HONORS
IN
EARTHQUAKE-RESISTANT STRUCTURES

Outcome of the course:

- Students who take this course will gain a thorough, critical understanding of advanced seismology and earthquakes.
- Students will gain an understanding of advanced concrete technology.
- Students who take this course will gain a basic knowledge of structural dynamics.
- Students will gain a detailed understanding of Seismic Design Philosophy construction technique of structures.

Course structure

Subject code	Subject name	Dept	Sem	L	T	P	Credit
CE10314A	Engineering Seismology	CE	IV	3	0	0	3
CE10315A	Advanced Concrete Technology	CE	V	3	0	0	3
CE10316A	Introduction to Structural Dynamics	CE	VI	3	0	0	3
CE10317A	Earthquake Design and Construction	CE	VII	3	0	0	3
CE10701A	Seminar	CE	VII	0	0	1	1
CE10603A	Project	CE	VII	0	0	14	7
	Total Credit			**12**	**0**	**15**	**20**

ENGINEERING SEISMOLOGY [3 0 0 3]
Subject code: CE10314A

Course Outcomes:

CO1: Critical understanding of advanced seismology and causes of earthquakes.
CO2: Rememberingthe seismic hazard and a detailed understanding of wave equations and their solutions.
CO3: Assess the design basis ground motion parameters and its application in earthquake engineering for disaster mitigation.
CO4: Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.
CO5: Predictionof earthquake – a brief idea.

Module no.	Description	Hours
01.	Propagation of earthquake Waves, Body & surface waves, laws of reflection, refraction and attenuation, travel times curves, internal structure of earth.	**7**
02.	Seismicity of earth, major earthquakes in the world, important Indian Earthquakes, earthquake catalogs, plate tectonics, causes of earthquakes. Magnitude, energy, intensity, acceleration, return period, frequency, Ground motion characteristics.	**12**
03.	Earthquake recording instruments, seismographs, different modes of recording analogue, digital, micro earthquake, teleseismic, local, strong motion, band width and their engineering implications.	**8**
04.	Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.	**7**
05.	Introduction to earthquake prediction– a brief idea.	**4**
	Total	**38**

References:

1. Richter,C.F. Elementary Seismology,Eurasia Publishing House (Pvt)LTD,New Delhi
2. Agrawal,P.N.,Engineering Seismology,Oxford & IBH Publishing Co.Pvt.Ltd,New Delhi
3. Aki,K and Richard, P.G.Quantitative seismology, Theory and Methods,Vol.I and II,W.H. Freeman & Co.
4. Rikitake,T.,1976 Earthquake Prediction, Elsevier Science, Amsterdam
5. Oldham,1989 Report on Great Earthquake of 12th June 1897, Memoir Geological Survey of India,V29.
6. Latest Codes of IS-1893-part-I 2016.

ADVANCED CONCRETE TECHNOLOGY [3 0 0 3]

Subject code: CE10315A

Course Outcomes:

CO1: Remembering advanced concrete terminology.
CO2: Understanding mixed design of concrete, high strength of concrete requirements for advanced concrete.
CO3: Remembering and understanding to use plasticizers, effect of water cement ratio and super plasticizers used in the construction works.
CO4: Analyzing the various Non Destruct Test (NDT)
CO5: Analyzing and evaluating the durability and fire hazards in concrete.

Module no.	Description	Hours
01.	**Concrete science:** Standards – specifications – Ingredients - cement and its types – Coarse Aggregate – Fine Aggregate, Chemical admixtures - Mineral admixtures - Polymer concrete, Mix design - Mix Design by IS :10262-2019 - Mix Design by ACI :312 - Other methods of mix design.	**08**
02.	**Concrete Types:** Normal Vibrated Concrete - High volume fly ash concrete - High strength concrete - Ready mix concrete, pervious concrete, Fiber Reinforced concrete –Self compacting concrete – Bacterial Concrete - Self curing concrete - Geopolymer Concrete. Useof waste materials in concrete:Waste from industry - Recycled aggregates – Sustainability, Green concrete - Eco-Friendly Concrete.	**11**
03.	**Durability and fire hazards in concrete:** Deterioration of concrete - Factors effecting the durability - Sulphate attack - Acid attack, Alkali Aggregate reaction – Carbonation – Abrasion.	**07**
04.	**Non Destruct Test (NDT):** Rebound Hammer Test - Ultrasonic pulse velocity test - Core Extraction for Compressive Strength Test - Windsor Probe System – pull out resistance test – pull off test.	**06**
05.	**Under Water Concrete:** Concrete in Cold weather - Concrete in Hot weather - miscellaneous topics.	**06**
	Total	**38**

References:

1. Concrete Materials, Properties, Specification and Testing by S. Popovics, Standard Publishers, India.
2. Properties of Concrete by A.M. Neville, ELBS Ed.
3. Waste Materials in Concrete Manufacture by Satish Chandra, Indian Standard Publishers
4. Non-destructive Testing in Concrete by Bungey, Surrey University Press, London.
5. IS 456, (2000), Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.
6. M. S. Shetty, Concrete Technology: Theory and Practice.
7. M.L. Gambhir, Concrete Technology.

INTRODUCTION TO STRUCTURAL DYNAMICS [3 0 0 3]

Subject code: CE10316A

Course Outcomes:

CO1: Understanding the basic knowledge of structural dynamics.
CO2: Remembering and understanding the Single degree of freedom system.
CO3: Application of Multi degree of freedom system in earthquake engineering.
CO4:Analysis of the analysis of multi-degree of freedom un-damped systems – Raleigh method, Power Method
CO5:Analysis of Static and dynamic structures.

Module no.	Description	Hours
01.	**Introduction:**Objectives, dynamic loading, types of dynamic problems. Formulation of equations of motion: a) D'Alembert's principle b) Principle of virtual work c) Variational approach.	04
02.	**Single Degree of Freedom Systems:** Components of the system, un-damped and damped free vibrations, logarithmic decrement, Forced vibrations due to harmonic excitation – steady state and transient response, transmissibility, vibration isolation, Forced vibrations due to general dynamic loading.	14
03.	**Multi-Degree of Freedom Systems:** Equations of motion, un-damped and damped free vibration, eigenvalues and eigen vectors, orthogonality conditions.	08
04.	**Damping**: Free vibration of shear buildings with and without damping, Approximate methods for the analysis of multi-degree of freedom un-damped systems – Raleigh method, Power Method.	04
05.	**Static and dynamic Analysis of structures:** Static and Response spectrum and Time history method.	08
	Total	38

References:

1. Rao, S.D., (1995), 'Mechanical Vibrations',3rd ed., Addison Wesely, NewYork, 19.
2. Chopra A.K., (2001), 'Dynamics of structures– Theory and application to Earthquake Engg.' Prentice - Hall of India Pvt. Ltd.New Delhi.
3. Seto, (1964), 'Mechanical vibrations, Schuam's Outline Series', McGraw Hill, Book Co., New York 19.
4. Jai Krishna, Chandrasekaran, A.R. and Brijesh Chandra, (1994), 'Elements of Earthquake Engg'., 2nd ed., South Asian Publishers, New Delhi,
5. Thansi by W.T, (1988), 'Theory of vibration – with Applications', C.B.S. Publishers and Distributors, New Delhi.
6. Paz. M, (2004), 'Structural Dynamics', 2nd ed., C.B.S. Publishers and Distributors, New Delhi.
7. Mukhopadhay., (2000), 'Vibrations of structures and structural systems' Oxford and IBH, New Delhi.
8. Biggs J.M., 'Introduction to structural dynamics' (McGraw Hill publications)
9. Clough and Penzien, (1993), 'Dynamics of structures' – McGraw Hill publications.

EARTHQUAKE DESIGN AND CONSTRUCTION [3 0 0 3]

Subject code: CE10317A

Course Outcomes:

CO1: Critical understanding of advanced seismology and causes of earthquakes.

CO2: Understanding and remembering the Seismic Design Philosophy and geometric configuration of buildings.

CO3: DistinguishMasonry Buildings and Reinforced Concrete Buildings.

CO4: Categorize the importance of Open Ground Storey, Short Columns, Shear walls.

CO5: Evaluate Load Paths, Non-structural Elements, Confined Masonry Construction, Sinking of Buildings, Quality controlduring Earthquakes.

Module no.	Description	Hours
01.	Causes of Earthquakes. Ground shaking, Seismic Zones, Seismic Effects on Structures, Indian Seismic Codes.	**3**
02.	Architectural Features Affect, Twisting of Buildings During Earthquakes, Seismic Design Philosophy of Buildings, Ductile Buildings for Good Seismic Performance, and Flexibility of Buildings.	**5**
03.	Earthquake response of Brick Masonry, Structural Configuration of Masonry Buildings, Importance of horizontal bands in masonry buildings, Importance of vertical reinforcement in masonry buildings, Earthquake Resistant Stone Masonry Buildings. Earthquake Affect in Reinforced Concrete Buildings, Role of Beams and Columns in RC Earthquakes resistant Buildings Resist. Importance of Beam-Column Joints in RC Buildings.	**11**
04.	Effect of Open Ground Storey Buildings, Short Columns Vulnerable during Earthquakes. Shear Walls in Seismic Regions. Reduction of Earthquake Effects on Buildings. Importance of Load Paths in Buildings, Harms Load Paths in Buildings, Importance of Non-structural Elements against Earthquakes.	**11**
05.	Confined Masonry Construction, Essential Features of Confined Masonry Houses, Foundations of Earthquake-Resistant Buildings. Sinking of Buildings into the Ground during Earthquakes, Quality control in Earthquake-Resistant Buildings.	**8**
	Total	**38**

References:

1. BMTPC, (2000), Guidelines: Improving Earthquake Resistance of Housing, Building Materials and Technology Promotion Council, New Delhi.
2. Bridge Rules, (1964), Rules Specifying the Loads for the Design of SuperStructure and Sub-Structure of Bridges and for Assessment of the Strength of Existing Bridges, Government of India, Ministry of Railways (Railway Board).
3. IRC 6, (2000), Standard Specifications and Code of Practice for Road Bridges - Section II: Loads and Stresses, Indian Roads Congress, New Delhi.

4. IS 456, (2000), Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.
5. SP 22 (S&T), (1982), Explanatory Handbook on Codes for Earthquakes Engineering - IS 1893:1975 and IS 4326:1976, Bureau of Indian Standards, New Delhi.
6. Paulay,T., and Priestley,M.J.N., (1992), Seismic Design of Reinforced Concrete Buildings and Masonry.
7. John Wiley, USA Mazzolani,F.M., and Piluso,V., (1996), Theory and Design of SeismicResistant Steel Frames, E&FN Spon, UK.
8. ACI 318, (2005), "Building Code Requirements for Structural Concrete and Commentary," American Concrete Institute, USA.
9. IS 13920, (1993), "Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces," Bureau of Indian Standards, New Delhi.
10. SP 123, (1991), "Design of Beam-Column Joints for Seismic Resistance," Special Publication, American Concrete Institute, USA.

SEMINAR [0 0 11]
Subject code: CE10701A

Serial No	Subject	Objective	Total Credit
1	Seminar	The students are required to undertake innovative and research oriented project under the direct supervision of a faculty member of the department. The Seminar should not only to reflect their knowledge gained in the previous semesters but also to acquire additional knowledge and skills by their own effort. The Seminar will be assigned at the 7^{th} Semester and the final evaluation is carried out at the end of 8^{th} Semester.	01

PROJECT [0 0 147]
Subject code: CE10603A

Serial No	Subject	Objective	Total Credit
1	Project	The students are required to undertake innovative and research oriented project under the direct supervision of a faculty member of the department. The Project should not only to reflect their knowledge gained in the previous semesters but also to acquire additional knowledge and skills by their own effort. The Projects will be assigned at the beginning of the 8^{th} Semester and the final evaluation is carried out at the end of 8^{th} Semester.	07