MCE/SE/101 THEORY OF ELASTICITY AND PLASTICITY

1. **Analysis of stress and strain in three dimensions**
   Stress at a point – components of stress; Principal stresses; Stress ellipsoid and stress director surface; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress; strain at a point – Components of strain; Differential equations of equilibrium ; Conditions of compatibility; Generalised Hooke's law

2. **Two-dimensional problems in rectangular coordinates**
   Plane stress ; Plane strain; Differential equations of equilibrium; Boundary conditions; Compatibility equations; Stress function; Governing differential equation; Solution by polynomials; End effects – Saint-Venant's Principle; Determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam by uniform load

3. **Two-dimensional problems in polar coordinates**
   General equations in polar coordinates; Stress distribution symmetrical about an axis; Effect of circular holes on stress distribution in plates; Concentrated force at a point of a straight boundary; Concentrated force acting on a beam; Stresses in a circular disc

4. **Torsion**
   Torsion of straight bars – Saint Venant's theory; Elliptic cross section; Membrane analogy; Torsion of a bar of narrow rectangular cross-section; Torsion of rolled profile sections; Torsion of thin tubes

5. **Plasticity**
   Yield criteria – Introduction, The Tresca yield criterion, The von Mises yield criterion; Stress-Strain relations – Introduction, Plastic potential and Plastic flow, Levy-Mises equations, Prandtl-Reuss equations

Text Books

1) Theory of elasticity by S.P.Timoshenko & J.N.Goodier, McGraw-Hill.
2) Advanced mechanics of solids by LS Srinath, TataMcGra-Hill
3) Computational elasticity by M. Ameen, Narosa Publishing House.
4) Introduction to Engineering plasticity by GK Lal and NV Reddy, Narosa Publishing House.
5) Plasticity for structural engineers by Chen and Han, Cengage Learning.

MCE/SE/102 DYNAMICS OF STRCUTURES

1. Introduction

Fundamental objective of structural dynamics; Types of prescribed loadings ; Essential characteristics of a dynamic problem; Methods of descritisation – Lumped, Generalised displacements, Finite element concept; Formulation of equation of motion ; Dynamic equilibrium equation using D'Alembert's Principle

2. Single-Degree-of-Freedom Systems

Force-displacement relation – Linear elastic systems; Damping force; Equation of motion-external force; Mass-spring-damper system; Undamped free vibration; Viscously damped free vibration; Harmonic vibration of undamped and viscously damped systems; Response to periodic excitation; Response to unit impulse; Response to arbitrary force; Response to step force; Response to rectangular pulse force; Numerical evaluation of dynamic response – Newmark's method

Earthquake response of linear systems – Earthquake excitation , Equation of motion, Response quantities, Time history analysis using Newmark's method for a particular ground motion (EL CENTRO), Response spectrum concept , Pseudo acceleration response spectrum, Peak structural response from the response spectrum, Elastic design spectrum

3. Multi-Degree-Of-Freedom Systems

Undamped free vibrations – Analysis of vibration frequencies, analysis of vibration mode shapes, orthogonality conditions

Analysis of dynamic response – Normal coordinates, Uncoupled equations of motion (undamped and viscously damped), Mode (displacement) superposition analysis – Viscously damped

Numerical evaluation of dynamic response - Newmark's method

4. Systems with Distributed Mass And Elasticity

Undamped and viscously damped free vibration of beams ; Analysis of dynamic response – Normal coordinates, uncoupled flexural equations of motion (undamped and viscously damped)

Analysis dynamic response – Normal coordinates; Uncoupled flexural equations of motion (undamped and viscously damped)

Text Books :

1) Dynamics of Structures by R.W. Clough and P.E. Penzien , McGraw-Hill, 1993.
2) Dynamics of Structures by A.K.Chopra , Prentice-Hall of India, 2001.
3) Structural Dynamics by Mario Paz, CBS Publishers, 1987.
4) Structural dynamics by M. Mukhopadhyay, Ane Books India .

MCE/SE/103 MATRIX METHODS OF STRUCTURAL ANALYSIS

(1) Basic Concepts of Structural Analysis :

Introduction; Types of Framed Structures; Deformations in Framed Structures; Actions and Displacements; Equilibrium; Compatibility; Static and Kinematic Indeterminacy; Structural Mobilities; Principle of Superposition; Action and Displacement Equations; Flexibility and Stiffness Matrices; Equivalent Joint Loads; Energy Concepts; Virtual Work.

(2) Fundamentals of the Flexibility Method:

Introduction; Flexibility Method; Temperature changes; Prestrains and Support Displacements; Joint Displacements; Member End Actions and support reactions; Flexibilities of prismatic members; Formalization of the Flexibility method.

(3) Fundamentals of the Stiffness Method :

Introduction; Stiffness Method; Temperature changes; Prestrains and Support Displacements; Stiffness of Prismatic Members; Formalization of the Stiffness Method.

(4) Computer Oriented Direct Stiffness Method :

Introduction; Direct Stiffness Method; Complete Member Stiffness Matrices; Formation of Joint Stiffness Matrix; Formation of Load Vector; Rearrangement of Stiffness and Load Arrays; Calculation of Results; Analysis of Continuous Beams; Plane Truss Member Stiffness; Analysis of Plane Trusses; Rotation of Axes in Two Dimensions; Application to Plane Truss Members; Rotation of Axes in Three Dimensions; Plane Frame Member Stiffness; Analysis of Plane Frames.

(5) Computer Programs for Framed Structures:

Flow Chart for the analysis of the following structures:

i) Continuous Beam
ii) Plane Truss
iii) Plane Frame

(6) Miscellaneous:

Analysis of large structures; Sub-structuring ; Static condensation procedure; Non – prismatic and curved members.

Text Books :

1. Matrix Analysis of Framed Structures by W. Weaver & J.M.Gere, CBS Publishers, 1986.
2. Computational structural mechanics by S.Rajasekharan and G. Sankarasubramanian, Prentice Hall of India , 2001.
3. Matrix and finite element analyses of structures by M.Mukhopadhay and A.H.Sheikh, Ane Books, 2004.

MCE/SE/104A ADVANCED THEORY AND DESIGN OF RCC STRUCTURES

1. **Behaviour of RCC members in Shear and Torsion**
   Kani's theory for shear; Skew bending theory for torsion; Different modes of failure; Design of beams in combined shear, bending and torsion

2. **Detailing of RCC structures**
   Basic principles of detailing – Truss analogy, Directional changes, General layout of reinforcement; Beam-column joints – Strut- and-Tie model, Detailing ; Beam-to-girder joints; Corners and T-Joints; Brackets and corbels

3. **Design of shear walls**
   Introduction; Classification of shear walls; Classification according to behaviour; Loads on shear walls; Design of rectangular and flanged shear walls

4. **Flat slabs**
   Shear in flat slabs and flat plates – One-way shear, Two-way (punching) shear, Shear due to unbalanced moment, Shear reinforcement design; Equivalent frame analysis of flat slabs – Historical development and definition of equivalent frame, Moment of inertia of slab-beams, Theoretical column stiffnesses, Use of published data for flat \ slabs, equivalent column method, arrangement of live load, Reduction in negative moments, Design procedure

5. **Yield line analysis of slabs**
   Introduction; Upper and lower bound theorems; Rules for yield lines; Analysis by segment equilibrium; Analysis by virtual work; Orthotropic reinforcement and skewed yield lines; special conditions at edges and corners; Fan patterns at concentrated loads; Limitations of yield line theory

6. **Design of statically indeterminate RC structures**
   Development of moment curvature diagrams; Moment redistribution in RC structures; Baker's method of design; Ductility of RC members; Confined concrete; Cambridge method of design ; Generation of load-deflection diagrams

Text books :

1. Advanced reinforced concrete design by P.C.Varghese, Prentice-Hall of India, 2005.
2. Reinforced concrete structural elements by P.Purushothaman, Tata McGraw-Hill, 1984.
3. Reinforced concrete design by S.U. Pillai and D.Menon, Tata McGraw-Hill, 2003.
4. Design of concrete structures by A.H.Nilson, McGraw-Hill, 1997.
5. Reinforced concrete structures by R.Park and T.Paulay, John Wiley & Sons, 1975.
6. Reinforce and Pre-stressed concrete structures by Kong and Evans, ELBS,1995.

MCE/SE/104B ARTIFICIAL INTELLIGENCE

Introduction of Artificial Intelligence (AI) techniques, potential benefits of AI techniques and its limitations.

Fundamentals of neural networks, back-propagation networks, Application of neural networks for various civil engineering problems.

Fuzzy sets and Crisp sets, Fuzzy Union, Fuzzy Intersection, Membership functions, fuzzification, fuzzy to crisp conversions, defuzzificattion, Theoretical representations of fuzzy sets and its application to project scheduling.

Aggregation Procedures, Fuzzy decision Making, Multi objective decision making, Minimax Criteria, Dominance Criteria, Applications of Fuzzy set theory in civil engineering for evaluation of alternatives, tender evaluation etc.

Need for Optimization, Fuzzy Linear Programming, symmetric Fuzzy Linear programming, tolerance interval, and its application to civil engineering problems.

Text Books :

1. Fuzzy logic with engineering applications by Timothy J. Ross, McGraw-Hill, Inc.
2. Zimmerman, H. J. (1996). "Fuzzy set theory ." Allied Publishers, India.
3. Dubios, D., and Prade, H. “Fuzzy sets and Systems: theory and applications.” Academic Press, New York, 1980.
4. Neural Networks, Fuzzy logic and Genetic Algorithms by Rajasekharan and Pai, PHI Learning

MCE/SE/104C STRUCTURAL OPTIMIZATION

1. Introduction

Function optimization and parameter optimization; Elements of problem formulation; The solution process; Analysis and design formulations; Specific versus General methods

2. Classical Tools in Structural Optimization

Optimization using differential calculus; Optimization using variational calculus; Classical methods for constrained problems; Local constraints and the minmax approach; Necessary and sufficient conditions for optimality; Use of series of solutions in structural optimization

3. Linear Programming

Limit analysis and design of structures; Prestressed concrete design by linear programming; Minimum weight design of statically determinate trusses ; A linear program in a standard form; The simplex method; Duality in linear programming

4. Unconstrained optimization

Minimization of functions of one variable; Minimization of functions of several variables; Specialised quasi-Newton methods; Probabilistic search algorithms

5. Constrained optimization

The Kuhn-Tucker conditions; Quadratic programming problems; Computing the Lagrange multipliers; Sensitivity of optimum solution to problem parameters; Gradient projection and reduced gradient methods; The penalty function methods ; Multiplier methods

6. Aspects of optimization process in practice

Generic approximations; fast reanalysis techniques; Sequential linear programming; Sequential non-linear approximate optimization; Special problems asscociated with shape optimization ; Optimization packages; Test problems – Ten bar truss

Text books :

1. Elements of structural optimization by Haftka and Gurdal ; Publisher : Springer
2. Structural optimization : Fundamentals and applications by U. Kirsch; Publisher : Springer
3. Optimization : Theory and Applications by SS Rao, Wiley Eastern Ltd.

MCE/SE/105A FRACTURE MECHANICS OF CONCRETE

1. **Introduction to fracture mechanics of concrete**
   Structural failure based on material performance; Concepts of linear elastic fracture mechanics; Fracture mechanics of concrete

2. **Principles of linear elastic fracture mechanics**
   Airy stress functions for problems in elasticity; Complex stress function; Elastic stress and displacement fields at crack tip; Stress intensity factors and crack opening displacements for useful geometries; Superposition of stress intensity factors; Plastic zone at crack tip; Griffith's fracture theory; Strain energy release rate for crack propagation; Relationship between stress intensity factor and strain energy release rate; Design based on linear elastic fracture mechanics

3. **Principles of non-linear fracture mechanics**
   Energy principles for crack propagation in non-linear materials; J-integral for non-linear elastic materials; Fracture resistance (R curve); Crack tip opening displacement;

4. **Structure and fracture process of concrete**
   Constituents and microstructure of concrete; Fracture behaviour and strain localization of concrete; Fracture process zone and toughening mechanisms; Experimental determination of fracture zone; Influence of fracture process zone on fracture behaviour of concrete

5. **Non-linear fracture mechanics for Mode I Quasi-Brittle Fracture**
   General description of quasi-brittle fracture; Fictitious approach – Energy dissipation for fictitious crack, Fictitious crack model by Bazant and Oh, Determination and influence of σ (w) relationship, Some comments on fictitious crack approach; Effective elastic approach – Energy dissipation for effective-elastic crack, Two-parameter fracture model by Jenq and shah, Size effect model by Bazant and Kazemi, Effective crack model by Karihaloo and Nallathambi, Effective crack model by Refai and Swartz, Some comments on effective-elastic crack approach; Comparison between Fictitious and effective-elastic crack approaches; Finite element analysis – Discrete crack approach, Smeared crack approach , Software available

Text Books :

1. Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials by Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang, Publisher : Wiley , 1995.
2. Analysis of Concrete Structures by Fracture Mechanics by by L. Elfgren, Publisher**:** Routledge, 1990.
3. Fracture mechanics – Applications to concrete , Edited by Victor C.Li and Z.P.Bazant, ACI SP118.
5. Elements of fracture mechanics by Prashant Kumar, Wheeler Publishing, 1999.

MCE/SE/105B FIBRE REINFORCED PLASTIC COMPOSITES

1. **Introduction**
   Definition; History of fibre reinforced composites; Constituent materials – Fibres, Polymeric matrix, Prepregs; Lamina and Laminate; General characteristics of FRP; Micromechanics and macromechanics; Properties of typical composite materials; Applications of FRPs in Civil engineering

2. **Processing of FRP Composites**
   Contact moulding; Compression moulding methods ; Filament winding

3. **Macromechanical behaviour of a lamina**
   Introduction; Stress-strain relations of a lamina with respect to its principal axes; Stress-strain relations of an arbitrarily oriented lamina; Typical elastic properties of a unidirectional lamina

4. **Macromechanical behaviour of a laminate**
   Introduction; Classical lamination theory – Lamina stress strain behaviour, Strain and stress variation in a laminate, Resultant laminate forces and moments; Special cases of laminate stiffnesses

5. **Design of FRP structures**
   Introduction; Composite structural design; The design spiral; Design criteria; Design allowables; Material selection; Selection of configuration and manufacturing process; Laminate design – selection of laminate, laminate design problem, laminate design Procedure; Mathematical analysis of the laminate – estimation of shear force, estimation of deflection, mathematical algorithm; Design examples – design of tension member, laminate design for strength, laminate design for stiffness

6. **Composite Joints**
   Introduction; Classes of laminate joints; Bonded joints- stress distribution, modes of failure, Merits and demerits of adhesive bonded joints; Mechanical joints – failure modes, advantages and disadvantages

Text books :

1. Mechanics of composite materials and structures by Madhujit Mukhopadhay, Universities Press, 2004.
2. Mechanics of composite materials by R.M.Jones, Publisher : Taylor & Francis, 1998.

MCE/SE/105C EXPERIMENTAL STRESS ANALYSIS AND MOTION MEASUREMENT

1. **Introduction to Strain Measurements**
   Experimental determination of strain; Properties of strain gage systems; Types of strain gages

2. **Strain Measurement using Electrical Resistance Strain Gages**
   Introduction; Strain sensitivity in metallic alloys; Gage construction; Strain gage adhesives and moulding methods; Gage sensitivities and gauge factor; The Wheatstone bridge ; Wheatstone bridge sensitivity; Temperature compensation ; Static recording and data logging – Manual strain indicators, Automatic data acquisition systems, PC based data acquisition systems; Strain analysis methods – Three element rectangular rosette

3. **Stress analysis using Photoelasticity**
   Wave theory of light; Refraction of light; The Polariscope – Plane polarisers, wave plates; Plane polariscope; Circular polariscope; Diffused light polariscope; The stress optic law for two-dimensional plane-stress bodies; Two-dimensional photoelastic stress analysis – Isochromatic fringe patterns, Isoclinic fringe patterns, Calibration methods, Principal stress separation methods, Scaling model-to-prototype stresses; Materials for two dimensional photoelasticity; Three-dimensional photoelasticity – Stress freezing

4. **Model analysis of Structures**
   Introduction – Objectives of structural model studies, Some basic definitions, Types of similitude , Classification of model studies, Model materials, Size effects; Principles of similitude – Dimensional analysis, Buckingham π Theorem, Variables in structural behaviour; Requirements of similitude; Direct approach

5. **Motion Measurement**
   Introduction; Vibrometers and Accelerometers; The seismic instrument; General theory of the seismic instrument; The seismic accelerometer; Practical accelerometers

Text Books :

1. Experimental Stress Analysis by Dally and Riley, McGraw-Hill, 1991.
2. Mechanical measurements by Bechwith, Merangoni & Lienhard, Pearson Education, 2003.
3. Model analysis of Structures by T.P.Ganesan, Universities Press, 2000.

MCE/SE/106A CONSTRUCTION ENGINEERING AND MANAGEMENT

1. Introduction

Classification of construction works; Various stages in the construction of a project

2. Construction equipment

Introduction; Classification of construction equipment; Earthmoving equipment; Hauling equipment; Hoisting equipment; Conveying equipment; Aggregate and concrete production equipment; Pile driving equipment; Tunneling and drilling equipment; Pumping and dewatering equipment

3. Management of Construction

Introduction; Management requirement; Need for mechanization; Financial aspects of construction plants and equipment; Factors affecting selection of construction equipment; Planning of construction equipment; Factors affecting the cost of owning and operating construction equipment; Planning of infrastructure for mechanisation; Role of operations research; Equipment management

4. Materials Management

Importance; Objectives; Costs; Functions of materials management department; Uses of materials management; Stores management; Materials procurement Materials handling

5. Construction Safety Management

Introduction; Importance of safety ; Causes of accidents; Responsibility for safety; Safety measures; Role of various parties in safety management; Measures to improve safety in construction ; Prevention of fires at construction sites

6. Quality control in construction

Importance of quality; Elements of quality- quality characteristics, design quality, quality of conformance; Organisation for quality control; Quality assuarance techniques- Inspection, Testing, Sampling; Documentation; Quality control circles

7. Human Factors in Construction

Qualities of efficient construction managers; Personality; Ethics and integrity; Personal drive; Multidisplinary capability; Human relations

8. Value Engineering

Definition ; Value engineering job plan; Life cycle costing; Value engineering Applications

9. Management Information Systems

Introduction; Definition of organization; Definition of management; Definition of management information system; Computer as information system; Use of computer in construction industry; Requirements of management information system; A data base approach; Salient features of some software packages used in construction industry

10. Information Technology in Construction Industry

Introduction; Information flow and communication; Knowledge data base; Learning organization attributes; Use of information technology in construction industry; Role of artificial intelligence and expert systems

Text Books :

1. Construction Engineering and Management by S.Seetharaman, Umesh Publications, 2003.
2. Construction project management by KK Chitkara, TataMcGraw-Hill
3. Construction planning, Equipment and methods by R.L.Peurifoy, C.J.Schexnayder and Aviad Shaptra, McGraw-Hill, 2005.

MCE/SE/106B DESIGN OF TALL BUILDINGS

1. **General Considerations**
   Introduction; Definition of a tall building ; Lateral load design philosophy; Concept of premium for height; Factors responsible for slimming down the weight of structural frame; Development of high-rise architecture; structural concepts

2. **Wind effects**
   Design considerations; Nature of wind; Extreme wind conditions; Characteristics of wind; Provisions of IS875(Part3); Wind tunnel engineering – Introduction, Description, of wind tunnels; Objectives of wind tunnel tests, Rigid model studies, Aeroelastic study

3. **Seismic Design**
   Introduction; Tall building behaviour during earthquakes ; Philosophy of earthquake design; Provisions of IS1893(Part1).

4. **Lateral Systems for Steel Buildings**
   Introduction; Semi-rigid frames; Rigid frames; Braced frames; Interacting system of braced and rigid frames

5. **Lateral Systems for Concrete Buildings**
   Introduction; Frame action of column and slab systems; Flat slab and shear walls; Flat slab, shear walls and columns; Coupled shear walls; Rigid frame; Widely spaced perimeter tube; Core-supported structures; Shear-wall frame interaction

6. **Lateral Systems for Composite Construction**
   Introduction; Composite elements; Composite systems

7. **Gravity Systems**
   Concrete floor systems; Prestressed concrete systems; Composite metal decks

8. **Structural Analysis**
   Introduction; Partial computer models; General computer analysis techniques; Special techniques for planar shear walls; Finite element analysis

Text Books :

1. Structural Analysis and design of tall buildings by B.S.Taranath, McGraw-Hill, 1988.
2. Steel,Concrete and Composite design of tall buildings by B.S.Taranath, McGraw-Hill, 1997.
3. Tall building structures by B.S.Smith and A.Coull, John Wiley & Sons, 1991.

MCE/SE/106C ADVANCED GEOTECHNICAL ENGINEERING

1) **Bearing Capacity of shallow foundations subjected to special loading and ground conditions**

Effect of eccentric loading, inclined load, inclination of base of foundation, sloping ground; Bearing Capacity of stratified soils; Meyerhof analysis, Vesic's analysis and Hansen's analysis.

2) **Settlement analysis**

Contact pressure, sources of settlement, uniform settlement, differential settlement, construction practices to avoid differential settlement, allowable bearing pressure of sands from SPT, immediate settlement in sands and clays- Terzaghi and Janbu's methods for clays , Schmertmann and Hartman method for cohesionless soils; consolidation settlement.

3) Machine Foundation

Fundamentals of Vibration; Free and Forced Vibration with and without damping; Natural frequency of foundation; Soil system; Dynamic soil properties; Vibration Isolation; Types of machines and machine foundation; I.S. Code of practice for design and construction of block foundation for reciprocating and impact type machines and framed foundations for high speed rotary machines.

4) Geotechnical Earthquake Engineering

Effect of type soil on the response spectrum; Liquefaction – Definition and types, Effect of liquefaction on built environment, Evaluation of liquefaction susceptibility, liquefaction hazard mitigation; Seismic slope stability – Introduction, Pseudo-static analysis, sliding block method.

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5) **Foundations in Expansive Soils**

Problems with expansive soils, Identification of expansive soils, Field observation to identify expansive soils, classification of expansive soils, swell pressure – Free swell method, constant volume method and method of different surcharges; Under- reamed pile foundations, CNS layer method, lime stabilization of expansive soils, lime- slurry pressure injection method.

Text books :

1) Hand book of machine foundations by Sreenivasulu, P & Vaidyanathan,C.V.
2) Foundation Analysis & Design by Bowles, J.E., McGraw- Hill Book Company.
3) Principles of Foundation Engineering, B.M. Das., PWS Publishing Company, ITP An International Thomson Publishing Company.
4) Geotechnical Earthquake Engineering by Steven L. Kramer, Pearson Education.
5) Basic and Applied Soil Mechanics by Gopal Ranjan and ASR Rao, Wiley Eastern Limited, New Delhi.
6) Geotechnical Engineering by SK Gulati & Manoj Datta, Tata McGraw- Hill Publishing Company Limited.
7) Foundations on Expansive Soils by F.H. Chen.
8) Soil dynamics and Machine Foundations by Swami Saran, Galgotia Publications Pvt. Ltd., New Delhi.

MCE/SE/151 STRUCTURAL ENGINEERING LABORATORY

Any 10 of the following experiments are to be carried out :

1. Study of the effect of water/cement ratio on workability and strength of Concrete.
2. Study of the effect of aggregate /cement ratio on strength of concrete
3. Mix design methods using a) I.S. Code method b) ACI Code method
4. A study of correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture
5. A study of behaviour of under-reinforced and over-reinforced beams
6. A study on the effect of span to depth ratio on the failure pattern of RC beams
7. A study of the effect of pre-stressing on the flexural behaviour of beams
8. Measurement of static strain by electrical resistance strain gauge
9. Determination of the material fringe value of a given photo elastic material.
10. Determination of principal stress difference in a circular disc subjected to diametrical compression.
11. Determination of principal stresses in a bar subjected to axial tension.
12. Determination of stress concentration factor
13. Dynamics of a three storey building frame subjected to harmonic base motion
14. Dynamics of three storey building frame subjected to non-harmonic (periodic) base motion
15. Dynamics of a one-storey building frame with planar asymmetry subjected to harmonic base motion

MCE/SE/201 FINITE ELEMENT ANALYSIS OF STRUCTURES

1. Basic Principles

Equilibrium equations; Strain-displacement relations; Linear constitutive relations; Principle virtual work; Principle of stationary potential energy

2. Element Properties

Different types of elements; Displacement models; Relation between nodal degrees of freedom and generalized coordinates; Convergence requirements; Compatibility requirement; Geometric invariance; Natural coordinate systems; Shape functions; Element strains and stresses; Element stiffness matrix; Element nodal load vector

Isoparametric elements – Definition, Two-dimensional isoparametric elements – Jacobian transformation, Numerical integration

3. Direct Stiffness method and Solution Technique

Assemblage of elements–Obtaining Global stiffness matrix and Global load vector; Governing equilibrium equation for static problems; Storage of Global stiffness matrix in banded and skyline form; Incorporation of boundary conditions; Solution to resulting simultaneous equations by Gauss elimination method

4. Plane-stress and Plane-strain analysis

Solving plane stress and plane-strain problems using constant strain triangle and four nodded isoparametric element

5. Analysis of plate bending

Basic theory of plate bending; Shear deformation plates; Plate bending analysis using four noded isoparametric element

6. Analysis of shells

Degenerated shell elements – Evaluation of element stiffness matrix and load vector for eight noded isopametric shell element

Text books :

1. Finite element analysis by C.S.Krishnamurthy, Tata-McGraw-Hill, 1994.
2. Matrix and finite element analyses of structures by M.Mukhopadhay and A.H.Sheikh, Ane Books, 2004.
3. Concepts and applications of finite element analysis by R.D.Cook et.al., John Wiley and Sons, 1989.

MCE/SE/202 STABILITY OF STRUCTURES

1. **Buckling of columns:**
   Introduction; Methods of finding critical loads; Critical loads for straight columns with different end conditions and loading; Inelastic buckling of axially loaded columns; Energy methods; Prismatic and non-prismatic columns under discrete and distributed loading; General Principles of elastic 0stability of framed structures.

2. **Buckling of Thin walled members of open cross section:**
   Torsion of thin-walled bars; warping; Non-uniform torsion; Torsional buckling under axial loading; Combined bending and torsion buckling.

3. **Lateral Buckling of Beams :**
   Beams under pure bending; Cantilever and simply supported beams of rectangular and I sections; Beams under transverse loading; Energy methods; Solution of simple problems.

4. **Buckling of Rectangular Plates:**
   Plates simply supported on all edges and subjected to constant compression in one or two directions; Plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.

5. **Buckling of Shells:**
   Introduction to buckling of axially compressed cylindrical shells.

6. **Mathematical treatment of stability problems:**
   Discrete/Discontinuous systems; Eigen value problem; Converting continuous systems to discrete systems using the finite element method – Buckling of a column with sudden change in cross-section

Text books :

1. Theory of elastic stability by Timoshenko & Gere, McGraw Hill, 1961.
2. Background to buckling by Allen and Bulson, McGraw-Hill, 1980.
3. Elastic stability of structural elements by N.G.R.Iyengar, Macmillan India Ltd., 2007.

MCE/SE/203 THEORY OF PLATES AND SHELLS

1. **Bending of long rectangular plates to cylindrical surface**
   Differential equation for cylindrical bending of plates; Cylindrical bending of uniformly loaded rectangular plates with simply supported edges; Cylindrical bending of uniformly loaded rectangular plates with clamped edges

2. **Pure bending of plates**
   Slope and curvature of slightly bent plates; Relations between bending moments and curvature in pure bending of plates; Particular cases of pure bending; Strain energy in pure bending of plates; Limitation on the application of the derived Formulae

3. **Symmetrical bending of circular plates**
   Differential equation for symmetrical bending of laterally loaded circular plates; Uniformly loaded circular plates; Circular plate loaded at centre

4. **Small deflections of laterally loaded plates**
   Differential equation of the deflection surface; Boundary conditions; Simply supported rectangular plates under sinusoidal load; Navier's solution for simply supported rectangular plates; Further applications of the Navier's solution; Levy's solution for simply supported and uniformly loaded rectangular plates; Concentrated load on a simply supported rectangular plate

5. **Introduction to Shells**
   Parametric representation of a surface; The first quadratic form; Equation to the normal of a surface; The second quadratic form; Principal curvatures, Gauss curvature, and lines of curvature; Some definitions; Classification of shell surfaces

6. **Cylindrical shells**
   Membrane theory of cylindrical shells; Bending theory of cylindrical shells loaded Symmetrically –Approximate solution by Schorer's method, Beam method of analysis

7. **Shells of double curvature : Membrane theory**
   Shells of revolution; Shells of double curvature; Synclastic shells; Anticlastic shells

8. **Folded Plates**
   Structural behaviour of folded plates; Equation of three shears; Application of Simpson's and Whitney's methods

Text books :

1. Theory of plates and shells by S.P.Timoshenko and S.Woinowsky-Krieger, McGraw-Hill, 1959.
2. Stresses in plates and shells by A.C.Ugural, McGraw-Hill, 1999.
3. Analysis of plates by T.K.Varadan and K.Bhaskar , Narosa Publishing House, 1999.
4. Design and construction of concrete shell roofs by G.S.Ramaswamy, CBS Publishers& Distributors,1986.

MCE/SE/204A EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

1. **Design forces for buildings**
   Introduction; Equivalent static method; Mode superposition technique; Dynamic inelastic-time history analysis; Advantages and disadvantages of these methods; Determination of lateral forces as per IS1893(Part 1) – Equivalent static method, Model analysis using response spectrum

2. **Ductility considerations in earthquake resistant design of RCC buildings**
   Introduction; Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920

3. **Earthquake resistant design of a long two-storey , two-bay RCC building**
   Determination of lateral forces on an intermediate plane frame using Equivalent static method and Model analysis using response spectrum; Analysis of the intermediate frame for various load combinations as per IS1893(Part 1); Identification of design forces and moments in the members; Design and detailing of typical flexural member ,typical column, footing and detailing of a exterior joint as per IS13920.

4. **Steel Buildings**
   Behavior of steel; Materials and workmanship; Steel frames – unbraced, braced; Ductile design of frame members; Flexural members; Frame members subjected to axial compression and bending; Connection design and joint behaviour ; Steel panel zones; Bracing members

5. **Base isolation of structures**
   Introduction; Considerations for seismic isolation; Basic elements of seismic isolation; seismic-isolation design principle; Feasibility of seismic isolation; Seismic-isolation configurations

Text books :

1. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.
2. Seismic design of reinforced concrete and masonry buildings by T.Paulay and M.J.N.Priestley, John Wiley & Sons, 1991.
3. Earthquake resistant design of structures by SK Duggal , Oxford University Press.
4. The seismic design handbook, Edited by F.Naeim, Kluwer Academic publishers, 2001.

MCE/SE/204B DISASTER MANAGEMENT

Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

Overview of Disaster situations in India: Vulnerability of profile of India and Vulnerability mapping including disaster – pone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction and rehabilitation. Case Studies: Lessons and Experiences from Various Important Disasters in India

Seismic vulnerability of urban areas. Seismic response of R.C frame buildings with soft first storey. Preparedness for natural disasters in urban areas. Urban earthquake disaster risk management. Using risks-time charts to plan for the future. Lateral strength of masonry walls. A numerical model for post earthquake fire response of structures.

Landslide hazards zonation mapping and geo-environmental problems associated with the occurrence of landslides. A statistical approach to study landslides. Landslide casual factors in urban areas. Roads and landslide hazards in Himalaya. The use of electrical resistivity method in the study of landslide. Studies in rock-mass classification and landslide management in a part of Garhwal-Himalaya, India.

Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Response of buried steel pipelines carrying water subjected to earthquake ground motion. Preparedness and planning for an urban earthquake disaster. Urban settlements and natural hazards. Role of knowledge based expert system in hazard scenario.

Text books :

1. Natural Hazards in the Urban Habitat by Iyengar, C.B.R.I., Tata McGraw Hill.
2. Natural Disaster Management, Jon Ingleton (Ed), Tulor Rose, 1999.
3. Disaster Management, R.B.Singh (Ed),Rawat Publications, 2000.
4. Disaster Management by Ramakant Gaur , Authorpress, 2008.
4. Anthropology of Disaster Management, Sachindra Narayan, Gyan Publishing House, 2000.

MCE/SE/204C GROUND IMPROVEMENT TECHNIQUES

1. **Introduction**

   Need for engineered ground improvement, classification of ground modification techniques; suitability, feasibility and desirability of ground improvement technique; objectives of improving soil.

1. **In-situ densification methods in granular soils**

   Introduction, Vibration at the ground surface, impact at the ground surface, vibration at depth, impact at depth.

2. **In-situ densification methods in cohesive soils**

   Introduction, preloading, sand drains, sand wicks, band drains, stone and lime columns.

3. **Reinforced earth**

   Principles, components of reinforced earth, governing design of reinforced earth walls, design principles of reinforced earth walls.

4. Geotextiles

Introduction, types of geotextiles, functions and their applications, tests for geotextiles, geogrids and its functions.

5. **Mechanical Stabilization**

   Soil aggregate mixtures, properties and proportioning techniques, soft aggregate stabilization, compaction, field compaction control.

7. Cement Stabilization

Mechanism, factors affecting and properties, use of additives, design of soil cement mixtures, construction techniques.

8. Lime and Bituminous Stabilization

Type of admixtures, mechanism, factors affecting, design of mixtures, construction methods.

Text Books :

1. Hausmann M.R(1990) Engineering Principles of ground modification, McGraw-Hill International edition.
2. Ground improvement Techniques, P.Purushothama Raju, Laxmi Publications Pvt. Ltd., New Delhi.
3. Robert M. Koerner, Designing with Geosynthatics, Prentice Hall New Jercy, USA.
4. Construction and Geotechnical methods in Foundation Engineering, R.M.Koerner, McGraw-Hill Book Company.
5. Current Practices in Geotechnical Engineering Vol.-I, Alam Singh and Joshi, International Book Traders, New Delhi.

MCE/SE/205A ADVANCED DESIGN OF STEEL STRUCTURES

1. **Wind loads on buildings**
   Introduction to wind load; Design wind speed and pressure; Wind pressure on roofs; Wind effect on cladding and louvers; Design of purlins for roofs and rails for cladding; Open sheds – Pitched roofs

2. **Braced industrial buildings**
   Introduction; Design of braced small industrial building with gantry

3. **Unbraced industrial buildings**
   Introduction; Rigid frames; Rigid frame knees; Gable frames ; Design of a simple gable frame industrial building with gantry

5. **Low-rise Multi-storey buildings**
   Introduction; Design of a two-storey building

6. **Towers**
   Introduction; Basic structural configurations; Loads on towers; wind load; Design of a simple tower

6. **Design of light gauge steel structures**
   Introduction; Types of sections; Material; Local buckling of thin elements; stiffened compression elements; Unstiffened compression elements; Compression members; Laterally supported flexural members; Laterally unsupported flexural members; Connections

Text books :

1. Design of steel structures by P.Dayaratnam , Wheeler Publishing, 1996.
2. Design of steel structures by A.S.Arya and J.L.Ajmani, Nemchand and Bros, 1996.
3. Economics of two-storey steel framed urban commercial building, INSDAG Publication, Kolkata.
4. Design of steel structures by B. Bresler, T.Y.Lin and J.B.Scalzi, John Wiley & Sons, 1968.
5. Design of steel structures by E.H .Galord,Jr. and C.N .Galord, McGraw-Hill, 1972.
6. Steel structures : Design and behaviour by C.G.Salmon and J.E.Johnson, Prentice-Hall, 1997.

MCE/SE/205B COMPOSITE CONSTRUCTION

1. Introduction

Steel-concrete composite construction; Economics of Steel-concrete composite construction – CBRI (India), British experience

2. Theory of composite structures

Objectives; Analysis of composite sections; Composite action; Failure modes; Creep and shrinkage

3. Composite beams - I

Introduction; Elastic behaviour of composite beams; Shear connectors; Ultimate load behaviour of composite beam; Serviceability limit states

7. Composite beams – II

Introduction; Applications of composite beam; Basic design considerations; Design application – Design equation for flexure, design using profile sheeting supported on steel beams, effect of degree of shear connection, Interaction between shear and moment, Serviceability; Effect of continuity- Analysis of continuous beams, Bottom flange stability, defection; Design of simply supported composite beam; Design of continuous composite beam

5. Composite columns

Introduction; Materials; Composite column design; Design method; Combined compression and uniaxial bending; Combined compression and biaxial bending; Steps in design; Design examples

6. Composite floors

Advantages of composite floors; Structural elements ; Bending resistance of composite slab; Shear resistance of composite slab; Serviceability criteria; Design considerations; Serviceability limit states

7. Connections in composite construction

Introduction; Ultimate strength of plastic region

Text books :

1. Composite construction using structural steel , INSDAG Publication, Kolkata
2. Handbook on composite construction – Multistorey buildings, INSDAG Publication, Kolkata.
3. Teaching resource for structural steel design, Vol. 2, INSDAG Publication, Kolkata .
4. Composite structures of steel and concrete, Vol. 1, Blackwell Scientific Publications,UK,1994.

MCE/SE/205C DESIGN OF PRESTRESSED CONCRETE STRUCTURES

1. **Design of Pre-tensioned and Post-tensioned Flexural members**
   Dimensioning of flexural members; Estimation of self weight of beams; Design of pre-tensioned beams; Design of post-tensioned beams

2. **Statically indeterminate pre-stressed concrete structures**
   Curvature diagrams of class I , II , III structures; Moment redistribution in prestressed concrete beam; Principle of design of Portal frames; Design of continuous beams; Cable profile – Concordant cable and linear transformation; Limit state of crack width for class IIII beams

3. **Prestressed concrete pipes and tanks**
   Circular prestressing; Types of prestressed concrete pipes; Design of prestressed concrete pipes; General features of prestressed concrete tanks; Analysis of prestressed concrete tanks; Design of pre-stressed concrete tanks

4. **Pre-stressed concrete poles, piles , sleepers and pressure vessels**
   Pre-stressing of concrete poles, piles , sleepers and pressure vessels

5. **Pre-stressed concrete slabs and grid floors**
   Types of pre-stressed concrete floor slabs; Design of pre-stressed concrete one-way slabs; Design of pre-stressed concrete two-way slabs; Design of pre-stressed concrete simple flat slabs; Design of pre-stressed concrete continuous flat slab floors; Analysis and design of pres-stressed concrete grid floors

6. **Pre-stressed concrete shells**
   Advantages of pre-stressing long span shell structures; Methods of pre-stressing shell structures; Design of pre-stressed concrete shell structures

Text Books:

1. Pre-stressed concrete by N.Krishna Raju, Tata-McGraw-Hill, 1995.
2. Pre-stressed concrete by N.Rajagopalan, Narosa Publishing House, 2005.
3. Pre-stressed concrete by T.Y.Lin & N.H.Burns, John Wiley & Sons,1981

MCE/SE/206A REPAIR AND REHABILITATION OF STRUCTURES

1. **Introduction**
   Deterioration of structures with aging; Need for rehabilitation

2. **Distress in concrete /steel structures**
   Types of damages; Sources or causes for damages; effects of damages; Case studies

3. **Damage assessment and evaluation models**
   Damage testing methods; Non-destructive testing methods

4. **Rehabilitation methods**
   Grouting; Detailing; Imbalance of structural stability; Case studies

5. **Methods of Repair**
   Shortcreting; Guniting; Epoxy-cement mortar injection; Crack ceiling

6. **Seismic Retrofitting of reinforced concrete buildings**
   Introduction; Considerations in retrofitting of structures; Source of weakness in RC frame building – Structural damage due to discontinuous load path; Structural damage due to lack of deformation; Quality of workmanship and materials; Classification of retrofitting techniques; Retrofitting strategies for RC buildings – Structural level (global) retrofit methods; Member level (local) retrofit methods; Comparative analysis of methods of retrofitting

Text books :

1. Diagnosis and treatment of structures in distress by R.N.Raikar, Published by R&D Centre of Structwel Designers & Consultants Pvt.Ltd., Mumbai, 1994.
2. Handbook on Repair and Rehabilitation of RCC buildings, Published by CPWD, Delhi, 2002 (freely available through Internet).
3. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.
4. Repair and protection of concrete structures by Noel P.Mailvaganam, CRC press London.
5. Concrete repair and maintenance Illustrated by Peter.H.Emmons, Galgotia publishers.
6. Failures and repair of concrete structures by S.Champion, John wiley and sons.
7. Handbook on seismic retrofit of buildings, Narosa Publishing House.

MCE/SE/206B ADVANCED BRIDGE ENGINEERING

1. **Types of bridges and Loading standards**
   Classification of bridges; Loading standards

2. **Bridge decks and Structural Forms**
   Slab decks; Voided slab deck; Pseudoslab; Maunshell top Hat beam; Beam and slab; Box girders; Curved and skew decks

3. **Behaviour and modeling of bridge decks**
   Simple beam method; Plate model; Articulated plate theory; Characterising parameters for longitudinal bending moments in highway bridges – Multicell box girders; Grillage method; Discrete methods; Bridge responses – Longitudinal bending moment; Transverse bending moment; Longitudinal twisting moment and transverse bending moment; Longitudinal and transverse shear

4. **Beam and slab bridge decks**
   Courbon's method of analysis; Reaction factors for longitudinal girders; Orthotropic plate method; Local wheel load effects – Slab supported on two opposite sides; Cantilever slab; Dispersion along the span – Slab spanning in two directions; Limitations of Pigeaud's method; Influence surfaces for moments; Analysis and design of reinforced concrete bridge deck

5. **Box Girder bridge decks**
   Evolution of box girders; Preliminary design and analysis; Structural action; Analysis for individual structural actions; Analysis and design of simple box girder deck

6. **Prestressed Concrete Bridges**
   Genera aspects; Advantages of prestressed concrete bridges; Pre-tensioned prestressed concrete bridge decks; Post-tensioned prestressed concrete bridge decks; Design of post-tensioned Prestressed concrete beam and slab bridge deck

Text books :

1. Bridge engineering by S.Ponnuswamy, TataMcGraw-Hill, 1986.
2. Bridge superstructure by N.Rajagopalan, Narosa Publishing House, 2006.
3. Prestressed concrete by N.Krishna Raju, Tata-McGraw-Hill, 1995.
4. Essentials of bridge engineering by D. John Victor, Oxford & IBH, 2001.

MCE/SE/206C FIBRE REIFORCED CONCRETE

1. **Introduction**
   Historical development; Specifications and recommended procedures

2. **Interaction between fibres and matrix**
   Fibre interaction with homogeneous uncracked matrix; Fibre interaction in cracked matrix; Interpretation of test data and analytical models; Composition of the matrix

3. **Basic concepts and mechanical properties : Tension**
   Basic concepts; Strong brittle fibres in ductile matrix; Strong fibres in a brittle matrix; Tension behaviour of fobre cement composites; Experimental evaluation of conventional fibre-cement composites; Elastic response in tension; Prediction of composite strength based on empirical approaches; Experimental evaluation of high-volume fraction fibre composites; Fracture mechanics approach; Apllications based on linear elastic fracture mechanics

4. **Basic concepts and mechanical properties : Bending**
   Mechanism of fibre contribution to bending; Flexural toughness; Prediction of load-deflection response

5. **Properties of constituent materials**
   Cement; aggregates; water and water-reducing admixtures; Mineral admixtures; Other chemical admixtures; Special cements; Metallic fibres; Polymeric fibres; Carbon fibres; Glass fibres

6. **Mixture Proportioning , Mixing and Casting procedures**
   Mix proportions for FRC containing coarse aggregates; Mixing and casting procedures

7. **Properties of freshly mixed FRC Containing coarse aggregates**
   Workability tests; Tests for air content; Yield and unit weight; Steel fibre-reinforced concrete; Polmeric fibre-reinforced concrete; Other fibres

8. **Properties of Hardened FRC**
   Behaviour under compression –FRC with steel fibres and FRC with polymeric fibres; Behaviour under tension – FRC with steel fibres and FRC with polymeric fibres; Behaviour under flexure – FRC with steel fibres and FRC with polymeric fibres; Behaviour under shear, torsion and bending – FRC with steel fibres and FRC with polymeric fibres

9. **FRC under fatigue and impact loading**
   Fatigue loading; Impact loading

Text books :

1. Fibre reinforced cement composites by P.N.Balaguru and S.P.Shah, McGraw-Hill, 1992.
2. Fibre reinforced cementious composites by A. Benturand and S.Mindess, Taylor & Francis, 1990.
3. Structural applications of fibre reinforced concrete , SP-182, ACI, 1998.

MCE/SE/251 COMPUTER AIDED DESIGN LABORATORY

Any 10 of the following problems are to be solved using Computer Programs / Application software like STAAD, SAP, NISA(Civil) etc.

1. Design of reinforced concrete beam (Singly/Doubly)
2. Design of reinforced concrete slab (One-way/Two-way)
3. Design of reinforced concrete column subjected to biaxial bending
4. Design of reinforced concrete retaining wall (cantilever type)
5. Design of steel welded plate girder
6. Lateral forces on a building due to an earthquake using equivalent static method
7. Lateral forces on a building due to wind
8. Analysis of pin jointed plane trusses
9. Analysis of rigid jointed plane frames
10. Plane stress analysis of using CST element
11. Plane stress analysis using four noded isoparametric element
12. Plate bending analysis using four noded isoparametric element
13. Free vibration analysis of a shear building using Generalised Jacobi Method
14. Forced vibration (steady-state response) analysis of a shear building subjected to harmonic excitation using mode superposition technique
15. Time-history analysis of single degree of freedom system subjected horizontal ground motion