, Non Linear Static, Non Linear Dynamic)

Analysis of Structure by Linear Static Method (Seismic Coefficient Method)

Analysis of Structure by Linear Dynamic Method (Random Response Method)

UNIT VI Ductile Detailing

UNIT VII Special Topics

- a) Introduction to Soil Liquefaction
- b) Structural Controls
- c) Seismic Strengthening

D. Lesson Planning

Unit no	Title of the Unit	Minimum Hours	Weightage (%)
I	Introduction to Dynamic Loads	01	03
II	Basics of Seismology	01	05
III	Behavior of Structures During Earthquake and Earthquake Resistant Features of Structure	11	25
IV	Fundamentals of Earthquake Vibrations of Structures	11	20
V	Earthquake Load Analysis on Structures	11	20
VI	Ductile Detailing	5	17
VII	Special Topics	5	10
TOTAL		45	100

E. List of Experiments:

Experiment No.	Name of Experiment
1	Spring Mass Model
2	Mode Shapes
3	Shear Wall and Bracing Systems
4	Pounding and “L” shape effect
5	Liquefaction

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 and practical which carries marks.
- At regular intervals assignments will be given. Students should submit all assignments during given period.
- Classroom participation and involvement in solving the problems in Tutorial rooms carries marks
- Internal exam of 30 marks will be conducted as a part of mid semester evaluation.
- Experiments shall be performed in the field related to course contents.
- The course includes a practical, where students have an opportunity to build an appreciation for the concept being taught in lectures.

G. Students Learning Outcomes:

- 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 get a diverse knowledge of earthquake engineering practices applied to real life problems
- The students will learn to understand the theoretical and practical aspects of earthquake engineering along with the planning and design aspects.

H. Term Work

- Presentation on Great Indian Earthquake and on great International Earthquake
- 25 examples on Unit IV

- Excel Sheet for seismic coefficient method and Random Response Method with manual checking
- Presentation on Each IITK-bmtpc Tips
- Analysis, Designing and Detailing of G+3 RC Frame Structure Considering Earthquake Loads

I. Recommended Study Materials

A. Reference Books and IS Codes:

1. Earthquake Resistant Design of Structures By Pankaj Agarwal & Manish Shrikhande, PHI Publications
2. Manish Shrikhande & Pankaj Agrawal; 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. IS: 1893 (Part-I) 2002, Criteria for Earthquake Resistant Design General Provision to Building
10. IS: 13920 (1993), Code of Practice for Ductile Detailing of RC Structures
11. IS: 4326 (1993), Code of Practice for Earthquake Resistant Design and Construction of Buildings
12. IS: 13827 (1993), Improving Earthquake Resistance of Earthen Buildings
13. IS: 13828 (1993), Guide lines for Improving Earthquake Resistance of low Strength Masonry Buildings
14. IITK-bmtpc, Earthquake Tips “Learning Earthquake Design and Construction” by C.V.R.Murthy, Building Material and Technology Promotion Council
15. IITK – GSDMA EQ 26 – V- 3.0 Design Example of a Six Storey Building

B. Web Materials:

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