SYLLABUS PRESCRIBED FOR
TWO YEAR P.G. COURSE IN
MASTER OF ENGINEERING
(FULL TIME)
CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)
SEMESTER : FIRST

1SFSE1 INTRODUCTION TO EARTHQUAKE ENGINEERING

Interior of earth, Engineering geology of earthquakes, plate tectonics, Seismicity of the world, tectonics features of India, Faults, Propagation of earthquake waves, Quantification of earthquake (magnitude, energy, intensity of earthquake), Measurements of earthquake (accelerograph, accelerogram recording), Determination of magnitude, Epicental distance, focal depth, etc. Ground motion and their characteristics, Factors affecting ground motions

Guidelines for achieving efficient seismic resistant planning, selection of sites, importance of architectural features in earthquake resistant buildings , continuity of construction, projection & suspended parts, special construction features like separation of adjoining structure, crumble section ,stair case etc, twisting of building, seismic effects on structures, inertia forces, horizontal & vertical shaking

Indian seismic codes, Behavior of masonry structure during earthquake, bands & reinforcement in masonry building opening in walls, importance of flexible structures, Behavior of R.C. building in past earthquakes

Concept of earthquake Resistant design, design philosophy, four virtues of EQRD: Stiffness, Strength, ductility and Configurations, Introduction to Capacity design concepts, Introduction to IS: 1893
Introduction to Soil liquefaction. Geotechnical design considerations.

Reference Books:

1. Dowrick, D. J.; Earthquake Resistant Design for Engineers & Architects; John Willey & Sons; 2nd Edition; 1987
2. Housner, G.W. & Jennings, P.C.; Earthquake Design Criteria, Earthquake Engineering Research Institute; Oakland; California; USA; 1982
3. Newmark, N.M. & Hall, W.J.; Earthquake Spectra & Design; Earthquake Design Criteria, Earthquake Engineering Research Institute; Oakland; California; USA; 1982
4. Wakabayshi, M.; Design of Earthquake Resistant Buildings, McGraw Hill Books Company; 1986
5. Okamoto, S.; Introduction to Earthquake Engineering; University of Tokyo press; 2nd Edition; 1984
6. Kramer, S.L.; Geotechnical Earthquake Engineering; Prentice Hall; New Jersey; 1996
7. Bolt, B.A.; Earthquakes; W. H. Freeman & Company; NY; 1988
8. Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press 2007

1SFSE2 THEORY OF PLATES AND SHELLS

Governing differential equations of thin rectangular Plates with various boundary conditions and loadings.
Introduction, Moment of curvature relation in pure bending, metrical bending of circular plates (Lateral loaded, uniformly loaded with clamped)
Laterally loaded rectangular plates, Differential equation of the deflection surface (Lagrange's equation), Boundary conditions, simply supported plates under sinusoidal loading, Navier's solution.
Finite differential method, differential equation to bent surface of anisotropic plate, Application to grid.
General shell geometry, classifications, stress resultants, equilibrium equation, Membrane theory for family of shells (Parabolic, Quaternary, Cycloid, Circular, hyperbolic).
Classical bending theories of cylindrical shells with and without edge beams, Finster Walder Theory, Schorer's Theory
Approximate analysis & design of cylindrical shells.

Reference Books:

1. Timoshenko, S. P. & Kriegar, W.; Theory of Plates & Shells; McGraw Hill; NY; 1970
2. Szilard, R.; Theory and Analysis of Plates; Prentice Hall; 1974
3. Novozhilov, V.V.; Thin Shells; Noordho of Groningen; 1964
4. Ramaswamy G. S., Design of Concrete Shells; Krieger Publication Co.; 1984
5. Chandrasekhar K.; Theory of Plates; University Press India Ltd.; Hyderabad; 1st Edition; 2001

1SFSE3 COMPUTER METHODS OF STRUCTURAL ANALYSIS

Objective:
The objective of this course is to understand the basic of structural analysis using stiffness approach, understand the concept of mathematical model of structure and hand on training on computer to solve problems.

Syllabus:
Memory problems in large structural systems: Incore & outcore techniques, half band storage and solution, sky line storage technique and solution, frontal technique

Flexibility method (structure approach) - flexibility coefficient. , physics meanings, basic determinant or released structure, choice of redundant, geometrical compatibility conditions. Matrix formulations, hand solution of simple problems on truss, beams, frames, with loads

Introduction to stiffness and flexibility approach, Stiffness matrix for spring, Bar, torsion, Beam (including 3D), Frame and Grid elements, Displacement vectors, Local and Global co-ordinate system, Transformation matrices, Global stiffness matrix and load vectors, Assembly of structure stiffness matrix with structural load vector, Analysis of plane truss, plane frame, plane grid and space frames subjected to joint loads.

Analysis for member loading (self, Temperature & Imposed) Inclined supports, Lack of Fit, Initial joint displacements. , Plane frame with effect of shear deformation, Global load vector for rigid jointed plane frame.

Reference Books:

1. Cheng, F.Y.; Matrix Analysis of Structural Dynamics; M. Dekke; NY; 2000
2. Kanchi M. B.; Matrix Methods of Structural Analysis; John Willey & Sons; 2nd Edition; 1999
3. Bathe, K.J.; Finite Element Procedures; Springer; 2nd Edition; 2002
4. Kasmali Aslam; Matrix Analysis of Structures; Brooks/Cole Publishing Co.; 1999
5. Cook R. D. et. al; Concepts and Applications of Finite Element Analysis; John Willey & Sons; NY; 1995
6. Gere W. and Weaver J. M.; Matrix Methods of Structural Analysis, 3rd Edition; Van Nostrand Reinhold; New York; 1990
7. Martin; H.C.; Introduction to Matrix Method of Structural Analysis; McGraw Hill Book Co.; 1966

Pre-requisite:
Knowledge of Matrices, Solution of simultaneous equations by using Gauss-Seidal, Gauss elimination & Crout's Method.

1SFSE4 STRUCTURAL DYNAMICS

Sources of vibration, types of excitations, Spring action and damping; Degrees of freedom; Application of Newton's laws, D'Alembert's principle, Single degree of freedom systems; Mathematical model of physical systems; free vibrations, damped free vibrations, critical damping, and response, periodic loading expressed in harmonics, dynamic load factor.

Single degree freedom system, response to impulsive loading, rectangular, triangular pulses, Duhamel Integral. Response to general dynamic loading, Numerical schemes such as Wilson-Theta, Newmark-Beta, constant linear acceleration & time domain and frequency domain analysis.

Multi-degree freedom system, stiffness and flexibility approaches, Lumped-mass matrix, free vibrations fundamental Frequencies and mode shapes, orthogonality of, response to dynamic loading, Formulations of equations of motion, mode superposition method, modal matrix, numerical scheme of iteration method.

Vibration of Continuous Systems: Free vibrations of Continuous systems-axial and transverse vibration of bars / beams. Response of continuous systems to dynamic loads. Rayleigh-Ritz method.

Structural response to earthquake, Response spectrum design earth quake, IS code provisions for multistory frames.

Reference Books:

1 Chopra, A. K.; Dynamics of Structures; Prentice Hall; 1995
2 Clough, R.W.; & Penzin, J.; Dynamics of Structures; McGraw Hill; 1993
3 Humar J. L.; Dynamics of Structures; Prentice Hall; 1990
4 Mario, Paz; Structural Dynamics; CBS Publ.; N-Delhi; 1995
5 Timoshenko, S.; Advanced Dynamics; McGraw Hill Book Co; NY; 1948
6 Meirovitch L.; Elements of Vibration Analysis; 2nd Edition; McGraw Hill International Edition; Singapore; 1986
7 Biggs, J.M.; Introduction to Structural Dynamics; McGraw Hill; NY; 1964

1SFSE5 EARTHQUAKE RESISTANT DESIGN OF REINFORCED CONCRETE STRUCTURES

Review of Limit State Design of RC members. Confinement of concrete
Philosophy of earthquake resistant design, Ductility, Redundancy & Over strength, Damping, Supplemental Damping, Base Isolation, Codal Provisions. Seismic behaviour of concrete,
Beams (Flexural, Shear and torsion)
Uni-axial and biaxial Beam-column (Axial, shear and moments)
Building frames, frame-shear wall buildings, Braced Buildings, Preliminary sizing and Mathematical modeling of buildings with different structural systems with and without diaphragms,
Earthquake, wind and other (i.e. blast, snow) load calculations along with dead load and live loads and their combinations.
Special aspects in Multi storied buildings: Effect of torsion, flexible first story, P-delta effect, effect of soil-structure interaction on building response, drift limitation.
Analysis and Design of multi-storied buildings with masonry infill,

Reference Books:

1. Paulay T. and Prestiley M.J.N.; Seismic design of R C & Masonry Buildings; John Willey & Sons; 2nd Edition; 1999
2. Booth, E.; Concrete Structures in Earthquake Regions; Longman Higher Education; 1994
3. Raynolds C.E.; Reinforced Concrete Design Handbook; 9th Edition; Rupa & Company; Calcutta; 1981
4. Raynolds, C.E.; Basic Reinforced Concrete Design; Vol.-II; Conc. Publications Ltd.; 1962
5. Fintel M.; Handbook of Concrete Engineering; 2nd Edition; CBS Publishers, Delhi; 1986
6. Park and Paulay; Reinforced Concrete Structures, John Wiley and Sons
7. Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press 2007

1SFSE6 EARTHQUAKE RESISTANT DESIGN OF REINFORCED CONCRETE STRUCTURES: STUDIO

Complete Design calculations and Drawings to be developed for a multi-storied building based on the above syllabus.

1SFSE7 COMPUTER AIDED ANALYSIS & DESIGN OF STRUCTURES: STUDIO

- Introduction to Computer systems and facilities. Operating systems, Software, Software development processes.

-Introduction to software packages like STAADPRO, STRUDS, SAP-2000, Etab and ANSYS

****

SEMESTER : SECOND

2SFSE1 FINITE ELEMENT METHOD

Introduction to Finite element method, History, Principles & discretization, Applications
Introduction to Rayleigh Ritz Method, Stress strain relationship, strain displacement relationship, Equilibrium equations (Total potential approach, Virtual work approach)
Shape function, Stiffness matrix, load vector for 2-D elements (Plane stress, Plane strain & Axi-symmetric) using Displacement formulation. Cartesian and Iso-parametric element formulation. Numerical Integration, convergence of Isoperimetric elements.
Formulation of 1-D elements (BAR, TORSION, BEAM) and 3-D solid elements.
Computer Implementation of FEM procedure for plane truss, Plane stress, Plane strain and Axi-symmetric problems.
Constraint Equations (Penalty, Lagrangian Method), Patch test, Mathematical modeling of structures.

Reference Books:

1. Zienkiwicz O. C. & Taylor, R. L.; Finite Element Method; Vol-I, II & III; Elsevier; 2000
2. Hughes, T .R. J.; Finite Element Method; Dover Publication; 2000
3. Bathe, K.J.; Finite Element Procedures; Pringor; 2nd Edition; 2002
4. Reddy, J. N.; Finite Element Method; John Willey & Sons; 1982
5. Buchanan, G.R.; Finite Element Analysis; McGraw Hill Publ.; NY; 1995
6. Belegundu A.D. & Chandrupatla T.R.; Finite Element Method in Engineering; Prentice Hall India; 1991
7. Pilkey W.D. & Wunderlich W.; Mechanics of Structures, Variation and Computational Methods; CRC Press; 2nd Edition
8. Cook, R. D. et. al; Concepts and Applications of Finite Element Analysis; John Willey & Sons; NY; 1995
9. Prathap G.; Finite Element Method; Kluwer Academic Publ.; Dordrecht; 1993
10. Irons, B. & Ahmad, S.; Techniques of Finite Elements; Elliswood, London; 1980

2SFSE2 ADVANCED DESIGN OF STEEL STRUCTURES

Introduction to Allowable Stress Design, Plastic design, Limit state Design
Loadings as per IRC, IRS, IS (IS:800-2007, IS: 875 part 1-V, IS: 1893) applicable to various steel structures.
Design of Beams, Beam-column, Plate Girders, Open web structures and Space structures by limit state method.
Bridges, Industrial Buildings including crane girders by using Limit State method
Welded and riveted connections.
Composite structures.

Reference Books:

1. Owens, G.W. & Knowles, P.R.; Steel Designers Manual; Blackwell; 1994
2. Gaylords E.H. & Gaylords, C. N.; Design of Steel Structures; McGraw Hill Publ.;1998
3. Steel Design Manual; ELBS and Granada Publishers; London
4. Johnson, R.P.; Composite Structures of Steel and Concrete; Volume-I; Granado Publishing Ltd.; London; 1975
5. Salmon and Johnson; Steel Structures – Design and Behaviour, Harper and Collins Publishers.
6. Subramanian N., Design of Steel Structures, Oxford University Press 2008
7. IS 800-2007, BIS

2SFSE3 **REPAIRS & RETROFITTING OF STRUCTURES**

Principles of Repair and Retrofitting, Terminology in Repair, Restoration, Strengthening and Rehabilitation, Criteria for Repair, Restoration and Retrofitting; Repair Materials; In-situ testing methods for RC and masonry structures; Seismic Hazard Evaluation; Techniques of repair and retrofitting of masonry buildings; Seismic evaluation of RC building-Demand capacity method, pushover analysis and performance based approach; Techniques of Repair and Retrofitting in RC buildings; Retrofitting of buildings by seismic base isolation and supplemental damping; Retrofitting of heritage structures; Retrofitting of bridges; Case studies in retrofitting.

Reference Books:

1. Pankaj Agrawal & Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall India.
2. Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press 2007

2SFSE4 **DESIGN OF PRESTRESSED CONCRETE STRUCTURES**

1. Introduction to pre-stressing, Analysis for pre-stress, Load balancing.
2. Partial pre-stressing, Grouting of beams, fire resistance of beams, special problems like stress corrosion, fatigue under dynamic loading etc.
3. Basic design for flexure (Type I structures), Introduction to Limit state method.
4. Limit state of collapse: Shear, Bond, deflection & cracking in pre-stressed concrete member
5. Comprehensive design of a rectangular and/or a T-section by limit state method.
6. Design of Poles, Piles and Sleepers.
7. Design and analysis of pre-stressed concrete pipes and circular tank.
8. Analysis and design of end block.
9. Comprehensive design of post-tensioned girders.
10. Analysis and design of continuous beams up to two spans linear transformation, concordant cable.
11. Analysis and design of portal frame, single storey and limited to two bays.

Reference Books:

1. Krishna Raju, N.; Prestressed Concrete Structures; TMH; Delhi; 1981
2. Lin, T.Y. and Burns, N.H.; Design of Prestressed Concrete Structures; 3rd Edition; John Wiley & Sons; NY; 1981
3. Ashok Jain, R. C. C. Design
4. P. Dayaratnam, Prestressed Concrete Structures, Oxford & IBH
5. Latest relevant BIS codes

2SFSE5 **Elective**
(1) SUBSTRUCTURES AND FOUNDATION DESIGN

Analysis and design of Piers, Abutments and Retaining walls.
Shallow foundations: Individual and combined footings for axial and bending loads (Uniaxial and biaxial), Loss of contacts.
Rafts, Annular Footings, Rigid and flexible foundations, Beams and slabs on elastic foundations.
Deep Foundations: Piles and Wells foundations.
Design of Machine Foundations.

Reference Books:

1. Hetenyi M.; Beam on Elastic foundation; University of Michigan Press; 1946
2. Bowles, J. E.; Foundation Analysis & Design; McGraw Hill; 5th Edition; 1996
3. Swami Saran; Soil Dynamics and Machine Foundations, Galgotia Publications (P) Ltd, New Delhi, 1999
4. Srinivasulu P, Vaidyanathan C V ; Handbook of Machine Foundation
5. Kurian N P; Modern Foundations – Introduction to advanced Techniques

2SFSE5 **Elective**
(2) EARTHQUAKE RESISTANT DESIGN OF BRIDGES AND DAMS

Bridges:

Performance in past earthquakes, Types of bridge superstructure and introduction to their design, sub-structure, bearings, IRC / IRS Bridge loadings and other codal recommendations, Performance of Bridges in past earthquakes. Seismic design philosophy for Bridges, State of art Modeling of bridges, Seismic Design of Substructures, Capacity design of substructures and ductile detailing,
Seismic design of well and pile foundations
Dams:

Performance of concrete and masonry gravity dams, seismic design considerations, dynamic analysis of dams. Dam-foundation-reservoir interaction, bending, shear and finite element method of analysis.

Reference Books:

1 Chen W.F. and Duan L., Bridge engineering Handbook; CRC Press; 1999
2 Fintel, M.; Handbook of Concrete Engineering; 2nd Edition; CBS Publishers Delhi; 1986

2SFSE5 **Elective**

(3) THEORY OF ELASTICITY AND STABILITY

Stress at a point, relationship between stresses and strains, Elastic modulii, Basic equations of theory of Elasticity. Plane stress-strain, Airy's stress function, strain-displacement relationship, Principal Planes and Principal stresses in three dimensions, equilibrium and compatibility in rectangular coordinates and other coordinate systems,

Simple applications in tension, bending and torsion.

Concept of Stability, Axial buckling of columns by Energy Criteria of Stability & approximate methods, lateral torsional buckling of beams and beam columns, Coupled axial torsion and flexural buckling.

Buckling of rectangular thin plates.

Reference Books:

1. Timoshenko, S. P.; Theory of Elasticity; McGraw Hill; 3rd Edition; NY; 1970
2. Timoshenko, S. P.; Theory of Elastic Stability; McGraw Hill; 2nd Edition; NY; 1961
3. Trahair N.S.; Flexural Torsional Buckling of Structures, E&FM SPON; London
4. Chen, W.F.; theory of Beam-Column-Space Behaviour and Design; 2nd Vol.; McGraw Hill;

2SFSE5 **Elective**

(4) DESIGN OF ENVIRONMENTAL STRUCTURE

1. Analysis and design of cylindrical shaped E.S.R, supported peripherally & internally making the tank floor a solid continuous slab system, Analysis and design of staging.
2. Design of underground water tanks, swimming pools, Jacks well
3. Design of Water Treatment Plant units, aeration tank, Clari-floculator, flash mixers.
4. Design of water sumps, filters, Design of digestion tank.

Reference Books:

1. Paulay T. & Park R.; Reinforced Concrete structures; John Willey & Sons
2. Krishna Raju N., Advanced R.C.C. Design, TataMcGraw Hill, New Delhi
   Reynolds C.E.; Reinforced Concrete Design Handbook; 9th Edition; Rupa & Company; Calcutta; 1981
3. Punmia B. C., R. C. C. Design, Laxmi publications
4. Datta N. P., Waste Water Treatment, Oxford & IBH Publication

2SFSE6 **ADVANCED DESIGN OF STEEL STRUCTURES: STUDIO**

Complete Design calculations and Drawings to be developed for the following structures based on syllabus For the relevant theory subject (2SFSE2)

1. Design of a steel bridge
2. Design of an Industrial shed
3.

2SFSE7 **DESIGN OF PRESTRESSED CONCRETE STRUCTURES: STUDIO**

Complete Design calculations and Drawings to be developed for the following structures based on syllabus For the relevant theory subject (2SFSE4)

1. Comprehensive design of a pre-tensioned Pole
2. Comprehensive design of a post-tensioned Girder
3. Field visit report

3SFSE1 & 4SFSE1 SEMINAR AND DISSERTATION

A Dissertation on Recent Trends in Structural Engineering to be submitted.
Marks shall be based on Seminar, dissertation. and Viva-Voce on dissertation.

****

Deleted: ¶