M.E. CIVIL ENGINEERING
(SPECIALIZATION STRUCTURAL ENGINEERING)

CE 51003: ADVANCED STRUCTURAL ANALYSIS

Theory :

Unit - 1.

- **MATRIX METHOD (FLEXIBILITY METHOD):** Force methods. Basic concepts, evaluation of flexibility coefficients, flexibility transformations. Analysis of a single member of different types. Transformation of single member.

Unit - 2.

- Applications to plane and space structures with pin joints and rigid joints. Energy approach in flexibility method., Effect of support displacements and transformation.

Unit - 3.

- **MATRIX METHOD (STIFFNESS METHOD):** Displacement methods, Basic concepts, Evaluation of stiffness coefficients, Direct stiffness method. Energy approach in stiffness method. Code No. approach for global stifness matrix. Effect of support displacement and temperature.

Unit – 4

- Symmetrical & antisymmetrical problems. Stiffness of plane & space frames. Solution of problems. Comparison of force and displacement methods of solution.

Unit - 5

- **SPACE FRAME:** Tension coefficient method for analysis of pin jointed structural frames. Applications and different types of space truss.
- Introduction to “Finite element method”
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Books & References Recommended:

Text Books

1. Basic Structural Analysis by *C.S.Reddy – (TMH Publisher)*
2. Matrix Analysis of Framed Structures by *William Wearer Jr. & James M.Gere (CBS Publisher)*

CE 51005 : THEORY OF ELASTICITY & PLASTICITY

Theory :

Unit - 1.

- **Theory of Elasticity :** Elastic behaviour of engineering materials, Stress and strain. Components of stress and strain in three dimensional structural model. Generalised Hooke's law. Elastic constants.
- Plane stress and plane strain problems in elasticity. Principal stresses and principal strains. Compatibility of stress and strain. Equilibrium equations and compatibility equations, Boundary conditions. Stress function.
- End effects, Saint Venant's principle, solution of problems by polynomials. Determination of displacements. Solutions of simple probelms of flexure of two dimensional structures. Solution of problems in form of Fourier series.

Unit - 2.

- General equations in polar co-ordinates, stress distribution symmetrical about axis, curved beams and cylinders, Strain components in polar coordinate. Stresses in circular disc. Concentrated loads and couples on structures and surfaces.
- Differential equations of equilibrium and conditions of compatibility in three dimensional stress field. principles of superposition, strain energy theorems, Castigtiano's theorems. principle of virtual work. Uniqueness of solutions.

Unit - 3.

- Concept of Beam columns, Differential equations for beam-columns. Beam columns with concentrated lateral loads and continuous leteral loads with different edge conditions. Application of trigonometric series for solution.
- Elastic Buckling of bars and frames, Eluer's column formula. critical loads, Use of theory of beam column for critical load calculation. Buckling of bars and frames for simple loading.

Unit - 4.

- **Theory of Plasticity:** Basic experiments of monotonic loading tension and compression tests, Loading-Unloading reloading types, Loading-Unloading Reverse Loading type, their Observations, Definitions of Nominal Stress, Strain, True Stress, Natural strain etc. and their relations. Bauschinger's effects, Strain hardening, Stress-strain Curves, their empirical equations.
- Stress and strain Tensors, principal stresses and strains, stress and stain invariants, maximum and octahedral shear stresses and strains, stress and strain deviator tensor.

Unit – 5.

- Definitions of yield criteria on II-plane, C-Curve etc. carious yield criteria like Rankines, Saint-Venant's, Trescas and von mises and their 2 Dimensional representation.
- Subsequent Yield Surfaces, Isotropic and Kinematic hardening, Plastc work, Prandtl-Renss Equations Plastic stress strain relations.

Books & References Recommended:

1.Timoshenko and Goadies, "*Theory of Elasticity*"
2.C.R.Calladine, "*Engineering Plasticity*" Pergamoa press 1969.
3.Amendelsoa, "*Plasticity Theory and Application*" Macmillen 1968
4.Lubliner, "*Plasticity Theory*"
5. Chakraborti P.K. "*Plasticity"* TMH

CE 51006 : CONCRETE TECHNOLOGY AND COMPOSITES

Theory :

Unit - 1.

CONCRETE : Properties of fresh & hardened concrete, Strength Characteristic, Shrinkage, Creep Durability, Fatigue.

Unit - 2

Concrete at Low and High Temperature. Air Entrained Concrete. High Performance, concrete,

Unit - 3.

Mix Design, Non Destructive Testing of Concrete.

Unit - 4.

MECHANICS OF COMPOSITES :

(a) **INTRODUCTION :** Types, Materials, definitions of lamina, laminates, etc.

(b) **BECHAVIOUR OF LAMINA :** Stress – Strain relationship for anisotropic, orthotropic and isotropic materials, transformation elastic constants, failure criterion for an orthotropic lamina introduction to micromechanics behaviour, law of mixture.

Unit - 5

BEHAVIOUR OF LAMINATE : Classical lamination theory, Stress – Strain relationship for a laminate, extensional bending coupling stiffness, Different configuration and corresponding stiffness, strength of lamina interlaminer stress.

Books & References Recommended:

1. Concrete Technology – by *M.S.Shetty*
2. Concrete Technology – by *A.M.Neville*
3. Mechanics of Composite Materials by *R.M.Jones*
4. Mechanics of Composite Materials by *J.N.Reddy*

CE 51007: THEORY AND DESIGN OF CONCRETE STRUCTURES

Theory :

Unit - 1.

- **Design Philosophies:** Introduction to various design philosophies, their merits and drawbacks, code provisions and their meaning.
- Introduction to Prestressed concrete

Unit - 2

- **Grid Structures:** Types of R.C. C. Grids, behaviour, design by approximate and exact methods.

Unit - 3

- **Flat Slab:** Definition, Types, Behaviour, Direct Design Method, Equivalent Frame Method.

Unit - 4

- Ductile Detailing of R.C. Frame for Seismic Forces, Inelastic Analysis of R.C. Beam and Frames.
- Design of shear wall.

Unit - 5

- **Circular Cylindrical Shells:** Behaviour, Design using ASCE Manual Method.
- **Folded Plate** : Types, Behaviour, Comparison with Shell, Analysis and Design using Whitney Method, Introduction to Simpson's Method.

Books & References Recommended:

1. Limit State method– by *A.K.Jain*
2. Reinforced Cement concrete by *Malik & Gupta*
3. Thin Concrete shells by *W.P.Bilington*
4.Prestressed Concrete by *Krishna Raju*
5. Advanced R.C.C. by *Vargheese*
6. Theory of plaste & shell by *S.P. Timoshenko*

CE 51505 : ADVANCED FOUNDATION ENGINEERING

Theory :

Unit - 1.

- **FOUNDATION :** Definition, purpose types, general requirements and selection of foundations.
- **EXPLORATION :** Sampling and in-situ soil measurements, methods, preliminary and detailed investigations and its planning various field tests. Interpretation of data.

Unit - 2.

- **BEARING CAPACITY OF SHALLOW FOUNDATIONS :** Field tests and laboratory methods of determination of B.C. settlement analysis.

Unit – 3

- **REQUIREMENT OF GOOD FOUNDATION :** Factors to be considered in design of foundation
- **DESIGN :** Design of a spread footings, combined footings, beams on elastic foundation, strap footings, ring foundations, raft foundations, piles, machine foundations.

Unit – 4

- Design of caissons and coffer dams, floating foundations. Footing with holes and notches.

Unit – 5

- **CODAL PROVISIONS:** General considerations and codal provisions for earthquake resistant. Design of foundation

Books & References Recommended:

1. Foundation Analysis & Design by *J.E.Bowles*
2. Basic & Applied soil – Mechanics by *Gopal Ranjan & Rao*
3. Principles of Foundations Engg. by *Braj M.Das*
4. Principles of Geotechnical Engg. by *Braj M. Das*
5. Geotechnical Earthquake Engg. by *Ksans*
6. Soil Mechanics in Engg. Practice by *Terzaghi M. Rech*
7. Fundamentals of Soil mechanics by *Taylor*

CE 5122 : NUMERICAL AND SYSTEMS METHODS

Theory:

Unit – 1

- Inversion of Matrix, Solutions of Simultaneous quations by elimination and Iterative methods.
- Solutions of ordinary differential equations by predictor corrector methods, Runge – Kutta Method.

Unit – 2

- Backward, Forward and Central Difference methods, Interpolation, Extrapolation, Non-dimensionalisation. Application to partial differential equation. Summation of series, Numerical Integration and application to large elements.

Unit – 3

- Introduction to optimisation, Mathematical programming techniques, Linear Programming, Integer Programming, Assignment and Transpiration Models, Dulity in L.P.

Unit – 4

- Total Stage Decision Making Processes, Dynamic programming, Network Programming, Optimum project schedule, Regression Analysis.

Unit – 5

- Random Variables, Discrete and Continuous Distributions, Empirical Distributions, Sampling, Point estimation, Bay's Theorem, Statistical Tests of Significance.

Books & References Recommended:

1. Numerical Methods by *S.Balaguruswami, TMH Publ.*
2. Numerical Recipes in Fortran.
3. Numerical Methods in FEA by *Bathe and Wilson, PHI Publ.*
4. Operation Research by *Taha*
5. Operation Research Techniques for Management by*Benerjee, Business Book Publication House.*
6. Optimization Method in OR and system Analysis by *K.V.Mittal, Wiley Eastern Ltd.*

CE 5123 : STABILITY OF STRUCTURES

Theory :

Unit – 1.

- Concepts of Stability.
- Euler Buckling Load, Critical Load of Laced, Battened and Tappred columns, Inelastic Buckling of column.

Unit – 2.

- Torsional Buckling, Torsional flexural buckling.

Unit – 3.

- Lateral Instability of Beams.
- Beam Columns.

Unit – 4.

- Local Buckling and post buckling behaviour of plates.

Unit – 5

- Application of Energy method and matrix method in stability problems.

Books & References Recommended:

Theory of Elastic Stability by *Timoshenko, TMH Publ.*

CE 5124 : STRUCTURAL OPTIMIZATION

Theory :

Unit – 1.

INTRODUCTION : Design process, role of optimization in design, optimum design problem formulation : Variables, Constraint and objective function, Basic concepts of optimum design : Unconstrained and constrained optimum design problem, Global optimality, Post Optimality analysis.

Unit – 2.

OPTIMIZATION TECHNIQUES :

Traditional Approaches :

(a) Linear programming : problem, solution procedure, sensitivity analysis.
(b) Non-linear programming-kuhn-tucker conditions, single variable search, multivariable search, constrained optimization (Penalty function approach).
(c) Introduction to geometric and dynamic progamming.

Unit – 3.

OPTIMIZATION TECHNIQUES

Non traditional optimization techniques :
Genetic algorithms – philosophy, positive features, operators.

Unit – 4.

STRUCTURAL OPTIMIZATION : Application of optimization in designing R.C.C. and Steel Structures.

(a) Optimal design of trusses and frames.
(b) Optimal design of thin walled columns under axial.

Unit – 5.

STRUCTURAL OPTIMIZATION : Application of optimization in designing R.C.C. and Steel Structures.

a) Compressive load panels subjected to in-plane compression and shear.
b) Grid Floor.
c) Box-beam under bending.

Books & References Recommended:

CE 51201 : THEORY OF VIBRATIONS

Theory :

Unit – 1.

Single Degree of Freedom System : Free and forced vibrations, Linear Viscous Damper, Coulomb Damper : Response to harmonic excitation, rotating unbalance and support excitation. Vibration isolation and transmissibility. Single degree of freedom system as vibrometer and accelerometer. Response to periodic and arbitrary excitation.

Unit – 2.

Duhamel's integral. Impuse response function. Laplace transform Fourier transform methods. Frequency response function. Phase-Plane Techniques. Critical speed of roters. Energy methods, Rayleigh's method, Equivalent viscous dampling.

Unit – 3.

Two Degree of Freedom System. Matrix Formulation, Free Vibration, Beat pnenomenon. Principle of damped and undamped vibration absorbers.

Unit – 4.

Multi-Degree of Freedom Systems : Matrix formulation, stiffness and flexibility influence coefficients. Eigenvalue problem. Normal modes and their properties. Matrix iteration technique for eigen values, and eigen vectors. Free and forced vibration by modal analysis.

Unit – 5.

Continous System : Axial vibration of bar, torsional vibration of shafts, transverse vibration of strings and bending vibration beams. Forced vibration. Normal mode method. Lagrangle's equation. Approximate methods of Rayleigh-Ritz, Galerkin etc.

Books & References Recommended:

CE 51453 : COMPUTING TECHNIQUES

Theory :

Unit – 1.

Computer Fundamentals : Computer Components, Hardware and Software, Different types of Input/Output units, Binary and Decimal Conversions, Machine, Assembly and High-Level languages, Operating System etc.

Elements of Fortran Programming : Constants and variables, Arithmetical, Logical Expression, Executable and Non-executable statements, Transfer of control statements, subscripted variables etc.

Unit – 2.

Numerical Errors and Accuracy : Round-off errors, Truncation Errors, Accuracy, Numerical stability.

Successive Approximations by Iteration, Rate of convergence, Termination of Iteration, Step Size and convergence criterion.

Struct./Civil Engg. Examples.

Unit – 3.

Numerical Integration and Differentiation : Tayler's series expansions, Finite difference approx, for the first and second derivatives, Partial Derivatitives, Trapazoidal and simpson's rules for Numberical Integration Romming Integration, Newton-cotes Higher-order formulas, Double Integration.

Structural Applications.

Unit – 4.

Matrices and Solution of Systems of Algebric Equation : Matrix Inversion, Pivotal condensation, Gaussian and Gauss-Jorden Elimination Methods, Chokski decomposition, Choleski Erout's methods, Gauss-Siedel iterations, Homogenous equations and Eigen values, Structure problems

Unit – 5.

Numberical Solution of Ordinary Differential Equations : Euler's and Modified Euler's Methods, Rung-Kutta Methods, Predictor-corrector Methods, Boundary value problems, Structural Examples.

Numberical Solution of Partial Differential Equations : Finite difference approximations, solution of Parabolic, Elliptic and Hyperbolic Equations.

Books & References Recommended:

CE 51503 : THEORY AND DESIGN OF METAL STRUCTURES

Theory :

Unit – 1.

Study and Interpretation of loading standards for buildings and bridges, Codal provisions for special structures.
Design of Rivetted, welded and boltes connections.
Design of Highrise framed buildings,

Unit – 2.

Design of storage storage structures. Bunkers, Silos, water tanks including design of staging and bracings

Unit – 3.

Design of truss bridges, plate girder bridges, including design of bracings and bearings. chimneys, guyed towers, T.V. towers and Antenna structures.

Unit – 4.

Introduction to design of space structures, Double layer grids, curved space frames, folded plates and suspended structures

Unit – 5.

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Design of light guage steel sections - applications to beams, flat
Design of Aluminium Structures.

Books & References Recommended:

CE 51504 : THEORY OF PLATES & SHELLS

Theory :

Unit – 1.

Theory of plates **:** Bending of long rectangular plates to the cylinderical surfaces with different edge conditions. Pure bending of plates - Differential equations of equilibrium. Theory of small deflections of laterally loads plates. Boundary conditions, moment - curvature relationship.

Unit – 2.

Analysis of rectangular plates. Navier's and levy type solutions, Exact theory of plates. Symmetrical bending of circular plates. Continuous rectangular plates.

Unit – 3.

Special and approximate methods of theory of plates, singularities, use of influence surfaces, use of infinite integrals and transforms, strain energy methods, experimental methods.

Unit – 4

Theory of shells **:** Classification of shells, Gaussain curvature, General theory of cylinderical shells, memberane theory and Bending theory for cylinderical shells. Long and short shells, shells, shells with and without edge beams. Fourrior loading.

Unit – 5.

Equations of equilibrium for shells of surface of revolution, Reduction to two differential equations of second order. Spherical shells, memberane theory for shells of double curvature-synclastic and anticlastia. Conoidael shells, Hyperbolic - parabolic shells, funicular shells.

Books & References Recommended:

CE 5155 : INSTRUMENTATION AND EXPERIMENTAL TECHNIQUES

Theory :

Unit – 1.

Generalized measurement systems, calibration and sensitivity. Standards of measurements of various quantities.

Detectors : Sensor system elements, transducer and devices, Different types of sensors, Modifying and transmitting method. Mechanical, Hydraulic, Electrical and Electronic System.

Unit – 2.

Construction details of : Temperature transducers, vibration and shock measurement. Vibration pick-ups, Force and Load transducers, Velocity transducers, Torque transducers, Pressure measurements and pressure transducers.

Unit – 3.

Photoelasticity : Basic optics and polariscope Photoelastic effect: Stress-optic relations, Isoclinics. Isochromatics, Calibration of model, Separation techniques. Fractional Fringe order determination, Analysis of photoelastic data. Introduction to 3D Photoelasticity, Stress Freezing techniques, Slicing Tech. And Scattered light photo elasticity.

Unit – 4.

Moiré Fringe Technique: Moiré phenomenon, Analysis of Moiré fringes. Measurement of strain, displacement, rotations and slope for in plane and out of plane problems.

Unit – 5.

Model Analysis : Different types of model, Laws of structural similitude and non-dimensional analysis, Buckingham Pi theorem, Predictions for prototype, size effect, Applications. Accuracy and reliability of structured models.

Books & References Recommended:

CE 51506 : FINITE ELEMENTS METHOD

Theory :

Unit – 1.

INTRODUCTION TO FINITE ELEMENT METHOD : General Applicability and Description of Finite Element Method comparison with other Methods.

Unit – 2.

SOLUTION OF FINITE ELEMENT METHOD : Solution of Equilibrium Problems, Eigen value problems, propagation problems, computer implementation of Gaussian eliminations, Choleski's dicomposition, Jocobi's and ranga Kutta Method.

Unit – 3.

GENERAL PROCEDURE OF FINITE ELEMENT METHOD : Discretization of the domain, Selection of Shapes, types and number of elements, node numbering technique, Interpolation Polynomials, their selection and derivation in terms of global and local coordinates, Convergence requirements. Formulation of Element Characteristic matrices and vectors, Variational approach. Assembly of Element matrices and Vectors and Derivation system equations, computation of element resultants.

Unit – 4.

ISOPARAMETRIC FORMULATION : Lagrange and Hermite interpolation functions, Isoparametric Elements. Numerical Integration.

Unit – 5.

STATIC ANALYSIS : Formulation of equilibrium equations, Analysis of truss, Frames, Plane Stress and Plane Strain Problems Plates and Shells.

Books & References Recommended:

CE 5174 : ANALYSIS AND DESIGN FOR DYNAMIC EFFECTS

Theory :

Unit – 1.

Systems with single degree of freedom – multidegree of freedom systems; vibrations of continuous elastic media – Beams, Plates.

Unit – 2.

Earthquake Analysis and Design, Dynamic Interacting problems. Ground Structure Dynamic interaction.

Unit – 3.

Wind induced Vibration of Structures. Fluid-structure dynamic interaction, Gust factors.

Unit – 4.

Introduction of to offshore structure design.

Unit – 5.

Study of Indian Standard Codal provisions for wind and Earthquake resistant design of Buildings, Transmission towers, stack like structures and bridges.

Books & References Recommended:

CE 5175 : ANALYSIS AND DESIGN OF BRIDGES

Theory :

Unit – 1.

General : Loadings and types of bridges, Site Selection, Economic Span.

Unit – 2.

R.C.C. : Design of simply supported solid slab bridge and girder bridge.

Unit – 3.

Steel : Design of Plate Girder and truss bridge (with Orthotropic deck).

Unit – 4.

Behaviour of R.C.C. and Steel Box-Girder Bridges.
Introduction to pre-stressed bridge, arch bridge and suspension bridge.

Unit – 5.

Bearings, Piers and Abutments.

Books & References Recommended:

CE 5176 : COMPUTER AIDED ANALYSIS AND DESIGN

Theory :

Unit – 1.

Programming Languages : Overview of programming languages FORTRAN-77/C++.

Unit – 2.

Computer Graphics : Introduction and applications point plotting and line generation, Computer Graphics Co-ordination Systems. X-D windowing and clippling.

Unit – 3.

Computer Aided Design : CAD in building Design and planning,

Unit – 4.

Construction Management Design and Detailing of Concrete and Steel Structure.

Unit – 5.

Computer Aided Analysis and Design of foundations and retaining structures : Design of shallow foundations; Pile Foundations, Retaining Walls.

Books & References Recommended:

CE 5177 : DESIGN OF TALL STRUCTURES

Theory :

Unit – 1.

Behaviour of Tall Structures under Static and Dynamic Loads, Model Analysis.

Unit – 2.

Characteristics and Wind and Earthquake Forces.
Gust Factor and Karman Vortices.
Approximate and Regorlons Methods of analysis for wind and Earthquake forces.

Unit – 3.

Shear walls, Frame Structures, Coupled shear walls, Tabular Structures, Ductility and reinforcement details at joint.

Unit – 4.

Criteria for design of Chimneys, T.V. Towers, and other Tall Structure.

Unit – 5.

Case Studies.

Books & References Recommended:

CE 5178 : PRESTRESSED CONCRETE DESIGN

Theory :

Unit – 1.

Introduction, Principles of prestressing, Different methods of prestressing – post tensioning and pre-tensioning.

Prestressed concrete materials. Need for high strength concrete and High concrete tensile steel. Creep and shrinkage of concrete, relaxation of steel. Losses of prestress friction and anchorage of steel.

Unit – 2.

Flexural strength of prestressed concrete section. Analysis of prestress, Resultant stress at a section, Line of Thrust, Load Balancing. Cracking moments.

Shear strength and torsional strength of prestressed concretes section. Principle stresses and principal shear stresses, Ultimate shear resistance.

Unit – 3.

Stress-pattern in anchorage zones. Transmission length. End zone reinforcement. Stress distribution in end block.

Unit – 4.

Design of members for flexure. Code recommendations. Rectangular and I-section. Working out of section dimensions for concrete and prestressing forces for steel. Application to design of slabs and continuous beams and Bridge girders. Design for concrdant table and tendon profiles.

Unit – 5.

Design of tension and compression members, Design for combined bending and compressive, Different approaches for design, Introduction to design of transmission poles, roof truss members, purlin, railway sleepers.

Books & References Recommended:

1. Lin T.Y., *Design of Prestressed Concrete Structures*.
2. Varatnam P., *Prestressed Concrete Structures*.
3. Ramaruthan S., *Prestressed Concrete*.
4. Graduate I.I., *Prestressed Concrete*.
5. Krishna Raju, *Prestressed Concrete*.
6. Evans R.H. and Bennett R.S., *Prestressed Concrete*.
7. *IS-1343.*
8. Mullick S.K. and Rangaswamy R.S., *The Mechanics of Prestressed Concrte Design.*
9. Sinha and Raj, Prestressed Concrete.