**TWO YEAR MTECH PROGRAMME COURSE STRUCTURE**
**(Effective from Academic Session 2018-19)**

| STRUCTURAL ENGINEERING | | | |
|---|---|---|---|
| **SEMESTER I** | | | |
| **Subject Code** | **Subject Title** | **Credits** | **Contact Hours** |
| 11M1WCE111 | Advanced Structural Analysis | 3 | 3 |
| 11M1WCE112 | Structural Dynamics | 3 | 3 |
| 11M1WCE113 | Design of Reinforced Concrete Structures | 3 | 3 |
| | Elective I | 3 | 3 |
| 13M1WCE131 | Finite Element Methods | 3 | 3 |
| 11M1WCE713 | Concrete Structures Laboratory | 2 | 4 |
| | **Total** | **17** | **19** |
| **SEMESTER II** | | | |
| 11M1WCE211 | Solid Mechanics in Structural Engineering | 3 | 3 |
| | Elective II | 3 | 3 |
| 11M1WCE213 | Earthquake Resistant Design of Structures | 3 | 3 |
| 11M1WCE214 | Theory of Plates and Shells | 3 | 3 |
| 12M1WCE231 | Prestress Concrete Structures | 3 | 3 |
| 12M1WCE271 | CAD Laboratory | 2 | 4 |
| | **Total** | **17** | **19** |
| **SEMESTER III** | | | |
| 12M19CE391 | Seminar | 02 | - |
| 12M19CE392 | Project Part-I | 18 | 36 |
| | **Total** | **20** | **36** |
| **SEMESTER IV** | | | |
| 12M19CE492 | Project Part II | 22 | 44 |
| | **Total** | **22** | **44** |

| LIST OF ELECTIVES | | |
|---|---|---|
| | **Course Code** | **Course Name** |
| **Elective I** | 11M1WCE114 | Modelling, Simulation and Computer Applications |
| | 11M1WCE332 | Advances in Construction Materials |
| | 12M1WCE332 | Repair and Retrofitting of Structures |
| **Elective II** | 11M1WCE212 | Design of Steel Structures |
| | 11M1WCE133 | Bridge Engineering |
| | 10M13CE432 | Construction Methods Improvement |

# Syllabus for MTech in Structural Engineering

**Advanced Structural Analysis**
Basic concepts, Degree of static and kinematic indeterminacy, Matrix algebra, Solution of simultaneous equations by Gaussian Elimination, Flexibility and Stiffness Matrices, System Approach: Development of stiffness matrix, Applications of stiffness method to continuous beams, trusses and frames. Effect of temperature, and prestrain. Element Approach: Element stiffness, 2D truss element and beam element, Transformation matrix, Assembly of global stiffness matrix, Storage requirement of stiffness matrix i.e. full storage, banded storage and skyline storage, Effect of node and element numbering, Boundary conditions, Application of stiffness method to beams, trusses and frames. Computer applications, Material and geometrical non-linearity, Application of Virtual work and energy principles.

**Structural Dynamics**
Concept of degrees of freedom and constraints, Equations of motion, Newton's Law and D' Alembert's Principle, Response of single degree of freedom systems to initial conditions, Response to harmonic excitation, Dynamic amplification factor, Transmissibility, Base Isolation, Response to non-harmonic excitations such as impulse, step loading and blast loading, Duhamel's Integral, Earthquake response analysis, Response spectrum, Theory of vibration pick – ups, Estimation of dynamic characteristics through experimental investigations, Multi degree of freedom systems, Orthogonality of mode shapes, Mode superposition method for seismic analysis.

**Design of Reinforced Concrete Structures**
Deflections of Reinforced Concrete Beams and Slabs; Estimation of Crack Widths in Reinforced Concrete Beams; Inelastic Analysis of Reinforced Concrete Beams and Frames; Design of Shear Walls, Cast-in-Situ Beam-Column Joints, strong-column weak-beam philosophy; Deep Beams, Chimneys, Ribbed Slabs; Design of Reinforced Concrete Members for Earthquake Resistance, Fire Resistance; Software Applications, Virendeel Girders, Concrete Trusses.

**Finite Element Methods**
Structural stiffness analysis, Introduction, Matrix Algebra and Gaussian Elimination, The structural element, One Dimensional Problems, Trusses, Assembly and analysis of a structure; Transformation of co-ordinates. Finite elements of a column, Element characteristics, Two Dimensional Problems, Plane stress and plane strain, Interpolation Functions, Numerical Integration and Modelling Considerations, Element characteristics, Two Dimensional Isoparametric Elements, Assessment of accuracy, Some practical applications. Axi-Symmetric stress analysis, some improved elements in two dimensional problems, Beams and Frames, Bending of plates, Techniques for Nonlinear Analysis, Three Dimensional Problems in Stress Analysis, Heat Conduction and Seepage Problems

**Concrete Structures Laboratory**
Design of concrete mixes for high strength and high-performance concrete. Testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

**Solid Mechanics in Structural Engineering**

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke's law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lame's equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant's method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

**Earthquake Resistant Design of Structures**

Behaviour of buildings and structures during past earthquakes and lessons learnt, goals of earthquake resistant design. Linear static procedure for seismic load calculation – IS 1893 – 2002, combination of gravity and seismic action. Multimodal and Multidirectional response spectrum analysis. Earthquake resistant measures at planning stage: Geotechnical and architectural considerations, irregularities, earthquake resistant measures in sloping roofs, staircase, foundations and general construction details IS : 4326 –1993, principals of earthquake resistant design – behaviour of concrete and steel, confined concrete, the capacity design method; Study of IS 13920 – 1993, behaviour of masonry structures during earthquakes, analysis and behaviour of masonry infilled RC frames, earthquake resistant measures in masonry buildings.

**Theory of Plates and Shells**

Some results from differential geometry: curves in 3D space – parameterized equation for curves, arc length as a parameter; surfaces - parametric description, curvilinear co-ordinates, first and second fundamental forms, principal curvature co-ordinates, derivatives of unit vectors, equations of Gauss and Codazzi; Membrane theory of shells: equilibrium equations, applications to shells of revolution under axisymmetric loads, applications to cylindrical shells under asymmetric loads, strain-displacement relations , application in calculation of displacements; Bending theory of shells: kinematic assumptions and strain displacement relations, stress measures and equilibrium equations, constitutive relations, cylindrical shell under axi-symmetric loads, bending of cylindrical shells; Bending theory of flat plates: thin plates, Kirchoff theory - strain displacement relations, stresses and stress resultants, constitutive equations, equilibrium equations, boundary conditions, derivation of theory from principle of virtual work, rectangular plates-solution by double Fourier series, circular plates, edge effects, anisotropic and layered plates, thick plates-Reissner-Mindlin-Naghadi type theories, moderate deflection analysis and buckling of plates.

**Pre-stressed Concrete Design**

Definition, Basic Principles, Types of prestressing, Systems of prestressing, Loss of prestress, materials used, Advantages and disadvantages. Critical load condition, Permissible stresses, Various suggested methods of design, Dimensionless Design variables, Solution of equations, Design Procedure based on flexure, Minimum weight design, Cable layout and profile of tendons, Design by load balancing method, Code provisions. Allowable stress considerations, Non-dimensionalised allowable stress equations and their solution, Shrinkage Stresses. Two span continuous beams and their analysis, Application of moment distribution method, Design of continuous beams, Continuous beams with variable section.

One way and two-way slabs, Beam and slab construction, Principal Stresses, failure due to shear, combined bending and shear, Bond, Prestressing cable at the centroidal axis, Symmetric multiple cable, cable with eccentricity, Inclined cables, Spalling and bursting stresses. Compression members, Tension members, Prestressed Concrete Pavements, Folded plates and Shells, Arches, Dams, Rigid frames, cylindrical tanks.

**CAD Laboratory**
Introduction to various research and design software's and their applications

## SYLLABUS FOR ELECTIVE COURSES

**Modelling, Simulation and Computer Applications**
Generalization of Finite Element concept: Mathematical models, numerical models and Physical models. Deterministic and stochastic models. Concepts of simulation: Lagrange multiplier and Penalty function. Non-linear analysis – total and updated Lagrangian formulation. Geometric non-linear analysis, truss, beam. Material non-linear analysis, Constitutive model, Plasticity. Dynamic problems and Finite Element analysis. Competitive situations: Optimization, Single and multiple objectives optimizations, Pareto optimal solutions. Introduction to linear and geometric programmings. Zero degree and single degree of difficulty. Growth and Decay processes: Discrete and continuous systems. Differential and Integral equation approach, Fibonacci growth. Probability Distributions: Binomial and Poisson distributions, Normal, Lognormal and pareto distributions. Generation of random numbers: Uniform variable, normal and lognormal variables. Queing theory: Montecarlo methods, solutions of Laplace equations in two dimensions.

**Advances in Construction Materials:** Newer and improved materials of construction, steel having greater ductility, tensile strength and corrosion resistance, high performance concrete, self-compacting concrete, chemicals, epoxies, latexes and bonding agents for repairs, geotextiles and geomembranes

**Repair and Retrofitting of Structures**
Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting, repair materials and techniques, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, analytical and experimental techniques, retrofit design and implementation, techniques of retrofitting and improving structural integrity of masonry buildings, codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

**Design of Steel Structures**
Properties of steel: mechanical properties, hysteresis, ductility; Hot-Rolled Sections: compactness and non-compactness, slenderness, residual stresses; Design of steel structures: inelastic bending – curvature, plastic moments, design criteria - stability , strength, drift; Stability criteria: stability of beams – local buckling of compression flange & web, lateral-torsional buckling, stability of columns - slenderness ratio of columns, local buckling of flanges and web, bracing of column about weak axis, method of design - allowable stress design, plastic design, load and resistance factor design; Strength Criteria: beams – flexure,

shear, torsion, columns - moment magnification factor, effective length, P-M interaction, bi-axial bending, joint panel zones; Drift criteria: P-Ä effect, deformation-based design; Connections: types – welded, bolted, location – beam column, column-foundation, splices.

**Bridge Engineering**

Definition, components of a bridge, classifications, importance of bridge. Investigation of Bridges: need for investigations, selection of bridge site, preliminary data to be collected, design discharge and its determination, linear waterway, economical span, vertical clearance above HFL, scour depth, choice of bridge type. Standard Specifications: for road bridges, I.R.C. loadings, code provisions on width of carriage way, clearances, loads considered etc. standard specifications for railway bridges, Railway bridge code. Reinforced Concrete Bridges: T-beam bridge, Courbon's theory for load distribution, balanced cantilever bridges, illustrative examples, pre-stressed concrete bridges, Slab Bridges. Sub Structure: Types of piers and abutments, design forces, design of piers and abutments. Bearing and Joints: Various types of expansion bearing and fixed bearings, elastomeric bearings, joints and their types. Introduction to construction, inspection and maintenance of bridges.

**Construction Methods Improvement:** Methods analysis, work analysis, work methods improvement, productivity analysis, measuring productivity, time study, standard data systems, predetermined time systems, work sampling, physiological work measurement, labour reporting, improving productivity, introduction to ergonomics, incentives to increase productivity, alternative methods for increasing productivity, case studies