

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

<b>FIRST SEMESTER</b>
Computer Programming & Graphics
Advanced Analysis of Structures
Design of Concrete Structures

<b>SECOND SEMESTER</b>
Design of Steel Structures
Structural Dynamics
Numerical Methods & Analysis

<b>THIRD SEMESTER</b>
Finite Element Methods
Elective-I
Seminar

<b>FOURTH SEMESTER</b>
Bridge Engineering
Elective-II
Project

<b>FIFTH SEMESTER</b>
Dissertation

<b>SIXTH SEMESTER</b>
Dissertation

**LIST OF ELECTIVES**

**ELECTIVE – I**

Advanced Strength of Materials

Earthquake Engineering

## Advanced Foundation Design

### ELECTIVE – II

Theory of Plates & Shells

Tall Buildings

Repair and Rehabilitation of Structures

## **SYLLABUS**

### **COMPUTER PROGRAMMING AND GRAPHICS**

Definition of a program, Programming methodology, Concept of Structural Programming, Definition and operations on arrays, stacks, queues, lists, evaluation of arithmetic expressions using stacks, list representation. Recursive and non-recursive definitions of tree structures, operations of recursive and non-recursive algorithms. Introduction to C language, operators and expressions, data input and output, control statement, use of while, do-while, nested loops, if-else, switch, pointers, continue and goto statements. Writing a complete C program on structural analysis and design problems. Introduction to computer graphics, application of two dimensional and three dimensional graphics

### **ADVANCED ANALYSIS OF STRUCTURES**

Static and kinematic indeterminacy, Principle of virtual work, Force-displacement methods, element approach. Application to continuous beams, and space frame problems. Nonlinear analysis, incremental procedures, material and geometrical nonlinearities, large deformation elasto-plastic analysis of frames.

### **DESIGN OF CONCRETE STRUCTURES**

Limit State concept: Design philosophy, statistical basis for loads and strengths. Design and analysis of sections for flexure, shear and torsion. Beams curved in plan. Yield line theory for slabs, yield line mechanisms, equilibrium and virtual work methods, special aspects, Hillerborg's strip method. Code provision of design of water tanks. Design of circular and rectangular water tanks.

### **DESIGN OF STEEL STRUCTURES**

Torsion of open and closed sections. Buckling and warping. Stability of frames. Discussions of design specifications for compression elements including those made with light gauge steel. Different types of steel and metallic alloys. Moment resistance connections. Behavior of material under repetitive loads and temperature effects. Fundamentals of limit state design. Applications of steel cables in large span roofs, non-linearity. Tubular sections. Orthotropic decks. Light gauge steel.

## **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. 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. Dynamic load factor. 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. Code provisions of Earthquake resistant Design.

## **NUMERICAL METHODS & 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, Hermit interpolation, Gregory, Newton's and Gaussian interpolation, Gauss and Hermite quadratic and quadrature rules for multiple integral, computer sub routine. Solution of large system of linear simultaneous equations, algorithm based on Gauss elimination for symmetric and unsymmetric banded equations, solution : in core and out of core, methods based on band width and its variants Solution methods for Eigen problems, Vector interaction methods, transformation methods, polynomial interaction techniques, methods based on sequence property, determinant search method and sub-space interaction method, large eigen problems, eigen value economizer scheme, computer programs. Numerical solution of parabolic, elliptic, and hyperbolic partial differential equations.

## **FINITE ELEMENT METHODS**

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.

## **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.

## **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 masonry 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.

## **ADVANCED FOUNDATION DESIGN**

Critical study of conventional methods of foundation design, analysis of settlement of soil and foundations, foundations of in expansive 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,

## **BRIDGE ENGINEERING**

Types of bridges, choice of bridge type, longitudinal arrangement and economic spans. Deck slab, orthotropic bridge deck. Rigid portal frame bridges, analysis and design. Load distribution theories: Courbons method, Hendry Jaeger method, Morice Little method, Grillage analogy, Design of T-type bridges. Box girder bridges in concrete and steel, behavior and structural section, analysis, design in reinforced and prestressed concrete, special features of design in steel. Cable stayed bridges, historical

development, materials and arrangements, analysis, non-linearity, design of cables and towers. Design of bearings, Methods of construction and rehabilitation of bridges.

### **THEORY OF PLATES AND SHELLS**

Plates: Pure bending of plates, Symmetrical bending of circular plates, plates with concentric hole loaded symmetrically. Rectangular plates. The plate equation, boundary conditions, Navier solution and alternate solutions for plate problems, Sinusoidal, uniform, concentrated, triangular and partially loaded under various edge conditions. Shells: definition of shell, classification of shells. Membrane theory for shells of revolution: typical cases, Loads with or without symmetry, distributed and edge loads. Membrane theory for cylindrical shells, tubes and pipes and barred vaults. Approximate analysis of cylindrical shells.

## **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;

## **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: Guniting 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