SARVEPALLI RADHAKRISHNAN UNIVERSITY BHOPAL

MTST-201 Finite Element Method

UNIT -1

Basic Concepts, Discretization; Displacement, Force and Hybrid Models Interpolation Functions for General Element Formulations: Compatibility and Completeness, Polynomial Forms: One Dimensional Elements, Geometric Isotropy, Triangular Elements, Rectangular Elements, Three Dimensional Elements, Isoperimetric Formulations, Axisymmetric Elements; Numerical Integration.

UNIT -2

Applications in Solid Mechanics: Plane Stress/Strain: FE Formulation: CST, LST; Stiffness Matrix, Load Matrix Formation Rectangular Element Isoparametric Formulation: Plate Elements and Shell Elements, Three Dimensional Elements FE Formulation: Axisymmetric Stress Analysis, Torsion, Interface Elements, Infinite Elements

UNIT- 3

Application in Structural Dynamics and Vibrations: Mass (Consistent and Diagonal) and Damping Matrices; Modal Analysis, Time History Analysis, Explicit Direct Integration/ Implicit Direct Integration and Mixed Methods.

UNIT -4

Introduction to Nonlinear Problems: Geometric and Material (Elasto-plastic), Solution Methods: Newton Ralphson Method, Modified Newton-Ralphson Method, Arc Method, A Problem of Geometric Nonlinearity.

UNIT- 5

Stationary Principles, Rayleigh Ritz Method and Interpolation; Weighted Residual Methods and Variational Methods, Numerical Errors and Convergence

Reference Books:

1. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill

2. R. D. Cook, Malkus and Plesha, "Concepts and Applications of Finite Element Analysis", 3rd Ed., John Wiley.

3. T. J. R. Hughes, "The Finite Element Method : Linear Static and Dynamic Analysis", Prentice Hall.

4. Klaus Juergen Bathe, "Finite Element Procedures", Prentice Hall of India.

5. O. C. Zienkiewicz., R. L. Taylor & J. Z. Zhu., "The Finite Element Method Its Basis & Fundamentals", Elsivier Publications.

SARVEPALLI RADHAKRISHNAN UNIVERSITY BHOPAL

MTST-202 Structural Dynamics

UNIT- 1

Overview of Structural Dynamics, Single Degree of Freedom Systems – Analysis of Free Vibrations – undamped and damped systems, estimation of damping by logarithmic decrement method.

UNIT -2

Formulation of equation of motion for generalized SDOF dynamic problems using virtual work method. Response of SDOFS systems to Harmonic, Periodic, Impulse Loads

UNIT- 3

Formulation of equation of motion for two/three DOF systems. Finding mode shapes and frequencies by solving the determinantal equation, and iterative techniques. Use of sweeping matrices for obtaining higher modes. Proof of Convergence. Modal superposition and Response Spectrum Methods.

UNIT -4

Response of single and multiple DOFS systems to Earthquake Loading using Time-Stepping Methods based on Forward Cauchy Euler, Backward Cauchy Euler and Trapezoidal Rule. Accuracy, stability and algorithmic dampingin step-by-step methods.

UNIT- 5

Earthquake response analysis of Multi-DOF systems subjected to earthquake ground motion. Concept of modal mass and mode participation factors, etc. Newark & Hall's linear and inelastic response spectra for earthquakes Introduction to IS code provisions regarding earthquake.

Reference Books:

1.Ray W. Clough & Penzien, "Dynamics of Structures", Mc Graw Hill.
2. Anil Chopra, "Dynamics of Structures ", Mc Graw Hill.

SARVEPALLI RADHAKRISHNAN UNIVERSITY
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MTST-203 Theory of Plates and Shells

UNIT -1

Classification of Plates, Governing Equations, Boundary Conditions, Analysis of Rectangular and Circular Plates.

UNIT-2

Grid Floor as Orthotropic Plate, Buckling of Plates. Design Criteria and Code Specification Classification of Shells.

UNIT-3

Membrane Theory for Shells of Revolution with Axisymmetric and Non-Axisymmetric Loadings Bending Analysis of Shells of Revolution for Axisymmetric Loadings.

UNIT-4

Membrane and Bending Theories of Cylindrical Shells. Theory of Edge Beams, Doubly Curved Shells Membrane Theory and Design of Hyperbolic Shells, Buckling of Shells.

UNIT -5

Design Applications, Analysis and Design of Folded plates, Cooling towers, Silos and Bunkers, Codal Specifications, Practical Considerations, Computer Applications.

Reference Books:

1.S.P. Timoshenko and S. Woinowsky-Krieger, "Theory of Plates and Shells", McGraw- Hill.
2. J.N. Reddy, "Theory and Analysis of Elastic Plates", 2nd Ed., Taylor & Francis.
3. B.K. Chatterjee, "Theory and Design of Concrete Shells", 3rd Ed., Chapman and Hall.
4. V.S. Kelker and R.T. Sewell, "Fundamentals of the Analysis and Design of Shell Structures", Prentice Hall.
5. R. Szilard, "Theory and Analysis of Plates : Classical and Numerical Methods, Prentice Hall.

SARVEPALLI RADHAKRISHNAN UNIVERSITY BHOPAL

MTST-204 Experimental Stress Analysis

UNIT- 1

Introduction to stress analysis by strain measurement, mechanical strain gages, Moire fringe method, Brittle coatings for stress indication, circuitry for resistance strain gages, calibrating strain gages, temperature compensation of circuitry, indication and recording equipments, unbalance of bridge systems, balanced bridge systems, reference bridge systems, constant current strain indicators, multichannel recording systems.

UNIT -2

Introduction to stress analysis by photo elasticity, optical theory, stress optical relationship, equipment and models, static stress analysis (2-D, 3-D techniques), stress analysis by photo elastic strain gages

UNIT -3

Conditions for crack growth, fracture mechanics and strength of solids, stress and displacement fields in the vicinity of crack tip, the Griffith Orowan-Irwin concept, stable and unstable crack growth, the integral variation principle in crack theory, some more model representations, cracks in linearly elastic bodies, stress intensity factor, basic numerical methods for calculating the stress intensity factor, calculation of stress intensity factor for double cantilever beam specimen by FEM, the method of section for an approximate calculation of stress intensity factor, some material characteristics used for evaluation of crack propagation resistance.

UNIT -4

Solution of some plane and three dimensional problems, constructional crack arrest, system of cracks, stress intensity factors for some practical important cases, shell with a crack trajectory.

Reference Books:

1. Dove, Adams, Experimental stress analysis and motion
2. Heteny, Experimental stress analysis
3. Dally, Rilay, Experimental stress analysis
4. VZ Panon, M Morozove, Elastic-plastic fracture mechanics

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MTST-205(A) Analysis And Design of High Rise Building

UNIT-1

Structural systems for multi-storey buildings, gravity and lateral loads on buildings, analysis of multi-storey frames. Behaviour of framed tube, tube-in-tube systems, and bundled tube systems.

UNIT-2

Importance of symmetry and regularity in plan, and regularity in elevation. Analysis for torsion in buildings.

UNIT -3

Design of buildings with shear walls and coupled shear walls, Design of floor slabs, raft and pile foundations.

UNIT -4

Design and detailing of various members and beam-column joints for ductility. The capacity design principle. Performance based design philosophy.

Reference Books:

1. U.H.Varyani, "Structural Design of Multi-storeyed Buildings", 2nd Ed., South Asian Publishers, New Delhi.
2. V.L. Shah & S.R.Karve, "Illustrated Design of Reinforced Concrete Buildings", (GF+3storeyed), Structures Publications, Pune.
3. Design of Multi Storeyed Buildings, Vol. 1 & 2, CPWD Publications.
4. Bungale S. Taranath, "Structural Analysis and Design of Tall Buildings", Mc-Graw Hill.
5. Bryan S. Smith and Alex Coull, "Tall Building Structures", Wiley India.
6. Wolfgang Schueller, "High Rise Building Structures", Wiley.

SARVEPALLI RADHAKRISHNAN UNIVERSITY BHOPAL

MTST-205(B) Reliability Based Civil Engineering

UNIT – 1

Probability Theory : Mutually exclusive events set theory, sample points and sample space, laws of probability, total probability theorem. Bayes rule, random variables discrete and continuous,jointly distributed discrete variables, marginal distribution, conditionaldistribution, jointly distributedcontinuous variables functions of random variables, moments and expectations, common probability distribution, normal lognormal, gamma and Beta distributions, external distributions.

UNIT –2

Resistance Distribution and Parameters : Statics of properties of concrete and steel statics of strength of bricks and mortal characterization of variables, allowable stresses based on specified reliability. Probabilistic Analysis of loads. Load as a stochastic process, dead load statistical analysis of live loads-maximum sustained load intensity model, maximum total load model, wind load-probability model for wind load.

UNIT – 3

Structural Reliability : General expression for reliability expression for probability of failure, reliability when strength (S) and loan (L) follow normal distribution lognormal distribution, exponential distribution, extreme value distributions, factor of safety corresponding to a given reliability. Monte Carlo Study of Reliability : Monte Carlo Method inverse transformation technique, Application to columns beams and frames.Level 2. Reliability.

Method : Basic variables and failure surface, first order second moment methodshasofer and lind's method. Non normal distributions, determination of reliability index of β structural elements.

UNIT – 4

Reliability Based Design : Determination of partial safety checking formats, development of reliability based criteria, optimal safety factors calibration of IS 456 and IS 800.

UNIT –5

Reliability of Structural Systems : System reliability, modeling of structural systems bounds on system reliability, automatic generation of a mechanism, generation of dominant mechanisms,reliability analysis of RCC and steel frames.

Reference Books :

1. Ranganathan R. Reliability Analysis and Design of Structures, TMH

2. Rao S.S. Reliability Based Design Mc Graw Hill Book Co. Inc.

3. Ghosh D.I. A Primer Reliability Theory, John Wiley, New York.
4. Lawis E E Introduction to Reliability Engineering John whey new York.

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MTST-205(C) Advanced Numerical Analysis

UNIT –1
Introduction, roots of a non-linear equation and roots of a polynomial of nth degree [incremental search method, method of successive approximations, Newton's method, bisection method, secant method, Müller's method, synthetic division, Bairstow's method] and convergence study

UNIT –2
Solution of (non-homogeneous) linear algebraic equations, review of matrix algebra, Gauss elimination method, Cholesky's decomposition method, householder method, Gauss-Siedal iterative method

UNIT –3
Solution of non-linear algebraic equations, method of successive approximation, Newton's method, modified Newton – Raphson method, secant method

UNIT –4
Eigen values and Eigen vectors, reduction of generalized Eigen value problem to the standard Eigen value problem, methods for obtaining Eigen values and Eigen vectors [polynomial method, vector iteration method, Mises power method, Jacobi method]

UNIT –5
Time marching schemes for solution of problems in time domain, numerical integration (2 – D) [Newton – Cotes method, Gauss – Legendre method]
Solution of ordinary and partial differential equations, Euler's method, Runge – Kutta method, finite difference method, applications to problems of beam and plates on elastic foundation, Laplacian equation, consolidation equation, laterally loaded piles etc

Reference Books :

1. Chapra, S. C. and Canale R. P., "Numerical Methods for Engineers", Tata McGraw hill
2. Carnahan, B., Luther, H. A. and Wilkes, J. O., "Applied Numerical Methods", John Wiley
3. Heath, M. T. ,"Scientific Computing : An Introductory Survey", McGraw hill
4. Douglas Faires, J. and Richard Burden, "Numerical Methods", Thomson
5. Rajasekaran, S., "Numerical Methods in Science and Engineering", S. Chand

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MT205(D) Condition Assessment and Retrofitting of Structure

UNIT –1

Deterioration of Concrete Buildings: Embedded Metal Corrosion, Disintegration Mechanisms, Moisture Effects, Thermal Effects, Structural Effects, Faulty Construction

UNIT –2

Evaluation of Concrete Buildings: Visual Investigation, Destructive Testing Systems, Non-Destructive Testing Techniques, Semi-Destructive Testing Techniques, Chemical Testing.

UNIT –3

Surface Repair & Retrofitting Techniques: Strategy & Design, Selection of Repair Materials, Surface Preparation, Bonding repair Materials to Existing concrete, Placement Methods,

UNIT –4

Strengthening Techniques: Strengthening Techniques, Beam Shear Capacity Strengthening, Shear Transfer Strengthening between Members, Column Strengthening, Flexural Strengthening, and Crack Stabilization

UNIT –5

Epoxy Bonded Replacement Concrete, Preplaced Aggregate Concrete, Shotcrete/ Gunite, Grouting, Injection Grouting, Micro concrete. Guidelines for Seismic Rehabilitation of Existing Buildings, Seismic Vulnerability and Strategies for Seismic Retrofit.

Reference Books :

1 Emmons, P.H., "Concrete Repair and Maintenance", Galgotia Publication.
2 Bungey, S., Lillard, G. and Grantham, M.G., "Testing of Concrete in Structures", Taylor and Francis.
3 Malhotra, V.M. and Carino, N.J., "Handbook on Non-destructive Testing of Concrete", CRC Press.
4 Bohni, H., "Corrosion in Concrete Structures", CRC Press.
5 FEMA 273; NEHRP Guidelines for the Seismic Rehabilitation of Buildings.

6 ATC- 40: Seismic Evaluation and Retrofit of Concrete Buildings, Vol. 1 & 2.
7 M.J.N., Seible, F. and Calvi, G.M., "Seismic Design and Retrofit of Bridges by Priestley", John Wiley.

SARVEPALLI RADHAKRISHNAN UNIVERSITY BHOPAL

MTST-205(E) Continuum Mechanics

UNIT –1
Vector and Tensors Algebra, Lineariziation and Directional Derivatives,Stress and Equilibrium, Analysis for Stresses, Translational and Rotational Equilibrium, Principal Stresses and Principal Planes in 3D, Stress Invariants, Cauchy and Kirchhoff Stress Tensor, Deviatoric and Volumetric Components, Work Conjugancy, Octahedral and von-Mises stresses.

UNIT –2
Kinematics, Linearized Kinematics, Strain Quadric of Cauchy, Principal Strains, Invariants, Equations of Compatibility, Finite Deformation, Material (Lagrangian) and Spatial (Eulerian) Descriptions, Deformation Gradient, Polar Decomposition, Volume change, Distortional Component of Deformation Gradient, Area Change.

UNIT –3
Equations of Elasticity,Hooke's Law, Generalized Hooke's Law, Anisotropic, Orthotropic and Isotropic Elasticity Tensor, Plane Stress and Strain Problems, Airy Stress Functions for Two-Dimensional Problems, Airy Stress Function in Polar Coordinates, Isotropic Hyper elasticity, Three-Dimensional Elasticity.

UNIT –4
Elasto-Plastic Behavior of Material, Elasto-Plastic Formulations, Material Yield Criteria- von Mises, Tresca, Mohr-coulomb, Ducker-Pager, Isotropic and Kinematic Hardening, Normality Principle, Plastic Flow Rule, Plastic Potential, Elasto-Plastic Stress-Strain Relations, Prandtl-Rauss Equations, Levy-Mises Relations, Hardening Modulus, Generalized Elasto-Plastic Stress-Strain Relations.

Reference Books :

1. Finite element analysis in Geotechnical Engineering theory, By David M Pottsand Lidija Zdravkovic, Thomas Telford
2. Mechanics of Materials and Interfaces: The Disturbed State Concept, By CS Desai, CRC Press LLC
3. Mechanics of Geomaterial Interfaces, By A.P.S. Selvadurai, M.J. Boulon, Elsevier

SARVEPALLI RADHAKRISHNAN UNIVERSITY BHOPAL

MTST-206 Advanced Structures Lab

To introduce the fundamentals of modeling, simulation and optimization techniques in Civil Engineering

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MTST-207 Structural Software Engg. LAB

1. STAAD Pro
2. ETABS
3. 3 D MAX