CIVIL ENGINEERING
M.E. (STRUCTURAL ENGINEERING) –
SCHEME OF INSTRUCTION AND EXAMINATION

I-SEMESTER

Code No.	Course title	Scheme of Instruction		Scheme of Examination			Total	Credits
		Lec.	Tut/drw.	Duration of Exam. (hrs)	Theory/ Lab./Viva	Sess.		
ST-1.1	Theory of Elasticity	4	—	3	70	30	100	4
ST-1.2	Advanced Reinforced Concrete Design	4	—	3	70	30	100	4
ST-1.3	Finite Element Methods of Analysis	4	—	3	70	30	100	4
ST-1.4	Structural Dynamics	4	—	3	70	30	100	4
ST-1.5	Computer Applications in Structural Engineering	2	2	—	50	50	100	3
ST-1.6	Bridge Engineering	2	2	—	50	50	100	3
Total		20 + 4 = 24			380	220	600	22

II-SEMESTER

Code No.	Course title	Scheme of Instruction		Scheme of Examination			Total	Credits
		Lec.	Tut./drw	Duration of Exam. (hrs)	Theory/ Lab./Viva	Sess.		
ST-2.1	Theory of Plates and Shells	4	—	3	70	30	100	4
ST-2.2	Stability of Structures	4	—	3	70	30	100	4
ST-2.3	Structural Reliability	4	—	3	70	30	100	4
ST-2.4	Earthquake Engineering	4	—	3	70	30	100	4
ST-2.5	Sub-Structure Design	4	—	3	70	30	100	4
ST-2.6	Rehabilitation and Repair of Structures (Viva-Voce)	2	2	—	50	50	100	3
Total		22 + 2 = 24			400	200	600	23

III-SEMESTER

Code No.	Course title	Scheme of Instruction		Scheme of Examination			Total	Credits
		Lec.	Tut./ Drg.	Duration of Exam. (hrs)	Theory/ Lab./Viva	Sess.		
ST-3.1	Industrial Structures	4	—	3	70	30	100	4
ST-3.2	Optimization Techniques	4	—	3	70	30	100	4
ST-3.3	Design of Structures (Viva-Voce)	4	--	--	50	50	100	2
ST-3.4	Thesis	—	—	—				
Total		8 + 4 = 12			190	110	300	10

IV-SEMESTER

ST-4.1	Thesis/Dissertation/Project work	100 marks	Credits: 25
	GRAND TOTAL	1600	80

CIVIL ENGINEERING
M.E. (STRUCTURAL ENGINEERING)

I-SEMESTER

ST 1.1 – THEORY OF ELASTICITY

Plane Stress and Plane Strain: Components of stress, Strain, Hookes law, Stress and strain at a point. Plane stress, Plane strain, Equations of equilibrium, Boundary conditions, Compatibility equations stress foundation.

Two Dimensional Problems in Rectangular Coordinates: Solution by polynomials, Saint Vanant's principle determination of displacements, Bending of cantilever loaded at the end, Bending of a beam by uniform load.

Two Dimensional Problem in Polar Coordinates: General equations of equilibrium, Stress function and equation of compatibility with zero body forces. Analysis of thick cylindrical shells with symmetrical leading about the axis, Pure bending of curves bars, Strain components in polar coordinates, Rotating disks.

Three Dimensional State of Stress: Differential equations of equilibrium – Boundary conditions for compatibility – Displacements – Equations of equilibrium in terms of displacements – Principle of superposition – Uniqueness of solution.

Torsion: Torsion of straight bars – St.-Venant solution – Stress function, Warp function – Elliptic cross section – Membrane analogy torsion of bar of narrow rectangular cross section.

Analysis of Stress and Strain in Three Dimensions: Introduction – Principal stresses, - Determination of principal stress – Stress invariants – Maximum sheering stress strain at point.

Shear Centre, Unsymmetrical Bending, Curved Flexural members – simple problems.

Books:
1. "Theory of Elasticity" by Timoshenko and Goodier, McGraw Hill Company.
2. "Applied Elasticity" by C.T. Wang.
3. "Advanced Strength of Materials" by Denhortog.

ST 1.2 – ADVANCED REINFORCED CONCRETE DESIGN

Deflection of Reinforced Concrete Beams and Slabs: Introduction, Short-term deflection of beams and slabs, Deflection due to imposed loads, Short-term deflection of beams due to applied loads, Calculation of deflection by IS 456, Deflection calculation by Eurocode, ACI simplified method, Deflection of continuous beams by IS 456, Deflection of slabs.

Estimation of Crack width in Reinforced Concrete Members: Introduction, Factors affecting crack width in beams, Mechanisms of flexural cracking, Calculation of crack width, Simple empirical method, Estimation of crack width in beams by IS 456, Shrinkage and thermal cracking.

Redistribution of Moments in Reinforced Concrete Beams: Introduction, Redistribution of moments in fixed beam, Positions of points of contraflexures, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of moment redistribution, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment-curvature (M - ψ), Relation of reinforced concrete sections, ACI conditions for redistribution of negative moments.

Approximation Analysis of Grid Floors: Introduction, Analysis of flat grid floors, Analysis of rectangular grid floors by Timoshenko's plate theory. Analysis of grid by stiffness matrix method, Analysis of grid floors by equating joint deflections, Comparison of methods of analysis, Detailing of steel in flat grids.

Design of Reinforced Concrete Members for Fire Resistance: Introduction, ISO 834 standard heating conditions, Grading or classifications, Effect of high temperature on steel and concrete, Effect of high temperatures on different types of structural members, Fire resistance by structural detailing from tabulated data, Analytical determination of the ultimate bending moment, Capacity of reinforced concrete beams under fire, Other considerations.

Earthquake Forces and Structural Responses: Introduction, Bureau of Indian standards for earthquake designs, Earthquake magnitude and intensity, Historical development, Basic seismic coefficients and seismic zone factors, Determination of design forces, Choice of method for multi-storeyed buildings, Difference between wind and earthquake forces, Torsion in buildings, Partial safety factors for design, Distribution of seismic forces, Analysis of structures other than buildings, Ductile detailing, Increased values of seismic effect for vertical and horizontal projections, Proposed changes in IS 1893 (Fifth revision).

Ductile Detailing of Frames for Seismic Forces: Introduction, General principles, Factors that increase ductility, Specifications of materials for ductility, Ductile detailing of beams – Requirements, Ductile detailing of columns and frame members with axial load (P) and moment (M) – Requirements. Shear walls, Joints in frames.

Inelastic Analysis of Reinforced Concrete Beams and Frames: Introduction, Inelastic behaviour of reinforced concrete, Stress-strain characteristics of concrete, Stress-strain characteristics of steels, Moment curvature relation (M-curves), Concept of plastic hinges (Moment rotation at plastic hinges), Effect of shear on rotation capacity, Inelastic or non-linear analysis of reinforced concrete beams, Allowable rotation for collapse load analysis, Baker's method for plastic analysis of beams and frames.

Durability and Mix Design of Concrete: Introduction, Types of cements produced in India, Durability of concrete, Carbonation and atmospheric corrosion of steel, Chloride penetration and steel corrosion, Presence of salts and steel corrosion, sulphates and concrete disintegration, Curing of concrete (IS 456 Clause 13.5), Summary of recommendations for durability of concrete, Polymer concrete, Mix design of concrete, Design of ordinary grade concrete, Design of high strength concrete, Design of very high strength concrete mixes, Mix design method.

High performance concrete.

References:

1. "Advanced Reinforced Concrete Design" by P.C. Varghese.
2. "Reinforced Concrete" by Park & Paulay.

ST 1.3 – FINITE ELEMENT METHOD OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics, Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), Basic component – A single element. Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions – All with reference to trusses under axial forces.

Concept of element, Various element shapes, Triangular element. Discretisation of a structure, Mesh refinement Vs. Higher order element, Inter connections at nodes of displacement models on inter element compatibility.

Three dimensional analysis – Various elements used, Tetra-hedrons, Hex-hedrons. Requirements on representation of element behaviour functions, Polynomial series. Isoparametric representation and its formulation.

Books:

1. "The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.
2. "Finite Element Analysis Fundamentals" by Richard H. Gallagher, Prentice Hall, 1975.
3. "Introduction to Finite Element Method" by Desai, C.S. and Abela, J.F., Van Nostrand, 1972.
4. "Finite Element Methods for Engineers" by Reger, T. Fenuer, The Macmillan Ltd., London, 1975.
5. "Fundamentals of Finite Element Techniques for Structural Engineers" by Drabbia, C.A. and Conner, J.J., John Wiley and Sons, 1971.
6. "Numerical Methods in Finite Element Analysis" by Klaus Jurgen and Edward, L., Wilson, Prentice Hall of India, New Delhi, 1978.

ST 1.4 – STRUCTURAL DYNAMICS

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion.

Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Structures with distributed mass and load, Single span beams, Normal modes of vibration, Forced vibrations of beams, Beams with variable cross-section and mass.

Approximate design methods, Idealized system, Transformation factors, Dynamic reactions response calculations, Design example (RC beam, Steel beam, RC slab), Approximate design of multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Books:
1. “Structural Dynamics” by John M. Biggs.
2. “Structural Analysis” by A. Ghali & A.M. Neville.

ST 1.5 – COMPUTER APPLICATIONS IN STRUCTURAL ENGINEERING

Computer Oriented Methods in Structural Analysis:
Stiffness method: Developing a computer program for the analysis of Grid Floors by using stiffness method.

Flexibility Method: Developing a computer program for the analysis of Portal Frames by using flexible method.

Finite Difference Method (FDM): Determination of deflections of plates by using FDM & Determination of natural frequency in a beam.

Finite Element Method (FEM): Discussion of engineering problems to demonstrate the versatility of finite element method. Coordinate system (local & global), Definition of stiffness matrix for a truss element and a beam element, Element assembly into global stiffness matrix, Boundary conditions.

Software Applications in Structural Engineering (by using STAAD, STRAP, STRUDS, etc.):
Analysis of reinforced concrete (RCC) and steel structures.
Analysis of plane and space truss and frames subjected to gravity and lateral loads.
Determination of natural frequency of a beam.
Dynamic analysis (Response spectrum) of plane frames.
Analysis of water tanks by using plate elements.

Design of Reinforced Concrete Members:
Design, detailing and estimating of beams, slabs, columns and foundations, Shear wall design.

Design of Steel Members:
Design of truss members.
Design of beams and columns.

References:
1. “The Finite Element Method” by Zienkiewicz, O.C., McGraw Hill Publications, London.
2. “Concepts and Applications of Finite Element Analysis” by Cook, R.D.
3. Reference Manual for STADD, STRAP, STRUDS, ANAYS, NISA, etc.

ST 1.6 – BRIDGE ENGINEERING

Loading Standards.

Design of Balanced Cantilever Bridge.

Design of Bow String Girder Bridge.

Design of prestressed concrete girder and box girder bridges considering only primary torsion, Design of end block.

Bridge Bearing: Types of bearings, Elastomeric bearing.

Piers, Aputments, Wingwalls factors effecting and stability, Well foundations. Design of well, Construction, Open sinking of walls, Plugging, Sand filling and casting of well cap.

II-SEMESTER

ST 2.1 – THEORY OF PLATES AND SHELLS

Bending of Long Rectangular Plates to a Cylindrical Surface: Differential equation for cylindrical bending of plates – Uniformly leaded rectangular plates with simple supported edges and with built in edges.

Pure bending of plates slopes – Curvatures of bent plates – Relations between bending moments and curvature – Particular cases – Strain energy in pure bending – Limitations.

Symmetrical Bending of Circular Plates: Differential equation – Boundary conditions.

Simply supported rectangular plates under sinusoidal leading – Naviers solution and its application to concentrated load – Levy's solution for uniformly distributed load or hydrostatic pressure – Bending of rectangular plates by moments distributed along the edges – Differential equation of rectangular plate within plane and lateral forces.

Membrane analysis:

a) Shells of revolution (axi-symmetrical loading), Spherical shells, Conical shells, Elliptical shell of revolution, Torus, Hyperboloid of revolution of one sheet, Shells of uniform strength membrane deformation.
b) Membrane analysis of shells of translation, Circular cylinder, Dyetrix, Parabola, Cycloid, Catenary and Membrane deformations.
c) Membrane analysis of shells of general shape: Anticlastic, Synclastic shells, Hyperbolic paraboloid, Candella shells, Conoid, Elliptic paraboloid, Rotational paraboloid.

Bending analysis of cylindrical shell: Beam method, Schorer method, Finsterwalder method.

Classification analysis.

Text Book:

1. "Theory of Plates and Shells" by Timeshenko, S. and Wernewsky-Kriegar.

References:

1. "Slressesin Shells" by Flugge.
2. "Design and Construction of Shells" by Ramaswamy, G.S.

ST 2.2 – STABILITY OF STRUCTURES

Buckling of Columns: Method of neutral equilibrium, Critical load of the Euler column, Linear column theory – An eigen value problem, Effective length concept, Higher order differential equation for columns initially bent columns, Effect of shear stress on buckling, eccentrically loaded columns, beam columns (Beam columns with concreted lateral load, distributed, load end moment), Inelastic buckling of columns, Double modulus theory, Tangent modulus theory, Shanley theory of inelastic column behaviour.

Approximate Methods of Analysis: Conservation of energy principles, Calculation of critical loads using approximate deflection curve, Principle of stationary potential energy, Raleigh-Ritz method, Buckling load of column with variable cross-section, Galerkin's method, Calculation of critical load by finite differences, Unevenly spaced pivot points, Matrix stiffness method, Effect of axial load on bending stiffness-slope deflection equations, Buckling of column loaded along the length using energy methods.

Buckling of Frames: Modes of buckling, Critical load of a simple frame using neutral equilibrium, Slope deflection equations and matrix analysis.

Lateral buckling of cantilever and simply supported beams of rectangular and I-sections and use of energy method and finite differences.

Buckling of Plates: Differential equation, Strain energy of bending, Critical load, Finite difference approach inelastic buckling of plates.

Matrix approach for Frames: Criterion for determination of critical loads, Stiffness influence coefficients for members without axial load, Deriviation of stability functions, Problem involving Non-sways, Modified stiffness of beams, Frames with sway, Multi-bar frames.

References:
1. "Principles of Structural Stability Theory" by Alexander Chajes.
2. "Theory of Elasticity Stability" by Timoshenko and Gere.

ST 2.3 – STRUCTURAL RELIABILITY

Concepts of Structural Safety: General, Design methods.

Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

Probabilistic Analysis of Loads: Gravity loads, Wind load.

Basic Structural Reliability: Introduction, Computation of structural reliability.

Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.

Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design.

Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

References:

1. "Structural Reliability Analysis and Design" by Ranganatham, R.
2. "Structural Reliability" by Melchers, R.E.

ST 2.4 – EARTHQUAKE ENGINEERING

Earthquakes, Epicenter, Hypocenter and earthquake waves, Measurement of ground motion, Seismic regions, Intensity and Isoseismals of an earthquake, Magnitude and energy of an earthquake, Consequences of earthquakes, Seismic zoning.

Earthquake Response of Linear Systems: Earthquake excitation, Equation of motion, Response quantities, Response history, Response spectrum concept, Deformation, Pseudo-velocity, and Pseudo-acceleration, Response spectra, Peak structural response from the response spectrum, Response spectrum characteristics, Elastic design spectrum, Comparison of design and response spectra, Distinction between design and response spectra, Velocity and acceleration response spectra, Appendix 6: E1 Centro, 1940 Ground motion.

Earthquake Analysis of Linear Systems:
Part-A: Response history analysis, Modal analysis, Multistorey buildings with symmetric plan, Multistorey buildings with unsymmetric plan, Torsional response of symmetric-plan builds, Response analysis for multiple support excitation, Structural idealization and earthquake response.
Part-B: Response Spectrum Analysis: Peak response from earthquake response spectrum, Multistorey buildings with symmetric plan, Multistorey buildings with unsymmetric plan.

Earthquake Response of Linear Elastic Buildings: Systems analyzed, Design spectrum and Response quantities, Influence of T_1 and p on response, Modal contribution factors, Influence of T_1 on higher-mode response, Influence of p on higher-mode response, Heightwise variation of higher-mode response, How many modes to include.

A Seismic Design of Structure: Design data and philosophy of design, Seismic coefficients, Permissible increase in stresses and load factors, Multistorey buildings, Base shear, Fundamental period of buildings, Distribution of forces along the height, Dynamic analysis, Effective weight, Miscellaneous considerations, Earthquake resistant construction of buildings, Ductility provisions in reinforced concrete construction, Water towers, Introduction, Behaviour under earthquake loads, Design features, Water tower as a rigid jointed space frame, Hydrodynamic pressures in tanks, Stack like structures, Introduction, Fundamental period of vibration, Seismic coefficient, Dynamic bending moment, Shear diagram, Bridges, Introduction, Seismic force, Live load, Super structure, Substructure, Hydrodynamic pressures on dams, Introduction, Zanger's method, Vertical component of reservoir load, Concrete or masonry gravity dams, Introduction, Natural period of vibration, Virtual mass, Dynamic displacements and accelerations, Dynamic shears and moments, Geometric method of stress analysis, Earth and rock fill dams, Introduction, Fundamental period of vibration, Stability of slope, Retaining walls, Introduction, Active and passive pressure due to fill, Point of application, Earth pressure due to uniform surcharge, Effect of saturation.

Books:

1. “Elements of Earthquake Engineering” by Jaikrishna and Chandrasekharan, Saritha Prakasham, Meerut.
2. “Dynamics of Structures, Theory and Applications to Earthquake Engineering” by Anil K. Chopra, Prentice Hall of India.

ST 2.5 – SUBSTRUCTURE DESIGN

Substructure Design: Introduction, Substructure – Definition and purpose, Role of foundation engineers, General requirements of substructure, Scope.

Ground Improvement Techniques: Introduction, Soil stabilization, Sand pile accept, Stone columns, Reinforced earth – Introduction, Basic mechanisms of reinforced earth, Choice of soil, Reinforcement, Strength characteristics of reinforced soil, Reinforced earth retaining walls and reinforced earth slab.

Marine Substructures: Introduction, Type of marine structures – Break waters, Wharves, Piers, Seawalls, Docks, Quay walls, Locks and moorings, Design loads, Combined loads, Wave action, Wave pressure on vertical walls, Ship impact on piled wharf structures, Design of breakwaters, Rouble-Mound break waters, Wall type break water, Gravity wall and anchored bulk head wharf structures, Design of piled wharf structures.

Sheet Piles: Introduction, Type of sheet pile structures, Design of cantilever sheet piling wall, Design of anchored bulkheads, Anchorage methods, Design of braced sheeting in cuts, Design of cellular cofferdams.

Foundations in Expansive Solis: Introduction, Mineral structure, Identification of expansive soils, Swell potential and swelling pressure, Traditional Indian practice, Methods of foundations in expansive soils, Replacement of soils and ‘CNS’ concept under reamed pile foundation, Remedial measure for cracked buildings.

Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Machine Foundations: Types of foundations, Design criteria, IS code previsions, Construction details of machine foundations vibration isolation.

References:

1. “Analysis and Design of Substructures Limit State Design” by Swami Saran, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. **“**Dynamics of Bases and Foundations” by Barken**.**McGraw Hill Company.

ST 2.6 – REHABILITATION AND REPAIR OF STRUCTURES

Materials: Construction chemicals, Mineral admixtures, Composites, Fibre reinforced concrete, High performance concrete, Polymer-impregnated concrete.

Techniques to Test the Existing Strengths: Destructive and non-destructive tests on concrete.

Repairs of Multistorey Structures: Cracks in concrete, Possible damages to the structural element beams, Slab, Column, Footing, etc., Repairing techniques like Jackchu, Grouting, External prestressing, Use of chemical admixtures, Repairs to the fire damaged structure.

Repairs to Masonry Structures & Temples: Damages to masonry structures – Repairing techniques, Damages to temples – Repairing techniques.

Foundation Problems: Settlement of soils – Repairs, Sinking of piles – Repairs.

Corrosion of Reinforcement: Preventive measures – Coatings – Use of SBR modified cementitious mortar, Epoxy resin mortar, Acrylic modified cementitious mortar, Flowing concrete.

Temporary Structures: Need for temporary structures under any Hazard, Various temporary structures, Case studies.

Case Studies: At least 10 case studies.

References:

1. "Renovation of Structures" by Perkins.
2. "Repairs of Fire Damaged Structures" by Jagadish, R.
3. "Forensic Engineering" by Raikar, R.N.
4. "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill.
5. "Concrete Structures: Repairs, Water Proofing and Protection" by Philip H. Perkins, Applied Sciences Publications Ltd., London, pp.302.
6. "Durability of Concrete Structure: Investigation, Repair, Protection" Edited by Geoffmangs, E. & FN SPON, An Imprint of Chapman & Hall, pp.270.
7. "Structural Failure" by Tomoss Weirzbicki, Norman Jones, Wiley Interscience, pp.551.
8. "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill, pp.375.
9. "Design and Construction, Failures, Lessons from Forensic Investigation" by Dov Kaminetzky, McGraw Hill, pp.600.

III-SEMESTER

ST 3.1 – INDUSTRIAL STRUCTURES

Introduction: Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Limit load, Coplanar load, Upper lower bound theorems. Redistribution of moments continuous beams: Relevant or irrelevant mechanisms, Types of mechanisms method for performing moment check.

Portal frame, Mechanisms, Combination of mechanisms, Moment check. Partial complete and over complete collapse.

Instantaneous Centre: The rigid frame, The instantaneous center of rotation, Multistorey Frames: Combination of mechanisms.

Light gauge steel structures: Local buckling of thin sections, Post packing of thin elements, Light gauge steel columns and compression members, Form factor for columns and compression members, Stiffened compression elements, Multiple stiffened compression elements, Unstiffened compression elements effective length of light gauge steel compression members, Basic design stress, Allowable design stress, Light gauge steel beams, Laterally supported light gauge steel beams web coupling. Allowable design stress in beams, Beams subjected to combined axial end bending stress connections.

Design of Steel Towers, Trestles and Masts: Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Analysis of towers (analysis as coplanar assembly of trestles), Mast, Trestle, Stress in trestle due to vertical loads, Stress in trestles due to horizontal loads, Design of members in towers, Design of foundation of towers.

Analysis of Mill Bents: Types of mill bents, Loads on mill bents, Assumption made in mill bent analysis, Analysis for wind loads, For various edge conditions of mill bents, Mill bents with double columns shear and moment diagrams, Wind loads analysis for two step columns.

Design of RCC and Steel Chimneys for wind and gravity laods.

Books:

1. “Plastic Analysis of Structures” by Beedle.
2. “Fundamentals of Structural Analysis” by Jakkula & Stephenson, Von Nostrand, East West Press.
3. “Design of Steel Structures” by Arya & Ajmani, Nemchand Publishers.

ST 3.2 – OPTIMIZATION TECHNIQUES

Introduction: Need and scope of optimization, Historical development. Statement of an optimization problems, Objective function and its surface, design variables, constraints and constraint surface. Classification of optimization problems, Various functions (continuous, discontinuous, and discrete) and Function behaviour (Monotonic, Non-monotomic and Unimodal).

Classical Optimization Techniques: Differential calculus method, Multivariable optimization by method of constrained variation and Lagrangian multipliers (generalized problem). Kuhn-Tucker conditions for optimality.

Fully stressed design and optimally criterion based algorithms, Introduction, Characteristics of fully stressed design theoretical basis – Examples.

Non-linear Programming: Unconstrained minimization – Fibonacci, Golden section, Quadratic and Cubic interpolation methods for a one-dimensional minimization and univariate method, Powel’s method, Newton’s method and Davidon Fletcher Powell’s method for multivariable optimization. Constrained minimization – Cutting plane method, Zoutendijk’s method and penalty function methods.

Linear programming – Definitions and theorems – Simplex method – Duality in linear programming. Plastic analysis and minimum weight design and rigid frame.

Introduction to quadratic programming, Geometric programming and Dynamic programming. Design of beams and frame using dynamic programming technique.

References:

1. “Optimization Theory and Applications” by Rao, S.S., Wiley Eastern Ltd., New Delhi, 1978.
2. “Mathematical Foundations for Design: Civil Engg. Systems” by Robert, M. Stark and Robert L. Nicholls, McGraw Hill Book Company, New York, 1972.

3. “Optimum Structural Design, Theory and Applications”, Edited by Gallegher, R.H. and Zienkiewiez, O.C., John Wiley and Sons, New York, 1973.
4. “Optimum Design of Structures” by Majid, K.I., Newnes-Butter Worths, London, 1974.

ST 3.3 – DESIGN OF STRUCTURES

Any TWO of the following:

a) Design of Folded Plates.

b) Design of Quay Walls.

c) Design of Bridges.

d) Design of Shells.