M.Tech. (Structural Engineering) **:** Civil Engineering Department

FIRST SEMESTER
Advanced Structural Analysis
Numerical Methods & Analysis
Advanced Design of Concrete Structures
Advanced Design of Steel Structures
Computer Aided Design Lab

SECOND SEMESTER
Structural Dynamics
Advanced Strength of Materials
Advanced Concrete Technology
Elective-I
Material Testing, Experimental Methods & Quality Control

THIRD SEMESTER
Finite Element Analysis
Elective-II
Seminar
Dissertation Part I

FOURTH SEMESTER
Dissertation Part II

LIST OF ELECTIVES

ELECTIVE – I

Theory of Elasticity and Plasticity

Earthquake Engineering

Analysis & Design of Bridge Superstructure

ELECTIVE – II

Repair and Rehabilitation of Structures Advanced

Foundation Design

Tall Buildings

SYLLABUS

ADVANCED STRUCTURAL ANALYSIS Static and kinematic indeterminacy,

Principle of virtual work, Stiffness & Flexibility Matrices,

Force-displacement methods, element approach. Application to continuous beams, plane and space frame problems.

Formulation of stiffness matrix for a typical multistory apartment building and industrial structure.

Nonlinear analysis, material and geometrical nonlinearities, large deformation elasto-plastic analysis of frames, introduction to incremental procedure.

NUMERICAL METHODS AND ANALYSIS

Error Analysis, Significant Figures, Absolute and Relative Errors, Accuracy and Precision, Computational Errors, Stability in Numerical Analysis.

Interpolation and Integration, General Interpolation Formulae, Polynomial Interpolation, Lagrange Interpolation, Newton's Interpolation and Gaussian Interpolation.

Introduction to Gauss and Hermite quadratures, Quadrature rules for multiple integrals. Least square approximation of functions, linear regression & its algorithm, polynomial regression, fitting exponential and trigonometric functions, weighted least square approximation, their use through MS Excel.

Solution of linear simultaneous equations, algorithm based on Gauss elimination, Decomposition method, Gauss-Seidel Method. Introduction to Solution of large system of linear simultaneous equations for symmetric banded equations.

Numerical solution of Nonlinear Equations using method of successive bisection, Secant method, method of successive substitution & Newton Raphson's Method.

Solution methods for Eigen Value problems. Numerical solution of Ordinary Differential Equations by Picard method, Euler & modified Euler methods and parabolic, elliptic, and hyperbolic partial differential equations. Programming in C^+ of the algorithms of all the above numerical methods.

ADVANCED DESIGN OF CONCRETE STRUCTURES

Revision of basic concepts of Limit State Design of prismatic members in flexure, shear & bond.

Redistribution of Moments in Fixed & Two span continuous beams. Calculation of deflection due to load, shrinkage & creep and calculation of crack width as per IS code.

Analysis & Design of axially loaded Short column & analysis with uniaxial and biaxial bending, Column interaction diagram, its construction & use. Introduction to design and analysis of selender columns.

Introduction to Analysis & Design of folded plates & circular shells.

Yield line theory for slabs, yield line mechanisms, equilibrium and virtual work methods, special aspects, Hillerborg's strip method.

ADVANCED DESIGN OF STEEL STRUCTURES

Torsion of open and closed sections. Buckling and warping. Stability of frames.

Light gauge steel sections, design of Structural elements with such sections..

Different types of steel and metallic alloys. Moment resistance connections. Behavior of material under fatigue and temperature effects including fire.

Applications of steel cables in large span roofs, non-linearity.

Tubular sections, Design of elements with tubular sections. Orthotropic decks. Plastic design of continuous beams, portal and gable Frames.

STRUCTURAL DYNAMICS

Dynamics of Structures: Objectives and importance. Types of dynamic loads, Dynamic degree of freedom, Mathematical modeling, Damping and stiffness, Torsional stiffness, Equivalent stiffness, Free and forced vibrations.

Single Degree of Freedom (SDOF) Systems: Undamped free vibrations, formulation of differential equation of motion: Newton's law of motion, D'Alembert's principle and energy approach. Natural frequency. Vibration response.

Single Degree of Freedom (SDOF) Systems: damped free vibrations, critically damped, under damped & over damped systems, formulation of differential equation of motion: Natural frequency. Vibration response.

Forced vibration response of SDOF damped and undamped systems to harmonic loading, rotating and reciprocating unbalance, support motion and impulsive type forcing function. Vibration isolation and transmissibility. Seismic Instruments.

Vibrations of two degree of freedom systems, matrix formulation of equations of motion, principal modes of vibrations. Extension of the concept to MDOF systems. Introduction to Rayleigh's principle, modal analysis.

ADVANCED STRENGTH OF MATERIAL

Elastic and plastic behavior of materials creep and fatigue, bending of bars with initial curvature, rings hoops etc. Torsion of non circular section, unsymmetrical bending, beams on elastic foundation, shear centre, shear flow, shear lag. Fracture mechanics, Analysis of laminates

ADVANCED CONCRETE TECHNOLOGY

Microstructure of concrete, deterioration mechanisms, assessment and control of corrosion in concrete structures,

Introduction to Special concretes, their specific properties & applications: Ready Mixed Concrete, Reactive powder concrete, Bacterial concrete, Light Weight concrete, High density concrete & its application for Radiation shielding.

Fibre reinforced concrete - Fibre materials, mix content, distribution and orientation, interfacial bond, properties in fresh state, strength and behavior in tension, compression and flexure of steel fibre reinforced concrete, mechanical properties, crack arrest and toughening mechanism, applications.

High strength concrete – constituents, mix proportioning, properties in fresh and hardened states, applications and limitations.

High performance concrete and self compacting concrete: Materials, mix design, techniques for performance measurement

THEORY OF ELASTICITY AND PLASTICITY

Theory of stresses. Infinitesimal and finite strains. Strain-displacement relationships. Compatibility. Stress-strain relationship. Elastic constants. Stress and displacement functions. Plane problems in Cartesian and polar coordinates. Elements of plasticity failure and yield criteria, flow rule, velocity field. Plastic stress-strain relations- incremental plasticity.

EARTHQUAKE ENGINEERING

Engineering seismology: Structure of the earth, causes of earthquakes/tsunami: plate tectonics, types of faults and basic terms related with earthquakes. Seismic waves:, surface waves, body waves & their characteristics.

Characteristics & types of earthquake. Magnitude of earthquake, local magnitude, body wave magnitude, surface wave magnitude, seismic moment magnitude.

Energy release, Relationship between magnitude & Energy.

Intensity of earthquake, seismicity and seismic zoning.

Effect of earthquake on structures in general. Planning/architectural concepts: size & plan of building, vertical layout & adjacency of buildings.

Seismic damages: Typical seismic behaviour & damages of masonary structures: in plane & out of plane failure, lack of integrity. Earthquake resistance provisions as per IS 4326.

Typical seismic behaviour & damages of R.C. structures. Soft storey effect & short column effect.

Earthquake resistant design philosophy: Torsion in buildings, calculation of centre of mass & centre of rigidity. Basic concepts of structural dynamics, Response spectrum concept, Construction of response spectrum. Use of response spectrum in earthquake resistant design, IS codal provisions for seismic analysis using given modes/coefficients and simple cases by static and dynamic analysis as per code.

Codal provisions for Ductile detailing in RC constructions.

ANALYSIS & DESIGN OF BRIDGE SUPERSTRUCTURES

Types of bridges, choice of bridge type, longitudinal arrangement and economic spans. Load distribution theories: Courbons method, Hendry Jaeger method, Morice Little method, Grillage analogy, Design of T-type bridges. Introduction to Box girder bridges, steel bridges & Cable stayed bridges: integral bridges, behavior, structural section & analysis. Design of neoprene bearings.

FINITE ELEMENT ANALYSIS

Finite element techniques: One dimensional Problems, FEM modeling, coordinates & shape functions, discretization, energy and variational approaches, basic theory, use of parametric and local coordinates, convergence criteria, numerical integration.

Element formulations, 2-D elements, plate bending elements, introduction to three dimensional elements. Applications, plane stress and plain strain problems, axi-symmetric solids, plates and shell structures, temperature problems.

Finite element equation treatment & boundary conditions, quadratic shape function, effect of temperature.

Nonlinear problems: Review of iterative and incremental procedures for material and geometrically nonlinear problems examples from plane stress and plane strain.

Introduction to programming, organization of FEM programs, equation solving techniques, input/output plotting and mesh generation aspects.

REPAIR AND REHABILITATION OF STRUCTURES

Introduction to Repair, Restoration and rehabilitation/strengthening of existing buildings. Causes of deterioration/decay and flexural & shear distress of concrete structures.

Diagnostic methods & analysis, preliminary investigations, experimental investigations using NDT, load testing, corrosion mapping, core drilling and other instrumental methods.

Cracks: structural & surface cracks, their identification & causes, methods of repair of small & large cracks: Gunite and Shot Crete, Epoxy injection, Mortar repair for cracks

Corrosion mechanism: corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

Strengthening of existing walls & RCC members, stitching, routing & Sealing, Jacketing Materials for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro- cement, Fiber reinforced concrete. FRP wrap, banded plates. Numerical problems on strengthening of concrete structures using above materials & techniques.

ADVANCED FUNDATION DESIGN

Critical study of conventional methods of foundation design,

Analysis of settlement of soil and foundations, foundations of in expensive and swelling soils, Dynamic soil properties, dynamic bearing capacity of shallow foundations, liquefaction of soils, Machine foundations for reciprocating and rotary type machines, vibration isolation.

Raft foundations, well foundations, special footings and beams on elastic foundations,

TALL BUILDINGS

Structural systems of tall buildings; Moment resistant. frames, braced frames, eccentrically braced frames, shear walls, coupled shear walls, frame shear wall interaction, tubular structures; approximate and matrix oriented methods of design of tall buildings;