# MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)
## M.Tech. in Computer Aided Structural Engineering
## Scheme of Instruction and Examination
## (Choice Based Credit System)

### I Semester

| S.No | Course Code | Course Title | Instruction | | | Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours Per Week | | | Max. Marks | | Duration of SEE in Hours | |
| | | | L | T | P | CIE | SEE | | |
| 1 | CE101PC | Theory of Elasticity | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 2 | CE102PC | Advanced Structural Analysis | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 3 | CE11XPE | Professional Elective-I | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 4 | CE11XPE | Professional Elective-II | 3 | 0 | 0 | 30 | 70 | 3 | 3 |
| 5 | CE101MC | Research Methodology& Intellectual Property Rights | 2 | 0 | 0 | 30 | 70 | 3 | 2 |
| 6 | AC10XHS | Audit Course - I | 2 | 0 | 0 | 30 | 70 | 3 | 0 |
| 7 | CE151PC | Numerical Analysis Lab | 0 | 0 | 3 | 30 | 70 | 3 | 1.5 |
| 8 | CE152PC | Advanced Concrete Technology Lab | 0 | 0 | 3 | 30 | 70 | 3 | 1.5 |
| 9 | EN151HS | Finishing School- I | 0 | 0 | 2 | 30 | 70 | 3 | 1 |
| | | **Total Hours/Marks/Credits** | **16** | **0** | **8** | **270** | **630** | | **18** |

### II Semester

| S.No | Course Code | Course Title | Instruction | | | Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours Per Week | | | Max. Marks | | Duration of SEE in Hours | |
| | | | L | T | P | CIE | SEE | | |
| 1 | CE201PC | FEM in Structural Engineering | 3 | 0 | - | 30 | 70 | 3 | 3 |
| 2 | CE202PC | Structural Dynamics | 3 | 0 | - | 30 | 70 | 3 | 3 |
| 3 | CE21XPE | Professional Elective-III | 3 | 0 | - | 30 | 70 | 3 | 3 |
| 4 | CE21XPE | Professional Elective-IV | 3 | 0 | - | 30 | 70 | 3 | 3 |
| 5 | AC20XHS | Audit Course – II | 2 | 0 | 0 | 30 | 70 | 3 | 0 |
| 6 | CE251PC | Advanced Structural Engineering Lab | 0 | 0 | 3 | 30 | 70 | 3 | 1.5 |
| 7 | CE252PC | Structural Design Lab | 0 | 0 | 3 | 30 | 70 | 3 | 1.5 |
| 8 | CE253PC | Mini Project with Seminar | 0 | 0 | 4 | -- | 100 | - | 2 |
| 9 | MA252BS | Finishing School- II | 0 | 0 | 2 | 30 | 70 | 3 | 1 |
| | | **Total Hours/Marks/Credits** | **14** | **0** | **12** | **240** | **660** | | **18** |

**L**: Lecture **T**: Tutorial **D**: Drawing **P**: Practical **CIE** - Continuous Internal Evaluation **SEE** - Semester End Examination

## List of Professional Electives

**Professional Elective-I**
CE111PE: Theory of Plates and Shells
CE112PE: Theory and applications of Cement Composites
CE113PE: Theory of Structural Stability

**Professional Elective-II**
CE114PE: Advanced Reinforced Concrete Design
CE115PE: Advanced Foundation Design of Reinforced Concrete
CE116PE: Numerical Methods in Structural Engineering

**Professional Elective-III**
CE211PE: Advanced Steel Design
CE212PE: Design of High-Rise Buildings
CE213PE: Design of Masonry Structures

**Professional Elective-IV**
CE214PE: Soil Structure Interaction.
CE215PE: Design of Pre-stressed Concrete Structures
CE216PE: Structural Optimization

## Audit Courses

**Audit Course-I**
AC101HS: English for Research Paper Writing
AC102HS: Sanskrit for Technical Knowledge
AC103HS: Stress Management by yoga

**Audit Course-II**
AC201HS: Disaster Management
AC202HS: Value Education
AC203HS: Pedagogy Studies
AC204HS: Personality Development through Life Enlightenment Skills

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# M.Tech. in Computer Aided Structural Engineering
# I Semester Syllabus
# CE101PC: Theory of Elasticity

## Course Objectives

- To impart knowledge on the basic concepts of theory of elasticity, and solve the Structural
- Engineering problems.
- Solve the Structural Engineering problems.

## Course Outcomes

- Demonstrate the application of plane stress and plane strain in a given situation.
- Develop the analytical ability to analyze two dimensional engineering problems.
- Evaluate the stresses for two dimensional engineering problems in polar coordinates.
- Analyze stresses and strains for three dimensional engineering problems.
- Acquire Skill to analyze torsion and prismatic members.

### Unit--I: Introduction to Elasticity

Elasticity - notation for forces and stress - components of stresses - components of strain - Hooks law. Plane stress and plane strain analysis - differential equations of equilibrium 2D &3D - boundary conditions – Strain Displacement Relations - compatibility equations – stress tensor and strain tensor.

### Unit--II: Two dimensional problems in rectangular coordinates

Introduction - solution by polynomials – Saint Venant's principle - determination of displacements - bending of simple beams stress function – Simply Supported and Cantilever Beams.

### Unit--III: Two dimensional problems in polar coordinates and Bending of Prismatic Bars

Introduction- stress distribution symmetrical about an axis - pure bending of curved bars - strain components in polar coordinates - displacements for symmetrical stress distributions Edge Dislocation - general solution of two-dimensional problem in polar coordinates - application to Plates with Circular Holes.Bending of prismatic bars - Stress function - bending of cantilever - circular cross section - elliptical cross section – rectangular cross section.

### Unit--IV: Analysis of stress and strain in 3D and general theorems

Principal stress - stress ellipsoid - director surface -determination of principal stresses Stress Invariants - max shear stresses - Homogeneous deformation - principal axes of strain-rotation. General Theorems: Differential equations of equilibrium - conditions of compatibility - determination of displacement - equations of equilibrium in terms of displacements - principle of super position - uniqueness of solution - the reciprocal theorem Strain Energy.

### Unit--V: Torsion of Circular Shafts

Torsion of Straight Prismatic Bars – Saint Venant's Method - torsion of prismatic bars - bars with elliptical cross sections - membrane analogy - torsion of a bar of narrow rectangular bars - torsion of shafts, tubes, bars etc.

**Suggested Readings:**

1. Timoshenko, Theory of Elasticity, 3rd Edition, McGraw-Hill Publications.
2. Sadhu Singh, Theory of Elasticity, Khanna Publications, New Delhi.

**Reference Books:**

1. Srinath L.S "Advanced Mechanics of Solids", Third Edition, Tata McGraw Hill Publishing company, New Delhi, 2009.
2. Fung,Y.C, Foundations of Solid Mechanics , Prentice Hall of India, 1968.
3. Chakarbarthy.J, Theory of Plasticity, Mc-Graw hill Publications, third edition, 2006.

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# M.Tech. in Computer Aided Structural Engineering
# I Semester Syllabus
# CE102PC: Advanced Structural Analysis

**Course Objectives**

- To impart knowledge on the analysis of indeterminate structures like continuous beams, trusses and portal frames.

**Course Outcomes**

- To appreciate the relationship between force and displacements.
- To generate global stiffness matrix from local and apply the direct stiffness method.
- To analyze different indeterminate structures using Flexibility method.
- To analyze different indeterminate structures using Stiffness method.
- To understand the effect of initial stresses and thermal stresses on the structural behaviour.

## Unit--I: Force Displacement Relations

Introduction to matrix methods of analysis - static indeterminacy and kinematical indeterminacy - degree of freedom - coordinate system - structure idealization stiffness and flexibility matrices - suitability element stiffness equations - elements flexibility equations - mixed force - displacement equations - for truss element, beam element and torsional element. Transformation of coordinates - element stiffness matrix - and load vector - local and global coordinates.

## Unit--II: Direct Stiffness Method

Assembly of stiffness matrix from element stiffness matrix - direct stiffness method - general procedure - banded matrix - semi bandwidth - assembly by direct stiffness matrix method.

## Unit--III: Flexibility Method

Analysis of plane truss - continuous beams with and without settlement - plane frame including side sway single storey, single – bay and garde frame by flexibility method using system approach by flexibility methods and gables frames by Gable System Approach.

## Unit--IV: Stiffness Method

Analysis of plane truss - continuous beams with and without settlement - plane frame including sides sway, grids and gable frames by stiffness methods, single bay– two storey, two bay single – storey.

## Unit--V: Special Analysis Procedures

Special analysis procedures – static condensation and sub structuring - initial and thermal stresses.

**Suggested Readings:**

1. Pandit & Gupta, Structural Analysis: A Matrix approach, McGraw Hill Publications, Second edition, 2015.
2. William Weaver J.R and James M. Gere , Matrix Analysis of Framed structures, Springer, 1990.

**Reference Books:**

1. Ashok. K.Jain, Advanced Structural Analysis, New Channel Brothers, 3rd edition, 2015.
2. Madhu B. Kanchi, Matrix Structural Analysis, Wiley, 2nd Enlarged Edition, 1994.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Professional Elective-I
## CE111PE: Theory of Plates and Shells

### Course Objectives

- The objective of the teacher is to impart knowledge and abilities to the students to:
- Achieve fundamental understanding of the classical theory of plates and shells.
- Introduce analytical techniques in thin plate theory and shells.
- Apply theory of plates and shells to the problems involving various geometrics and boundary conditions.
- Apply Navier, Levy's, and Rayleigh—Ritz solutions to plates with different end conditions.
- Provide enhanced knowledge in solid mechanics and advanced structural mechanics.

### Course Outcomes

- Analyze rectangular plates using analytical methods and energy methods.
- Apply Navier, Levy's solutions to thin rectangular plates.
- Analyze circular plates with different loading conditions.
- Understand different types of shells, their functional behavior and various methods to analyze them.
- Analyze shells of double curvature and axi-symmetric shells.

**Unit--I: Cylindrical Bending and pure bending of plates**

Different kind of plates – Assumptions – Derivation of differential equation for cylindrical bending of long rectangular plates - Analysis of uniformly loaded rectangular plates with edges simply supported and fixed subjected to uniform load.

**Bending of plates**: Slope and curvature of slightly bent plates – Relations between moments and curvature - Particular cases of pure bending - Strain energy in pure bending –Energy methods like Ritz and Galerkin Methods to rectangular plates subjected to simple loadings

**Unit--II: Small Deflection Theory of Thin Rectangular Plates**

Assumptions – Derivation of governing differential equation for thin plates – Boundary conditions–simply supported plate under sinusoidal load – Navier solution – Application to different cases – Levy's solution for various boundary conditions subjected to different loadings like uniform and hydrostatic pressure.

**Unit--III: Circular Plates**

Differential Equation for symmetrical bending of laterally loaded circular Plates – Uniformly loaded circular plates – circular plate concentrically loaded – circular plate loaded at center.

**Unit--IV: Shells and Equations of equilibrium**

Functional behaviour – examples – structural behaviour of shells classification of shells – Definitions – various methods of analysis of shells – merits and demerits of each method – 2D - Membrane equation. Equations of equilibrium: Derivation of stress resultants – cylindrical shells – Flugges simulations equations.

**Unit--V: Shells of Double curvatures and Axi-symmetrical shells**

Introduction to the shells of Double curvatures- Geometry, analysis and design of elliptic paraboloid, conoid and

hyperbolic parabolic shapes, inverted umbrella type. Axi- Symmetrical shells: General equation - Analysis and axi-symmetrical by membrane theory. Application to spherical shell and hyperboloid of revolution cooling towers.

### Suggested Readings:

1. Timoshenko P., Woinowsky S. Krieger ,Theory of Plates & Shells , Tata MC Graw Hill, Second Edition.
2. Ramaswami.G.S., Analysis and design of concrete shell roofs, CBS publications.

**Reference Books:**

1. Billington, Design of concrete shell roofs, Tata MC Graw Hill, NewYork
2. Bairagi N.K.. Shell Analysis, Khanna Publishers, New Delhi.
3. Varghese P.C.,Design of Shells and Folded Plates, PHI Learning Pvt.Ltd.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Professional Elective-I
## CE112PE: Theory and Applications of Cement Composites

**Course Objectives**

- To understand composite materials and their behaviour
- To understand principles of material science applied to composite materials.
- To understand the stress strain behaviour of composite materials.
- To study the equations to analyze problems and methods to solve practical composites mechanics problems.

**Course Outcomes**

- To formulate constitutive behaviour of composite materials—Ferro cement, SIFCON and Fiber Reinforced Concrete-by understanding their strain-stress behaviour.
- To classify the materials as per orthotropic and anisotropic behaviour.
- To Estimate strain constants using theories applicable to composite materials.
- To Analyze and design structural elements made of cement composites.

### Unit-I: Introduction to Composite Materials

Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations-Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.

### Unit-II: Mechanical Behaviour

Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness.

### Unit-III: Cement Composites

Types of Cement Composites, Terminology, Constituent Materials And their Properties, Construction Techniques for Fiber Reinforced Concrete — Ferro cement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.

### Unit- IV: Mechanical Properties of Cement Composites

Behavior of Ferrocement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.

### Unit-V: Application of Cement Composites & Analysis and Design of Cement Composite Structural Elements

FRC and Ferro cement -Housing, Water Storage, Boats and Miscellaneous Structures. Composite Materials-Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants.Analysis and Design of Cement Composite Structural Elements—Ferro cement, SIFCON and Fiber Reinforced Concrete.

### Suggested Readings:

1. Robert M. Jones, Mechanics of Composite Materials, Second Edition, Scripta Book Company.
2. Agarwal.B.D., Analysis and Performance of Fiber Composites, Wiley Publishers, Third Edition.

**Reference Books:**

1. Cahn R. W., VCH, West Germany, Material Science and Technology, Vol. 13-Composites.
2. Callister W. D. Jr., Adapted by Balasubramaniam R., Materials Science and Engineering-An Introduction, John Wiley & Sons, NY,Indian Edition, 2007.
3. Chawla.K.K.,Composite Materials, Science and Engineering, Third Edition, Springer.
4. Deborah D. Chung L., Composite Materials Science and Applications.
5. Danial Gay, Suong Hoa V. and Stephen, Tosi W., Composite Materials Design and Applications.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Professional Elective-I
## CE113PE: Theory of Structural Stability

**Course Objectives**

- Achieve fundamental understanding of stability criteria.
- Determine stability of columns and frames under different loading conditions
- Determine stability of beams and plates under different loading conditions
- Understand various theories of inelastic buckling

**Course Outcomes**

- Apply different methods to find stability and understand design philosophies.
- Determine stability of columns
- Determine stability of frames
- Determine stability of beams and plates
- Understand the concepts of inelastic buckling and dynamic approach

### Unit- I: General Principles
Concept of Stability, Types of Stability, Methods of Analyses in Stability, Design Philosophies.

### Unit- II: Stability of Columns
Axial and Flexural Buckling, Lateral Bracing of Columns, Buckling load of a column with variable cross section, Torsional and Torsional-Flexural buckling of columns.

### Unit- III: Stability of Frames
Modes of buckling, Critical load of a frame using neutral equilibrium, Calculation of critical loads using slope-deflection equations, Member Buckling versus Local Buckling, Slenderness Ratio of Frame Members.

### Unit- IV: Stability of Beams and stability of Plates
Differential equation for lateral buckling, lateral buckling of beams in pure bending, lateral buckling of a cantilever beam, lateral buckling of a simply supported I-beam.

Stability of Plates: Axial flexural buckling of Rectangular Plates, Shear flexural buckling of Rectangular plates, buckling under combined loads.

### Unit- V: Inelastic Bucking
Introduction - Double modulus Theory, Tangent Modulus Theory, Eccentrically loaded columns, Dynamic approach.

### Suggested Readings:
1. Timoshenko and Gere, Theory of elastic stability, Tata Mc GrawHill,1981.
2. Chen W.F. and Lui E.M., Structural Stability, Elsevier Science Publishing Co, New York .
3. Alexander Chajes, Principles of Structural Stability Theory, Prentice Hall, New Jersey.

### Reference Books:
1. Iyengar, N. G. R., Structural Stability of columns and plates, Eastern west press Pvt.Ltd.
2. Bleich F. Bucking, Strength of Metal Structures, Tata McGraw Hill, New York.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Professional Elective-II
## CE114PE: Advanced Reinforced Concrete Design

### Course Objectives

- To recall the various limit states of IS 456-2000.
- To apply the limit state analysis for continuous beams and slabs.
- To demonstrate about Ribbed slabs and Flat slabs.
- To understand the analysis and design Deep beams, Corbels and Nibs.
- To design slender columns and combined footings.

### Course Outcomes

- Able to apply various limit states in the design of beams and slabs.
- Able to redistribute moments and design slabs by yield line analysis.
- Able to examine Ribbed slabs and compare different methods available for design of Flat slabs.
- Able to design Deep beams, Corbels and Nibs.
- Able to propose the detailing of Slender columns and combined footings.

### Unit- I: Basic Design Concepts

Behaviour in flexure, Design of flanged beam sections, Design for shear – Design for Torsion, Limit state of Serviceability: Deflections of Reinforced concrete beams and slabs short term deflections and long-term deflection estimation of crack width in RCC members, calculation of crack widths.

### Unit- II: Limit Analysis of R.C. Structures and Yield Line analysis

Rotation of a plastic hinge, Redistribution of moments, moment rotation characteristics of RC member, I.S. code provisions, applications for fixed and continuous beam.
Yield line analysis for slabs: Upper bound and lower bound theorems – yield line criterion – Virtual work and equilibrium methods of analysis – For square and circular slabs with simple and continuous end conditions. Moment Curvature diagram.

### Unit- III: Ribbed slabs and Flat slabs

Ribbed slabs- Analysis of the Slabs for Moment and Shear, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of Reinforcements. Flat slabs- Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat Slabs-Check for one way and two-way shears-Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip sketch showing reinforcement details.

### Unit- IV: Design of Reinforced Concrete Deep Beams & Corbels

Deep beam-Steps of Designing Deep Beams, Design by IS 456. Checking for Local Failures, Detailing of Deep Beams, Analysis of Forces in a Corbels, Design of Procedure of Corbels, Design of Nibs.

### Unit- V: Compression members and Combined Footings

Design of Compression Members – Design of Slender Columns- sketch showing reinforcement details.Design of Combined Footings - Distribution of Soil Pressure - Geometry of Two-column Combined Footing – Design Considerations in Two-Column Footings sketch showing reinforcement details.

**Suggested Readings:**

1. Unnikrishnan Pillai S. & Devdas Menon ,"Reinforced Concrete Design"; Tata Mc.Graw-Hill Publishing Company Ltd. New Delhi 2010.
2. Karve S. R. and Shah V.L ,"Limit State Theory and Design of Reinforced Concrete", S. R. Publication .

**Reference Books:**

1. Varghese P.C. ,"Advanced Reinforced Concrete" Prentice Hall of INDIA Private Ltd. 2008.
2. Varghese P.C.,"Design Reinforced Concrete Foundations" Prentice Hall of INDIA Private Ltd.
3. Subramanian N., "Design of Reinforced Concrete Structures" , Oxford University Press.
4. IS 456-2000- Code for Plain and Reinforced Concrete.
5. SP 16-Design aids for Reinforced Concrete.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Professional Elective-II
## CE115PE: Advanced Foundation Design of Reinforced Concrete

**Course Objectives**

- To impart knowledge on types of shear failures and foundations.
- To become familiar with settlement analysis
- To distinguish different types of footings and proportioning
- To recognize types of pile foundations and design it.
- To aware of analysis and techniques of foundations in expansive soils

**Course Outcomes**

- Get knowledge on types of shear failures and foundations.
- Perform settlement analysis.
- Distinguish different types of footings and proportioning.
- Design pile foundations.
- Analyze foundations in expansive soils using various techniques.

**Unit- I: Design of Foundations**

Introduction -Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity. Shallow Foundations Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test. Settlement Analysis:

**Unit- II: Settlement of Foundations**

Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesion less soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

**Unit- III: Proportioning of Footings and Raft foundations**

Proportioning of footings - Isolated column footings, Strip, combined Footings and Strap Footing. Raft Foundations- Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of sub grade reaction.

**Unit- IV: Pile Foundations and Foundations of Transmission Line Towers**

Pile Foundations - Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction. Foundations of Transmission Line Towers - Introduction, Necessary information, Forceson tower foundations, General design criteria, Choice and type of foundation, Design procedure.

**Unit- V: Expansive Soils**

Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.

**Suggested Readings:**

1. Swami Saran, Analysis and Design of Substructures, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Gopal Ranjan and Rao A.S.R.,Basic and Applied Soil Mechanics, New Age International Publications

**Reference Books:**

1. Bowles J.E. ,Foundation Analysis and Design , Mc Graw Hill Publishing Co.
2. Teng W.C., John Wiley , Foundation Design , New York.
3. Swami Saran , Analysis and Design of Substructures, Oxford & IBH Publishing Co.
4. Varghese P.C.,Foundation Engineering , Prentice Hall of India.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Professional Elective-II
## CE116PE: Numerical Methods in Structural Engineering

**Course Objectives**

- To impart knowledge about various methods of analysis.
- Linear equations.
- Understand the different mathematical techniques.
- Problem solving.

**Course Outcomes**

- The learner will be able to apply various mathematical techniques for solving linear equations.
- Solving Structural engineering problems using interpolation techniques.
- Understanding boundary conditions for beams.
- Use of numerical differentiation & Lagrange interpolation method.
- To use Ordinary Differential Equations.

### Unit- I: Solutions of linear equations

Direct method – Cramer's rule, Gauss – Elimination method- Gauss – Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over – relaxation method. Eigen values and eigen vectors: Jacobi method for symmetric matrices- Given's method for symmetric matrices- Householder's method for symmetric matrices-Rutishauser method of arbitrary matrices – Power method.

### Unit- II: Interpolation

Linear Interpolation - Higher order Interpolation - Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation -piece-wise and spline Interpolation.

### Unit- III: Finite Difference and their Applications

Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulas using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson's extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas- Numerical solution to spatial differential equations – Application to Simply Supported Beams, Columns & rectangular Plates.

### Unit- IV: Numerical Differentiation & Numerical Integration

Difference methods based on undetermined coefficients- optimum choice of step length– Partial differentiation. Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson's method – New Marks Method and Application to Beams – Calculations of Slopes & Deflections.

### Unit- V: Ordinary Differential Equation

Euler's method – Backward Euler method – Midpoint method – single step method, Taylor's series method- Boundary value problems.

**Suggested Readings:**

1. Jain M. K., Iyengar S. R. K. and Jain R. K., Numerical Methods for Scientific and Engineering Computations. Willey Eastern Limited. New Age International (p) Ltd., Publishers.
2. Krishna Raju N. and Muthu K. U., Numerical Methods for Engineering Problems, M.C. Millan Publishers, New Delhi

**Reference Books:**

1. Stevan C. Chopra, Raymond P. Canal, Numerical Methods for Engineers Mc. Graw Hill Book Company. April 2009
2. Xavier C.,C Language and Numerical methods, New Age International Publisher. March 2012.
3. Shanta Kumar M., Computer based numerical analysis,Khanna Book publishers New Delhi.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
## CE101MC: Research Methodology & Intellectual Property Rights

**Course Objectives**

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

**Course Outcomes**

At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**Unit-I**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

**Unit-II**

Effective literature studies approaches, analysis Plagiarism, Research ethics.

**Unit-III**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

**Unit-IV**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**Unit-V**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**Suggested Readings:**

1. C. R. Kothari and Gaurav Garg, "Research Methodology – Methods and Techniques", New Age International
2. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

**Reference Books:**

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Audit Course- I
## AC101HS: English for Research Paper Writing

**Course Objectives**

Students will be able to:
- Improve their writing skills and level of readability
- Learn about structure and organization of sections and sub sections
- Develop requisite skills to write the title
- Enhance effective writing skills to publish research papers

**Unit-I**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**Unit-II**

Clarifying, Highlighting Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstract, Introduction

**Unit-III**

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check

**Unit-IV**

Key Skills for: Writing a title, Writing an abstract, Writing an Introduction, Writing a review of the literature

**Unit-V**

Key skills for: Writing methods, Writing the results, Writing the discussion, Writing the conclusions.
Useful phrases and mechanics of effective writing to publish research papers.

**Suggested Readings:**

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

**Reference Books:**

1. Goldbort R (2006) Writing for Science, Yale University Press(available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Audit Course - I
## AC102HS: Sanskrit for Technical Knowledge

**Course Objectives**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

**Course Outcomes**

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

**Unit-I**

Alphabets in Sanskrit

**Unit-II**

Past / Present / Future Tense, Simple Sentences

**Unit-III**

Order, Introduction of roots

**Unit-IV**

Technical information about Sanskrit Literature

**Unit-V**

Technical Concepts of Engineering - Electrical, Mechanical, Architecture, Mathematics

**Suggested Readings:**

1. Prathama Deeksha-Vempati Kutumbshastri “Teach Yourself Sanskrit”, Rashtriya Sanskrit Sansthanam, New Delhi Publication

**Reference Books:**

1. Dr. Vishwas, Samskrita “Abhyaspustakam” -Bharti Publication, New Delhi
2. Suresh Soni “India’s Glorious Scientific Tradition”, Ocean books (P) Ltd., New Delhi

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
Audit Course - I
## AC103HS: Stress Management by Yoga

**Course Objectives**

- To achieve overall health of body and mind
- To overcome stress

**Course Outcomes**

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

**Unit-I**

Definitions of Eight parts of yoga. (Ashtanga)

**Unit-II**

Yam and Niyam.

**Unit-III**

Do's and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha

ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**Unit-IV**

Asan and Pranayam

**Unit-V**

i) Various yoga poses and their benefits for mind & body

ii) Regularization of breathing techniques and its effects-Types of pranayam

**Suggested Readings:**

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur

**Reference Books:**

1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
## CE151PC: Numerical Analysis Lab

**Course Objectives**

- Find the Roots of Non-Linear Equation Using Bisection, Newton's method
- Fitting of a curve for a given data by using Least Square Approximations
- Solve the System of Linear Equations Using Gauss - Elimination Method, Gauss - Seidal Iteration Method, Gauss - Jorden Method.
- Integrate numerically using Trapezoidal & Simpons's rules
- Numerical Solution of Ordinary Differential Equations by Euler's & Runge-Kutta method

**Course Outcomes**

- Find Roots of non-linear equations by Bisection method and Newton's method.
- Do curve fitting by least square approximations
- Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jordan Method
- To Integrate Numerically Using Trapezoidal and Simpson's Rules
- To Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge- Kutta Method.

**List of Experiments:**

1. Find the Roots of Non-Linear Equation Using Bisection Method.
2. Find the Roots of Non-Linear Equation Using Newton's Method.
3. Curve Fitting by Least Square Approximations.
4. Solve the System of Linear Equations Using Gauss - Elimination Method.
5. Solve the System of Linear Equations Using Gauss - Seidal Iteration Method.
6. Solve the System of Linear Equations Using Gauss - Jorden Method.
7. Integrate numerically using Trapezoidal Rule.
8. Integrate numerically using Simpson's Rules.
9. Numerical Solution of Ordinary Differential Equations By Euler's Method.
10. Numerical Solution of Ordinary Differential Equations ByRunge- Kutta Method.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus

## CE152PC: Advanced Concrete Technology Lab

**Course Objectives**

- To prepare mix design of different concrete.
- To understand the relationship between different strengths of concrete.
- To perform RCPT on concrete

**Course Outcomes**

- Design high grade concrete and study the parameters affecting its performance.
- Understand the principles of design of experiments
- Apply engineering principles to understand behavior of structural/elements.

**List of Experiments/Assignments:**

1. Mix design of standard grade and high strength concrete
2. Study of stress-strain curve of high strength concrete
3. Correlation between cube strength, cylinder strength, split tensile strength of high strength and standard grade concrete
4. Study of modulus of rupture of high strength and standard grade concrete
5. Behavior of under reinforced beam under flexure loading
6. Behavior of over reinforced beam under flexure loading
7. Behaviour beam under Shear (with and without shear reinf.)
8. Fresh properties of self-compacting concrete.
9. Rapid chloride permeability test of standard grade concrete.

**Reference Books:**

1. Neville A. M, Properties of Concrete, 5th Edition, Prentice Hall, 2012.
2. Shetty. M. S, Concrete Technology, S. Chand and Co., 2006.
3. Santha Kumar A.R. , Concrete Technology, Oxford University Press.

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## M.Tech. in Computer Aided Structural Engineering
## I Semester Syllabus
## EN151HS: Finishing School-I
## (Common to all Branches)

**Course Overview**

- In view of the growing importance of English as a tool for global Communication and the consequent emphasis on training students to acquire language skills, this syllabus has been designed to develop linguistic, communicative and critical thinking competencies of Engineering students.

**Course Objectives**

- The main objective of this finishing school curriculum is to provide content for developing the LSRW skills of language learning and to facilitate proficiency in both receptive and productive skills, among students.

**Methodology:**

- Every Session will have activities on all the four skills-Listening, Speaking, Reading and Writing.
- To personalize the learning a variety of case studies and structured problem solving activities will be given to small groups and the teachers will facilitate peer reviews.
- Continuous grading, peer review and positive reinforcement will be emphasized
- Vocabulary exercises will also be a part of every session
- All sessions are designed to be student-centric and interactive.

**Unit-I: Fundamentals of Communication**

**Unit Overview:**

This is an introductory module that covers the fundamentals of communication. This module is intended to enable the students to communicate using greetings and small sentences/queries.

**Learning Outcomes:**

The students should be able to:

- Respond to questions
- Engage in informal conversations.
- Speak appropriately in formal situations
- Write formal and informal emails/letters

**Competencies:**

- Greeting appropriately
- Introducing themselves, a friend
- Situational Dialogue writing
- Responding to simple statements and questions both verbally and in writing
- Writing an email with appropriate salutation, subject lines, introduction and purpose of mail.
- Using appropriate vocabulary for both formal and informal situations.
- JAM sessions.

**Sessions:**

1. Introduction to Formal and Informal Conversations (Listening Activity)
2. Informal Conversations
3. Informal Conversations - Writing
4. Formal Conversations
5. Formal Conversations – Writing
6. Grammar-Prepositions

7. Adjectives and Degrees of Comparison
8. Word formation: Prefixes and Suffixes

### Unit–II: Rational Recap

**Unit Overview:**

The module enables the participants to organize their communication, structure their speaking and writing, explain their thoughts/ideas, and summarize the given information.

**Learning Outcomes:**

**The students should be able to:**

- Classify content and describe in a coherent form
- Recognize and list the key points in a topic/message/article.
- Compare and contrast using appropriate structure
- Explain cause and effect
- Use appropriate transitions in their presentations and written assignments

**Competencies:**

- Organizing the communication based on the context and audience
- Structuring the content based on the type of information.
- Explaining a technical/general topic in detail.
- Writing a detailed explanation/process
- Recapitulating

**Sessions:**

1. Introduction to Mind maps
2. Classification
3. Sequencing
4. Description and Enumeration

### Unit-III: Narrations and Dialogues

**Unit Overview:**

The Module is intended to develop the desired level of language competence that enables them to narrate and participate in casual dialogues.

**Learning Outcomes:**

The students should be able to

- Narrate a message/story/incident, both verbally and in writing.
- Describe an event/a session/ a movie/ an object / image
- Understand Vocabulary in context

**Competencies:**

- Framing proper phrases and sentences to describe in context
- Reading Stories and articles and summarizing.
- Speaking fluently with clarity
- Listening for main ideas and reformulating information in his/her own words
- Drawing and write appropriate conclusions, post reading a passage.
- Speaking Reading and Writing descriptive sentences and paragraphs
- Using appropriate tenses, adjectives and adverbs in conversations and written tasks

**Sessions:**

Grammar: Verb, Tenses

1. Recalling and Paraphrasing
2. Describing Events
3. Describing Objects/ Places
4. Story Telling
5. Describing Hypothetical events

### Unit-IV: Technical Expositions and Discussions

**Unit Overview:**

The module enables the students to build strategies for effective interaction and help them in developing decisive awareness and personality, maintaining emotional balance.

**Learning Outcomes:**

The students should be able to:

- Participate in Professional discussions by providing factual information, possible solutions, and examples.

**Competencies:**

- Comprehending key points of a topic and identifying main points including supporting details.
- Construct a logical chain of arguments and decisive points.
- Writing a review about a product by providing reasons, causes and effects

**Sessions:**

Based on Case Studies

1. Compare and Contrast
2. Cause and Effect
3. Problem and Solution

### Unit-V: Drawing Conclusions

**Unit Overview:**

This module is intended to provide necessary inputs that enable the studentsto draw conclusions out of a discussion and provide reports.

**Learning Outcomes:**

Students should be able to:

- Provide logical conclusions to the topics under discussion.
- Prepare, present, and analyze reports.

**Competencies:**

- Reasoning skills - Coherent and logical thinking
- Reporting and Analyzing skills.
- Analyzing the points discussed.
- Connecting all points without gaps.
- Connectives
- Communicating the decisions

**Sessions:**

1. Report Writing
2. Reasoning
3. Analyzing
4. Generalization and Prediction
5. Précis writing

**Minimum Requirement**

**Interactive Communication Skills Lab:** A Spacious room with movable chairs and audio-visual aids with a Public-Address System, an LCD and a projector with Internet Connectivity, Handycam Camcorder with 4K recording facility with tripod.

### Reference Books:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
2. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
3. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.
5. English Vocabulary in Use series, Cambridge University Press 2008.

6. Handbook for Technical Communication by David A. Mc Murrey & Joanne Buckley. 2012.Cengage Learning.
7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
8. Job Hunting by Colm Downes, Cambridge University Press 2008.
9. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009
10.Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
## CE201PC: FEM in Structural Engineering

**Course Objectives**

- To obtain an understanding of the fundamental theory of the FEA method
- To understand the use of the basic finite elements for structural applications using truss,
- beam, frame, and plane elements
- To understand the applications to solid mechanics
- To learn about the software packages used for FEM applications

**Course Outcomes**

- Use Finite Element Method for Structural Analysis.
- Execute the Finite Element Program/ Software.
- Solve continuum problems using finite element analysis

### Unit- I: Introduction

History and Applications, Finite element modeling, Shape functions, Boundary functions, Nodal equilibrium equations, Direct Stiffness Method, Minimum Potential Energy Principle, Assembly of Global Stiffness Matrix, Element Strain and Stress.

### Unit- II: Methods to Engineering Analysis and One Dimensional Elements

Discretization, Rayleigh –Ritz Method, Weighted Residual Method**,** Galerkin Method, Application to Structural Elements, Interpolation Functions, Compatibility and Completeness Requirements, Polynomial Forms, Applications.

One Dimensional Elements- Spring, Bar and Truss elements, Element Stiffness Matrix, Strain Displacement Matrix, Load vector, Force Vector.

### Unit- III: Application to Solid Mechanics

Plane Stress, CST Element, Plane Strain Rectangular Element, Isoparametric Formulation of the Plane Quadrilateral Element, Axi- Symmetric Stress Analysis, Strain and Stress Computations.

### Unit- IV: Three Dimensional Elements

Types**,** Triangular Elements, Rectangular Elements, Strain Displacement Relationship, Isoparametric Formulation, Axi-Symmetric Elements, Numerical Integration, Gaussian Quadrature.

### Unit- V: FEM Implementation

Structure of FEA program, Pre-Processing, Solution, Post-Processing, Computer Program for FEA, Use of Commercial FEA Software packages

.

### Suggested Readings:

1. Krishna Murthy C.S., Finite Element Method. MC Graw-Hill Publishers.
2. Chandrupatla, T.R, Belegundu A.D., Finite Element Methods in Engineering, Prentice Hall India.

### Reference Books:

1. Bhavikatti S.S, Finite Element Analysis, New Age International Publishers, 3rd Edition.
2. Cook R. D., Concepts and Applications of Finite Element Analysis, Wiley J., New York.
3. Hutton David, Fundamentals of Finite Element Analysis, Mc Graw Hill.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
## CE202PC: Structural Dynamics

**Course Objectives**

- To impart knowledge on the fundamental of structural dynamics and their applications.

**Course Outcomes**

- Able to understand the fundamentals of vibrations.
- Able to develop equation of motion for dynamic response of single degree freedom systems.
- Develop equation of motion and determine mode shapes for dynamic response of multi degree-of freedom systems.
- Determine mode shapes for dynamic response of continuous systems
- Able to understand the earthquake response of structures.

### Unit- I: Theory of vibrations

Introduction - Elements of vibratory system - Degrees of Freedom - Continuous System - Lumped mass idealization - Oscillatory motion - Simple Harmonic motion - Vectorial representation of S.H.M. - Free vibrations of single degree of freedom system - undamped and damped vibrations - critical damping - Logarithmic decrement - Forced vibration of SDOF systems - Harmonic excitation - Vibration Isolation -Dynamic magnification factor – Phase angle.

### Unit- II: Introduction to Structural Dynamics and Single Degree of Freedom Systems

Fundamental objectives of dynamic analysis -Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods – Direct equilibration using Newton's law of motion / D'Alembert's principle, Principle of virtual work and Hamilton principle. Single Degree of Freedom Systems- Formulation and solution of the equation of motion - Free vibration response - Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral.

### Unit- III: Multi Degree of Freedom Systems

Selection of the degrees of Freedom - Evaluation of structural property matrices - Formulation of the MDOF equations of motion – Un-damped free vibrations - Solutions of Eigen value problem for natural frequencies and mode shapes - Analysis of Dynamic response – Normal co-ordinates - Uncoupled equations of motion - Orthogonal properties of normal modes - Mode superposition procedure.

### Unit- IV: Practical Vibration Analysis and Continuous Systems

Introduction - Stodola method - Fundamental mode analysis - Analysis of second and higher modes - Holzer method - Basic procedure.

Continuous Systems- Introduction - Flexural vibrations of beams - Elementary case – Derivation of governing differential equation of motion - Analysis of undamped free vibrations of beams in flexure - Natural frequencies and mode-shapes of simple beams with different end conditions.

### Unit- V: Introduction to Earthquake Analysis

Deterministic Analysis of Earthquake Response-Types of Earthquake Excitations- Excitation by Rigid base Translation -Lumped SDOF systems, Generalized single degree of freedom system. Linear Static Method – Analysis for obtaining response of multi storied RC Building.

**Suggested Readings:**

1. Clough & Penzien, Dynamics of Structures, McGraw Hill, New York
2. Anil K. Chopra, Dynamics of Structures, Pearson Education (Singapore), Delhi.
3. Thomson. W.T., Theory of vibrations CBS Publishers and Distributors

**Reference Books:**

1. Mario Paz, Structural Dynamics, C.B.S Publishers, New Delhi.
2. Roy. R. Craig, Structural Dynamics, John willy & fours
3. I.S: 1893 (Part 1) - 2016, “Code of practice for Earthquake resistant design of Structures"

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Professional Elective-III
## CE211PE: Advanced Steel Design

**Course Objectives**

- To Understand the basic principles bolted, welded and connections.
- To Analyse beam-column connections and framed connection
- To Design of industrial roof truss subjected to wind force
- To Design the steel truss girder bridges.
- To understand the behaviour of plastic theory and to carry out plastic analysis of beams and portal frame

**Course Outcomes**

- Analyse and design the beam-column connections.
- Design and detail steel members and eccentric connections
- Analyse steel components for different loads acting on them
- Design steel truss girder bridge according to IS 800-2007
- Analyze structures using plastic method of analysis

### Unit- I: Bolted Pinned and Welded Connections

Simple connections-Bolted Connections –Load Transfer Mechanism – Failure of Bolted Joints – Specifications for Bolted Joints – Bearing – Type Connections – Tensile Strength of Plate – Strength and Efficiency of the Joint – Combined Shear and Tension – Slip-Critical connections – Prying Action-Combined Shear and Tension for Slip-Critical Connections. Design of Groove Welds - Design of Fillet Welds – Design of Intermittent Fillet Welds – Failure of Welds.

### Unit- II: Eccentric and Moment Connections

Introduction – Beams – Column Connections – Connections Subjected to Eccentric Shear – Bolted Framed Connections –Bolted Seat Connections – Bolted Bracket Connections. Bolted Moment Connections – Welded Framed Connections- Welded Bracket Connections – Moment Resistant Connections.

### Unit- III: Analysis and Design of Industrial Buildings

Dead loads, live loads and wind loads on roofs. Design wind speed and pressure, wind pressure on roofs; wind effect on cladding and louvers; Design of angular roof truss, tubular truss, truss for a railway platform. Design of purlins for roofs, design of built up purlins, design of knee braced trusses and stanchions. Design of bracings.

### Unit- IV: Design of Steel Truss Girder Bridges

Types of truss bridges, component parts of a truss bridge, economic Proportions of trusses, self weight of truss girders, design of bridge Compression members, tension members; wind load on truss girder Bridges; wind effect on top lateral bracing; bottom lateral bracing; portal Bracing; sway bracing Design of Lacing.

### Unit- V: Plastic Analysis and Design

Introduction – Plastic Theory – Plastic neutral Axis plastic moment, Elastic & Plastic Section modulii shape factors plastic Hinge – Fundamental condition conditions in plastic analysis, methods of plastic analysis – collapse load – simply supported, propped cantilever beam, fixed beams continuous beams, portal frame single bay single storey

portal frame at different level subjected to vertical and horizontal loads, Method of instantaneous center gable frame – Trial and error method – plastic moment distribution method – continuous beam– ultimate Deflections for beams and frames

**Suggested Readings:**

1. Duggal S K, Limit state design of steel structures', Tata McGraw Hill Education, Private Limited, 2nd edition 2017.
2. Ramachandra & Vivendra Gehlot , Design Steel Structures Volume – II, Scientific Publishes.
3. Subramanian. N, Design of Steel structures', Oxford University press, 2nd Edition, 2016.

**Reference Books:**

1. Dayaratnam P., Design of Steel Structures, S. Chand, Edition 2011-12.
2. Indian Standard Code – IS – 800-2007.
3. Indian Standard Code – IS – 875 – Part III – 2015.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Professional Elective-III
## CE212PE: Design of High-Rise Buildings

### Course Objectives

- To understand various load actions on the high rise structures
- To understand the behavior of RC and Steel chimneys under various loads
- To understand the torsional effects on structural elements.

### Course Outcomes

- Analyse, design and detail Transmission/ TV tower, Mast and Trestles with different loading conditions.
- Analyse, design and detail the RC and Steel Chimney.
- Analyse, design and detail the tall buildings subjected to different loading conditions using relevant codes.

### Unit- I: Design of transmission/ TV tower, Mast and trestles
Design of transmission/ TV tower, Mast and trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads.

### Unit- II: Analysis and Design of RC and Steel Chimney
Analysis and Design of RC and Steel Chimney, Foundation design for varied soil strata.

### Unit- III: Tall Buildings
Tall Buildings: Structural Concept, Configurations, various systems, Wind and Seismic loads, Dynamic approach, structural design considerations and IS code provisions. Fire fighting design provisions.

### Unit- IV: Sectional shapes and other effects
Sectional shapes, properties and resisting capacity, design, deflection, cracking, pre stressing, shear flow, design concepts for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

### Unit- V: Buckling analysis
Introduction to overall buckling analysis of frames, translational, torsional instability, case studies.

### Suggested Readings:
1. Taranath. B. S, Structural Analysis and Design of Tall Buildings, Mc Graw Hill, 1988.
2. Varyani U. H., Structural Design of Multi-storeyed Buildings, South Asian Publishers, New Delhi, 2nd Edition, 2002.
3. Manohar S. N. Tall Chimneys, Tata Mc Graw Hill Publishing Company, New Delhi.

### Reference Books:
1. Shah V. L. & Karve S. R., Illustrated Design of Reinforced Concrete Buildings (GF+3storeyed), , Structures Publications, Pune, 2013.
2. Smith Byran S. and Coull Alex, Tall Building Structures, Wiley India. 1991.
3. Wolfgang Schueller, High Rise Building Structures, Wiley., 1971.
4. Design of Multi Storeyed Buildings, Vol. 1 & 2, CPWD Publications, 1976.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
## CE213PE: Design of Masonry Structures

### Course Objectives

- Understand masonry materials and its mechanical properties.
- Analyze the flexural strength of reinforced masonry members.
- Understand the interaction between the members.
- Demonstrate shear strength and ductility of reinforced masonry members
- Understand the stability of wall and static push over analysis

### Course Outcomes

- Able to select proper masonry materials and design approach.
- Design different type of masonry wall for different loading condition
- Determine the interaction between the retaining walls, Pier and Foundation.
- Design the reinforced masonry members for shear strength.
- Perform elastic and inelastic analysis of masonry walls

### Unit-I: Introduction

Historical Perspective, Masonry Materials, Masonry Design Approaches, Overview of Load Conditions, Compression Behaviour of Masonry, Masonry Wall Configurations, Distribution of Lateral Forces.

### Unit-II: Flexural Strength

Flexural Strength of Reinforced Masonry Members: In plane and Out-of-plane loading.

### Unit-III: Interactions

Structural Wall, Columns and Pilasters, Retaining Wall, Pier and Foundation.

### Unit-IV: Shear Strength

Shear Strength and Ductility of Reinforced Masonry Members.

### Unit-V: Prestressed Masonry and Elastic and Inelastic Analysis

Prestressed Masonry - Stability of Walls, Coupling of Masonry Walls, Openings, Columns, Beams. Elastic and Inelastic Analysis, Modeling Techniques, Static Push Over Analysis and use of Capacity Design Spectra.

### Suggested Readings:

1. Robert G .Drysdale, Ahmad A Hamid, Masonry structures: Behavior and Design Boulder, CO Masonry Society, 3rd edition, 2008.
2. Narendra Taly, “Design of Reinforced Masonry Structures”, ICC, 2nd Edition, 2010
3. Hendry A.W., “Structural masonry”- Palgrave Macmillan Education Ltd., 2nd edition.

### Reference Books:

1. Sven Sahlin, “Structural Masonry”- Prentice Hall Publisher: Prentice Hall, 1971.
2. Jagadish K .S, Structural Masonry, I K International Publishing House Pvt Ltd, 2015.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Professional Elective-IV
## CE214PE: Soil Structure Interaction

**Course Objectives**

- To analyze the soil structure interaction behavior.
- To soil structure complexities with respect to different types of loading and different structures.

**Course Outcomes**

- Understand soil structure interaction concept and complexities involved.
- Evaluate soil structure interaction for different types of structure under various conditions of loading and subsoil characteristics.
- Prepare comprehensive design-oriented computer programs for interaction problems based on theory of sub grade reaction such as beams, footings, rafts etc.
- Analyze different types of frame structure founded on stratified natural deposits with linear and non-linear stress-strain characteristics.
- Evaluate action of group of piles considering stress-strain characteristics of real soils.

**Unit-I: Conventional Methods**

Critical Study of Conventional Methods of Foundation Design, Nature and Complexities of Soil Structure Interaction.

**Unit-II: Application of Advanced Techniques**

Application of Advanced Techniques of Analysis such as Finite Element Method (FEM) and Finite Difference Method.

**Unit-III: Evaluation of Soil Structure Interaction**

Relaxation and Interaction for the Evaluation of Soil Structure Interaction for Different Types of Structure under various Conditions of Loading and Subsoil Characteristics.

**Unit-IV: Computer Programs for Specific Problems**

Preparation of Comprehensive Design Oriented Computer Programs for Specific Problems, Interaction Problems based on Theory of Sub Grade Reaction Such as Beams, Footings, Rafts Etc.

**Unit-V: Analysis of Framed structures and Pile Capacity**

Analysis of Different Types of Frame Structures Founded on Stratified Natural Deposits with Linear and Non-Linear Stress-Strain Characteristics. Determination of Pile Capacities and Negative Skin Friction, Action of Group of Piles Considering Stress-Strain Characteristics of Real Soils, Anchor Piles and Determination of Pullout Resistance.

**Suggested Readings:**

1. Bowels J.E, Analytical and Computer Methods in Foundation, McGraw Hill Book Co., New York, 1974.

**Reference Books:**

1. Desai C.S. and Christian J.T., Numerical Methods in Geotechnical Engineering, McGraw Hill Book Co., New York.

2. Selvadurai A.P.S., Elastic Analysis of Soil-Foundation Interaction, Elsevier Scientific Publishing Company.
3. Swami Saran.,Analysis & Design of substructures, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Kurian N. P., Design of Foundation System- Principles & Practices, Narosa Publishing.
5. Soil Structure Interaction - The real behavior of structures, Institution of Structural Engineers.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Professional Elective-IV
## CE215PE: Design of Pre-Stressed Concrete Structures

**Course Objectives**

The objectives of the course are to

- Study the behavior of pre-stressed concrete sections under flexure.
- Understand concepts continuous and composite beams.
- Develop skills in analysis and design of sections for compression and bending.
- Know different pre-stressed concrete slabs.
- * Get the knowledge of circular pre-stressing.

**Course Outcomes**

- Design the pre-stressed concrete structures for flexure and shear using IS 1343:2012.
- Design composite beams.
- Design sections for compression and bending.
- Design prestressed concrete slabs.
- Analyse and Design prestressed concrete pipes, tanks, poles and piles.

### Unit-I: Design of Prestressed Concrete Sections

Design of sections for flexure, Minimum section modulus- prestressing force- Limitation of prestress in long spans-limiting zone for the prestressing force- Design of sections for the limit state of collapse in flexure-Design of sections for axial tension.

### Unit-II: Statically Indeterminate Structures and Composite Beams

Primary and secondary moments – methods of Analysis of secondary moments. Analysis of continuous beams.
**Composite Beams:** Different Types- Propped and Unpropped- stress distribution- Differential shrinkage- Analysis of composite beams- General design considerations.

### Unit-III: Design of sections for Compression and Bending

Load-Moment Interaction curves for prestressed concrete short columns-Design of long prestressed columns-design of prestressed concrete compression members in biaxial bending- practical design considerations-design of prestressed sections for shear and torsion.

### Unit-IV: Prestressed Concrete Slabs

Types of prestressed concrete floor slabs- design of prestressed concrete one way and two-way slabs-design of prestressed concrete simple flat slabs.

### Unit-V: Prestressed Concrete Pipes, Tanks, Poles and Piles

Circular prestressing-Types of prestressed concrete pipes- Design of prestressed concrete pipes- analysis and design of prestressed concrete tanks-Design of prestressed concrete poles, partially prestressed pretensioned poles-advantages of prestressed concrete piles-types of prestressed concrete piles-design considerations-pile reinforcements-pile shoes-sheet piles.

**Suggested Readings:**

1. Krishna Raju N, Prestressed concrete, Tata Mc Graw Hill, New Delhi. 1981.

2. Ramamrutham S., Prestressed concrete, Dhanpat Rai & Sons, Delhi.
3. Rajagopalan N., Prestressed Concrete, Narosa Publishing House.

**Reference Books:**

1. Muthu K.V., Prestressed concrete, PHI learning Pvt. CEO.
2. Gutan Y, Limited state design of prestressed concrete, Applied science publishers, 1972.
3. IS:1343-2012-code of practice for prestressed concrete.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Professional Elective-IV
## CE216PE: Structural Optimization

**Course Objectives**

- To impart knowledge on Variational principle for optimization
- To impart knowledge on optimization techniques
- To impart knowledge on Geometric Programming
- To impart knowledge on frequency constraint.

**Course Outcomes**

- The learner will be able to Use Variational principle for optimization
- The learner will be able to Apply optimization techniques to structural steel and concrete members.
- The learner will be able to perform Geometric Programming and Stochastic Programming
- The learner will be able to Design using frequency constraint.

### Unit-I: Introduction
Simultaneous Failure Mode and Design, Classical External Problems.

### Unit-II: Calculus of Variation
Calculus of Variation- Variational Principles with Constraints.

### Unit-III: Linear Programming
Linear Programming, Integer Programming, Nonlinear Programming, Dynamic Programming.

### Unit-IV: Programming
Geometric Programming and Stochastic Programming

### Unit-V: Applications and Design
Applications- Structural Steel and Concrete Members, Trusses and Frames. Design:-Frequency Constraint, Design of Layouts.

**Suggested Readings:**

1. Haftka, Raphael T., Gürdal, Zafer, Elements of Structural Optimization, Springer.

**Reference Books:**

1. Cherkaev Andrej, Variational methods for Structural optimization, Springer.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Audit Course – II
## AC201HS: Disaster Management

**Course Objectives**

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in
- Provide knowledge about different disasters tools to handle disasters, methods for disaster management

**Course Outcomes**

- Understanding disasters, manmade hazards & vulnerabilities
- Understanding disaster management mechanism
- Understanding capacity building
- Understanding concepts
- Understanding planning of disaster management

### Unit-I: Introduction & Disaster Prone Areas in India

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Study of Seismic Zones; Areas prone to Floods and Droughts, Landslides and Avalanches; Areas prone to Cyclonic and Coastal Hazards with special reference to Tsunami; Post-Disaster Diseases and Epidemics

### Unit-II: Repercussions of Disasters and Hazards

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

### Unit-III: Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community preparedness.

### Unit-IV: Risk Assessment

Disaster Risk- Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment: Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

### Unit-V: Disaster Mitigation

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

**Suggested Readings:**

1. Nishith R., Singh A K, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep et. al.," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Manual on Disaster Management, National Disaster Management, Agency Govt of India.

**Reference Books:**

1. Goel S.L., Disaster Administration and Management Text and Case Studies", Deep Publication Pvt. Ltd., New Delhi.
2. Pandharinath N., Rajan CK, Earth and Atmospheric Disasters Management BS Publications 2009.
3. National Disaster Management Plan, Ministry of Home affairs, Government of India (http://www.ndma.gov.in/images/policyplan/dmplan/draftndmp.pdf).

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Audit Course – II
## AC202HS: Value Education

**Course Objectives**

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

**Course Outcomes**

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

**Unit-I**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

**Unit-II**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.

**Unit-III**

Personality and Behavior Development -Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

**Unit-IV**

Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

**Unit-V**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

**Suggested Readings:**

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Audit Course – II
## AC203HS: Pedagogy Studies

**Course Objectives**

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**Course Outcomes**

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

**Unit-I**

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

**Unit-II**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

**Unit-III**

Evidence on the effectiveness of pedagogical practices, Methodology for the indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

**Unit-IV**

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

**Unit-V**

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

**Suggested Readings:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston:

Blackwell.
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

**Reference Books:**

1. Akyeampong K (2003) Teacher training in Ghana -does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. Akyeampong K, Lussier K, Pryor J, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
3. www.pratham.org/images/resource%20working%20paper%202.pdf.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
Audit Course-II
## AC204HS: Personality Development through Life Enlightenment Skills

**Course Objectives**

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

**Course Outcomes**

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

**Unit-I**

Neetisatakam-Holistic development of personality

- Verses-19, 20, 21, 22 (wisdom)
- Verses-29, 31, 32 (pride & heroism)
- Verses-26, 28, 63, 65 (virtue)

**Unit-II**

Neetisatakam-Holistic development of personality

- Verses-52, 53, 59 (dont's)
- Verses-71, 73,75,78 (do's)

**Unit-III**

Approach to day to day work and duties.

- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47, 48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5, 13, 17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

**Unit-IV**

Statements of basic knowledge.

- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16, 17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:

**Unit-V**

- Chapter2-Verses 17, Chapter 3-Verses 36, 37, 42,
- Chapter 4-Verses 18, 38, 39
- Chapter18 –Verses 37, 38, 63

**Suggested Readings:**

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. P.Gopinath , Bhartrihari's Three Satakam (Niti-sringar-vairagya) , Rashtriya Sanskrit Sansthanam, New Delhi.

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus

## CE251PC: Advanced Structural Engineering Lab

**Course Objectives**

- To make students to learn principles of design of experiments
- To investigate the performance of structural elements.
- To evaluate the different testing methods and equipments.

**Course Outcomes**

On completion of this course, students are able to

- Achieve Knowledge of design and development of experimenting skills.
- Understand the principles of design of experiments
- Design and develop analytical skills.
- Summarize the testing methods and equipments.

**List of Experiments**

1. Non-destructive testing (NDT) of concrete using Rebound hammer
2. Non-destructive testing (NDT) of concrete using Ultra sonic pulse velocity meter
3. Detection reinforcement in a structural member using profometer
4. Testing of brick masonry Block
5. Testing of simply supported R.C.C One way slab
6. Testing of simply supported R.C.C Two way slab
7. Testing of concrete by extracting concrete core
8. Behaviour of Plain and Fiber reinforced concrete under flexure
9. Testing of R.C beam under torsion

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## M.Tech. in Computer Aided Structural Engineering
## II Semester Syllabus
## CE252PC: Structural Design Lab

**Course Objectives**

- Learn Staad Pro / ETABS software
- Understanding IS Code books
- Designing & Detailing skill development
- Use of Excel sheets
  Analyzing skills & Problem solving skills

**Course Outcomes**

- Design of RCC Structures
- Design of Steel Structures
- Detailing of RCC Structures
- Detailing of Steel Structures
- Design and Detail complete Multi-Storey Frame Buildings.

**List of Experiments:**

1. Static analysis of Building structure using software (ETABS / STAADPRO)
2. Dynamic analysis of Building structure using software (ETABS / STAADPRO)
3. Design of residential RCC using software (ETABS / STAADPRO)
4. Design of Steel structure using software (ETABS / STAADPRO)
5. Preparation of EXCEL sheets for structural design of columns
6. Design of beams using Excel program
7. Design of One way and Two way slabs using Excel program
8. Preparation of Excel sheets for isolated footing
9. Preparation of Excel sheets for combined footing

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**M.Tech. in Computer Aided Structural Engineering**

II Semester Syllabus

**MA252BS: Finishing School-II**

(Common to all Branches)

## Course Objectives

This is a foundation course and aims to enhance employability skills in students.

- Students will be introduced to higher order thinking skills and problem-solving on the following areas - Arithmetic ability, Numerical ability and General reasoning.
- Students will be trained to work systematically with speed and accuracy while solving problems.

## Course Outcomes

- At the end of the course students will be able to:
- Solve questions on the above-mentioned areas using shortcut and smart methods.
- Understand the fundamental concepts of Aptitude skills.
- Perform calculations with speed and accuracy.

### Unit-I: Quantitative Aptitude - Numerical Ability

- Number systems
- LCM & HCF
- Speed Math
- Divisibility Rules
- Square root
- Cube root
- Problems on numbers with shortcuts

### Unit -II: Quantitative Aptitude- Arithmetic Ability-I

- Percentage
- Profit loss and discounts
- Simple and Compound interest
- Ratio proportions
- Averages

### Unit-III: Quantitative Aptitude- Arithmetic Ability-II

- Pipes and Cisterns
- Ages
- Time-Speed-Distance
- Clocks & Calendars
- Venn diagrams
- Tables and graphs

### Unit-IV: Reasoning Ability – General Reasoning-I

- Coding decoding
- Directions
- Series completions - Letter, Number & Element Series
- Seating arrangements
- Odd one out

- Spatial ability questions

**Unit-V: Reasoning Ability- General Reasoning -II**

- Analogies
- Alphabet Analogy
- Numerical Analogy
- Classification
- Alphabet Classification
- Word Classification
- Miscellaneous Classification
- Alphabet test
- Arranging words in Alphabetical Order
- Problems based on Letter-Word
- Problems based on Alphabetical Quibble
- Blood Relations
- Statements and conclusions
- Direction Sense test

**Reference Books:**

1. R.S. Aggarwal - Quantitative Aptitude for Competitive Examinations.
2. Arun Sharma - Quantitative Aptitude for CAT.
3. Arihant Publications - Fast Track Objective Arithmetic.
4. Sarvesh K.-Quantitative aptitude
5. B.S. Sijwalii and Indu Sijwali , A New Approach to Reasoning Verbal & Non-Verbal.
6. Agarwala Vikas and R.S. Aggarwal ,A Modern Approach to Logical Reasoning,.

## III Semester

| S.No. | Course Code | Course Title | Instruction Hours Per Week | | | Examination Max. Marks | | Duration of SEE in Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CIE | SEE | | |
| 1 | CE31XPE | Professional Elective-V | 3 | 0 | - | 30 | 70 | 3 | 3 |
| 2 | CE32XOE | Open Elective | 3 | 0 | - | 30 | 70 | 3 | 3 |
| 3 | CE351PC | Dissertation –I / Industrial Project | 0 | 0 | 20 | 50 + 50 | -- | - | 10 |
| | | **Total Hours/Marks/Credits** | **6** | **0** | **20** | **160** | **140** | | **16** |

## IV Semester

| S.No. | Course Code | Course Title | Instruction Hours Per Week | | | Examination Max. Marks | | Duration of SEE in Hours | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CIE | SEE | | |
| 1 | CE451PC | Dissertation -II | 0 | 0 | 32 | 50+ 50 | -- | - | 16 |
| | | VIVA VOCE | | | | -- | 100 | - | |
| | | **Total Hours/Marks/Credits** | **0** | **0** | **32** | **100** | **100** | | **16** |

**L**: Lecture **T**: Tutorial **D**: Drawing **P**: Practical **CIE** - Continuous Internal Evaluation **SEE** - Semester End Examination

### List of Professional Electives

**Professional Elective-V**

CE311PE: Earthquake Resistance Design of Buildings.
CE312PE: Industrial Structures
CE313PE: Bridge Engineering

**List of Open Electives offered by Civil Department to other Departments**

CE321OE: Construction Management
CE322OE: Finite Element Methods
CE323OE: Composite Materials.

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## M.Tech. in Computer Aided Structural Engineering
## III Semester Syllabus
Professional Elective-V
## CE311PE: Earthquake Resistance Design of Buildings

**Course Objectives**

- To impart knowledge on the seismology and
- To impart knowledge behavior of buildings during earthquakes
- To impart knowledge on design of shear wall
- To impart knowledge on structural walls
- To impart knowledge Ductility Considerations in Earthquake Resistant design of RC Buildings

**Course Outcomes**

- The learner will be able to analyse seismic forces
- The learner will be able to design buildings to resist seismic forces
- The learner will be able to design the shear wall
- The learner will be able to design the structural walls
- The learner will be able to design ductility Considerations in Earthquake Resistant Design of RC buildings

### Unit-I: Engineering Seismology

Earthquake phenomenon cause of earthquakes-Faults- Plate tectonics- Seismic waves- Terms associated with earthquakes-Magnitude/Intensity of an earthquake-scales- Energy Released-Earthquake measuring instruments-Seismoscope, Seismograph, accelerograph- Characteristics of strong ground motions- Seismic zones of India. Introduction-Functional Planning-Continuous load path-Overall form-simplicity and symmetry- elongated shapes-stiffness and strength - Seismic design requirements-regular and irregular configurations-basic assumptions.

### Unit-II: Conceptual Design of Buildings

Horizontal and Vertical Load Resisting Systems - System and Members for Lateral Loads and High Rise / Tall Structures. Twisting of Buildings – Flexible Building and Rigid Building Systems. Strength and Stiffness – Ductility – Definition – Ductility Relationships – Choice of construction Materials – Unconfined Concrete & Confined Concrete - Design Earthquake Loads – Basic Load Combinations – Permissible Stresses. Seismic Methods of Analysis – Static Method – Equivalent Lateral Force Method. Dynamic Analysis – Response Spectrum Method.

### Unit-III: Earthquake Resistant Design

Seismic Design Requirements and Methods.RC Buildings – IS Code based Method.- Vertical Irregularities – Mass Irregularity TorsionalIrregularity-Plan Configuration Problem - Design Lateral Force, Base Shear Evaluation – Lateral Distribution of Base Shear – Structural Walls Strategies and the Location of Structural Walls – Sectional Shapes – Behaviourof Unreinforced and Reinforced Masonry Walls – Behaviourof Walls Box Action andBands-Behaviour of infill Walls-NonStructuralElements–Failure Mechanism of NonstructuralElements-Effects of Nonstructural Elements on Structural System – Analysis – Prevention of Damage to Nonstructural Elements – Isolation ofNon-Structures.

### Unit-IV: Design of Shear walls

Classification according to Behaviour, Design of Shear walls- Shear Wall Functions & Loads Transfer Mechanism .Loads in Shear walls, Design of Rectangular and Flanged Shear walls, Derivation of Formula for Moment of Resistance of Rectangular Shear walls – Behaviour of Coupled Shear Walls.

### Unit-V: Ductility Considerations in Earthquake Resistant Design of RC Buildings

Introduction- Impact of Ductility- Requirements for Ductility- Assessment of Ductility- Factors affecting Ductility- Ductile detailing considerations as per IS 13920.Behavior of beams, columns and joints in RC buildings.during earthquakes-Vulnerability of open ground storey and short columns during earthquake- Seismic Evaluation andRetrofitting. Capacity Based Design: Introduction to Capacity Design, Capacity Design for Beams and Columns- Case studies.

### Suggested Readings:

1. Duggal S. K., Earthquake Resistant Design of structures –Oxford University Press.
2. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of structures, Prentice Hall of India Pvt.Ltd.
3. Paulay T. and Priestly M.J.N., Seismic Design of Reinforced Concrete and Masonry Building,John Wiley & Sons.

### Reference Books:

1. Anand S.Arya, Masonry and Timber structures including earthquake Resistant Design –Nemchand &Bros.
2. Miha Tomazevic, Earthquake Resistant Design of Masonry Building –Imperial college Press.
3. Subramanian N., Design of Reinforced Concrete Structures , Oxford University Press.

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## M.Tech. in Computer Aided Structural Engineering
## III Semester Syllabus
Professional Elective-V
## CE312PE: Industrial Structures

**Course Objectives**

- To impart knowledge about different types of industrial structures their analysis
- Design industrial structures for different conditions as per codal provision.

**Course Outcomes**

- Understand the various methods of analysis.
- Able to plan and design different types of industrial structures such as cold formed members,
- Able to design RC bunkers, Silos.
- Understand the analysis and design of Chimneys.
- Able to design Cylindrical shells.

### Unit-I: Planning of Industrial Structures

Planning of Industrial Structures – types of industrial structures – different components of industrial structures – Bracings of Industrial Buildings – Design of Steel Industrial Buildings.

### Unit-II: Thin Walled / Cold Formed Steel Members

Definitions – Local Buckling of Thin-Elements-Post Buckling of Thin-Elements – Light Gauge Steel Columns and Compression Members – Form-Factor for Columns and Compression Members – Behaviour of Stiffened Elements Under Uniform Compression – Multiple Stiffened Compression Elements –Effective Length of Light Gauge Steel Compression Members – Light Gauge Steel Tension Members.

### Unit-III: RC Bunkers & Silos

Introduction – Janssen's Theory – Airy's Theory – Design of Square, Rectangular and Circular Bunkers; Design of Silos.

### Unit-IV: RC Chimneys

Introduction – Wind Pressure – Stresses in Chimney Shaft Due to Self-Weight and Wind – Stresses in Horizontal Reinforcement Due to Wind Shear – Stresses Due to Temperature Difference – Combined Effect of Self Load, Wind and Temperature – Temperature Stresses in Horizontal Reinforcement Problems.

### Unit-V: Design

Design Principles of Cylindrical Shells & Design Problems.

### Suggested Readings:

1. Krishna Raju N., Advanced Reinforced Concrete Design CBS Publishers & Distributors, 2005
2. Ram Chandra and Virendra Gehlot , Design of Steel Structures, vol-II, 2007.

### Reference Books:

1. Dayaratnam P.,Design of Steel Structures., Publisher : S. Chand, Edition 2011-12.
2. Galyord & Gaylord , Design of Steel Structures, Publisher: Tata Mc Graw Hill, Education. Edition 2012.
3. Indian Standard Code – IS – 800-2007.
4. Indian Standard Code – IS – 875 – Part III – 2015.

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## M.Tech. in Computer Aided Structural Engineering
## III Semester Syllabus
Professional Elective-V
## CE313PE: Bridge Engineering

### Course Objectives

- Introduce the concepts in bridge design.
- The analysis of bridge decks and sub structure

### Course Outcomes

- The method of design of concrete bridges
- Design of solid slab and continuous bridges
- Basic principles and design of prestressed bridges
- Analysis of bridge decks
- Design loads of abutments and piers.

### Unit-I: Concrete Bridges

Introduction-Types of Bridges-Economic span length-Types of loading-Dead load- live load-Impact Effect-Centrifugal force-wind loads-Lateral Loads-Longitudinal forces-Seismic loads- Frictional resistance of expansion bearings-Secondary Stresses-Temperature Effect-Erection Forces and effects-Width of roadway and footway-General Design Requirements.

### Unit-II: Solid slab, Girder Bridges & Continuous Bridges

Introduction-Method of Design. Girder Bridges - Introduction-Method of Design-Courbon's Theory. Continuous Bridges - Introduction- Span lengths- Analysis of Continuous Bridges-Decking of Girders with constant Moment of Inertia-Continuous bridges with variable Moment of Inertia-Method of Analysis -Girders with Parabolic Soffit-Method of plotting Influence lines-Girders with Straight Haunches-Design steps for Continuous Bridges.

### Unit-III: Pre-Stressed Concrete Bridges

Basic principles- Method of Pre-stressing-Pre-tensioning and Post- tensioning- Comparison- Freyssinet Method-Magnel-Blanet System-Lee-Mc call system-Basic Assumptions-Losses in Prestress-Equation based on Initial and final stress conditions-Cable Zone- Design of selections-Condition of first crack- Ultimate load design-Shear-Vertical Prestressing- Diagonal Tension in I-section-End Block-Magnel's method-Empirical Method-General Design requirements-Mild steel reinforcement in prestressed concrete member-Concrete cover and spacing of pre-stressing steel-Slender beams-Composite Section-Propped-Design of Propped Composite Section-Unpropped composite section-Two-stage Prestressing-Shrinking stresses-General Design requirements for Road Bridges.

### Unit-IV: Analysis of Bridge Decks

Harmonic analysis and folded plate theory-Grillage analogy- Finite strip method and FEM.

### Unit-V: Sub-structure of bridges

Substructure- Beds block-Piers- Pier Dimensions- Design loads for piers- Abutments- Design loads for Abutments.

### Suggested Readings:

1. Aswani M.G., Vazirani V.N. and Ratwani M.M., Design of Concrete Bridges, Khanna Publishers , 1995.
2. Krishna Raju, Design of Bridges, Oxford & Ibh; 5th edition, 2005
3. Hambly E.C. , Bridge Deck Behaviour.CRC Press; 2nd edition, 1990

**Reference Books:**

1. Raina V.K., Concrete Bridge Practice, Shroff Publishers, Second Edition, 2019.
2. Johnson D. Victor, Essentials of Bridge Engineering, CBS Publishers & Distributors Pvt Ltd, India; 6th edition, 2017.

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## M.Tech. in Computer Aided Structural Engineering
## III Semester Syllabus
Open Elective
## CE321OE: Construction Management

### Course Objectives

- To know about the various Construction Management Techniques available for execution of project.
- To understand Resource planning, different types of contract.
- To learn the occupational and safety Hazard Assessment.

### Course Outcomes

- Plan, coordinate and control of project from beginning to completion.
- Distinguish different types of contracts that can be used for a project
- Adopt the most effect method for meeting the requirement in order to produce a functionally and financially viable project.

### Unit-I: Management process

Management Roles, Management theories. Social responsibilities. Planning and strategic management. Strategy implementation. Decision making: tools and techniques – Organizational structure. Human resource management-motivation performance- leadership.

### Unit--II: Classification of Construction projects

Construction stages, Resources- Functions of Construction Management and its Applications. Preliminary Planning-Collection of Data-Contract Planning – Scientific Methods of Management: Network Techniques in construction management - Bar chart, Gant chart, CPM, PERT- Cost & Time optimization.

### Unit--III: Resource planning

Planning for manpower, materials, costs, equipment. Labour-Scheduling. Forms of scheduling – Resource allocation. Budget and budgetary control methods

### Unit--IV: Contract

Types of contract, contract document, and specification, important conditions of contract – tender and tender document - Deposits by the contractor - Arbitration. Negotiation - M.Book - Muster roll -stores.

### Unit--V: Management Information System

Labour Regulations: Social Security - welfare Legislation - Laws relating to Wages, Bonus and Industrial disputes, Labour Administration - Insurance and Safety Regulations - Workmen's Compensation Act -other labour Laws - Safety in construction: legal and financial aspects of accidents in construction. occupational and safety hazard assessment. Human factors in safety. Legal and financial aspects of accidents in construction. Occupational and safety hazard assessment

### Suggested Readings:

1. Ghalot, P.S., Dhir, D.M., Construction Planning and Management, Wiley Eastern Limited 1992.
2. Chitkara, K.K., Construction Project Management¸ Tata McGraw Hill Publishing Co, Ltd., New Delhi 998.

**Reference Books:**

1. Punmia, B, C., Project Planning and Control with PERT and CPM, Laxmi Publications, New Delhi, 1987.
2. Sengupta, B. & Guha, H, Construction Management And Planning by: Tata McGraw-hill publications.

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## M.Tech. in Computer Aided Structural Engineering
## III Semester Syllabus
Open Elective
## CE322OE: Finite Element Methods

**Course Objectives**

- Understand in general how finite elements obtain approximate solutions to differential equations
- Appreciate the structure of a typical finite element program
- Gain experience of finite element analysis applied to classical geotechnical problems (e.g. settlement, seepage, consolidation, slope stability)
- Gain insight into the soil properties needed for finite element analysis

**Course Outcomes**

- To understand the fundamental theory of the Finite Element Method
- To apply the Finite Element theory to solve soil behavior under external loads.

**Unit-I**

**Introduction:** Concepts of FEM, Steps involved in Finite Element Analysis Procedure, Merits and Demerits. Principles of Elasticity: Stress equations, Strain-Displacement relationships in matrix form, Plane stress, Plane strain and axi-symmetric bodies of revolution with axi-symmetric loading.

**Unit-II**

**Element Properties**: Concept of an element, various element shapes, Displacement models, generalized coordinates, Shape functions, Convergent and Compatibility requirements, Geometric invariance, Natural coordinate system - area and volume coordinates.

**Unit-III**

**Generation of Element Stiffness and Nodal Load Matrices, Isoparametric Formulation**: Concept, Different isoparametric elements for 2D analysis, formulation of 4-noded and 8-noded isoparametric quadrilateral elements, Lagrangian elements, Serendipity elements.

**Unit-IV**

**Assemblage of Elements:** Discretization of a structure, numbering systems, Aspect ratio its effects, Assemblage, Direct Stiffness method.

**Unit-V**

**Geotechnical Applications:** Sequential construction, Excavations and embankments, Bearing capacity and Settlement analysis.

**Suggested Readings:**

1.Chandrupatla T R and Belegundu A D "Introduction to Finite Elements in Engineering".
2.Krishna Murthy C. S. - Finite element analysis - Theory and programming, Tata McGraw- Hill,1994

**Reference Books:**

1. Desai, C. S. and Abel J.F, Introduction to the Finite Element Method, Van Nostrand Reinhold Company (1972).

2. Reddy, J. N. - Introduction to the Finite Element Method - McGraw-Hill Publishers, 1993.
3. Zienkiewicz, O. C. - Finite element Methods, McGraw-Hill Publishers, 1971.

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## M.Tech. in Computer Aided Structural Engineering
## III Semester Syllabus
Open Elective
## CE323OE: Composite Materials

**Course Objectives**

- To understand composite materials and their properties, relationship between them and manufacturing methods.
- To understand principles of material science applied to composite materials.
- To study the equations to analyze problems by making good assumptions and learn systematic engineering methods to solve practical composites mechanics problems

**Course Outcomes:**

- Apply fundamental knowledge of mathematics to modelling and analysis of composite materials.
- Understand the manufacturing process of various composite materials.
- Analyze the failure modes of composites

**Unit--I**

**Introduction:** Definition - Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**Unit-II**

**Reinforcements:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements.
**Mechanical Behavior of Composites:** Rule of mixtures, Inverse rule of mixtures. lsostrain and lsostress conditions.

**Unit-Ill**

**Manufacturing of Metal Matrix Composites:** Casting - Solid State diffusion technique, Cladding - Hot isostatic pressing. Properties and applications.
**Manufacturing of Ceramic Matrix Composites:** Liquid Metal Infiltration - Liquid phase sintering. Manufacturing of Carbon - Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**Unit-IV**

**Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs - hand layup method - Autoclave method - Filament winding method - Compression moulding - Reaction injection moulding. Properties and applications, Introduction to Machining of Composites.

**Unit-V**

**Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**Suggested Readings:**

1. Cahn R. W. VCH,Material Science and Technology, West Germany.Vol. 13.
2. Agarwal B. D., Analysis and Performance of Fiber Composites, Wiley Publishers. Third Edition.

**Reference Books:**

1. Robert M. Jones, Mechanics of Composite Materials, Second Edition, , Scripta Book Company.
2. Callister W. D. Jr., Adapted, Balasubramaniam R., Materials Science and Engineering-An Introduction, John Wiley & Sons, NY, Indian Edition, 2007.
3. Chawla K. K., Composite Materials,.
4. Deborah D. L. Chung, Composite Materials Science and Applications,.
5. Danial Gay, Suong V. Hoa and Stephen W. Tosi, Composite Materials Design and Applications.