# Draft copy of Proposed Course Structure for Post Graduate Degree Programme

# M. Tech. in Civil Engineering

# with Specialization in

# Computer Aided Structural Engineering

Dr. Babasaheb Ambedkar Technological University

Lonere 402103, Dist. – Raigad, Maharashtra, INDIA

# Program Objectives

Goal of the Civil engineering with a specialization in Computer Aided Structural Engineering (CASE) at Dr. Babasaheb Ambedkar technological University, Lonere is to provide students with preparation to become worthy of professional careers in the field and to be motivated for lifelong learning. All prescribed courses have definite objectives and outcomes. Program objectives are expected qualities of engineers as under:

a) Preparation: To prepare students to excel in various educational programmes or to succeed in industry /technical profession through further education/training;

b) Core Competence: To provide students with a solid foundation in mathematical, scientific fundamentals required to solve Structural problems;

c) Breadth: To train students with a breadth of scientific knowledge to comprehend, analyze, design & create novelproducts and solutions for real life problems;

d) Professionalism: To inculcate in students professional/ethical attitude, effective team work skills, multidisciplinary approach and to relate engineering issues to a broader context;

e) Learning Environment: To provide students with academic environment of excellence, leadership, ethicalguidelines and life-long learning needed for a long / productive career.

In addition to above Dr. Babasaheb Ambedkar Technological University, Lonere graduate is expected to be

1. Taking pride in their profession and have commitment to highest standards of ethical practices and relatedtechnical disciplines;

2. Able to design structural system that is safe, economical and efficient;

3. Capable of using modern tools efficiently in all aspects of professional practices;

4. Dealing successfully with real life civil engineering problems and achieve practical solutions based on a soundscience and engineering knowledge;

5. Shall be engage in continuous research, development and exchange of knowledge for professional development;

6. Be honest in their control and performing their duties and promote effective use of resources through open,honest and impartial services to the public;

7. Act in such a manner which will uphold the honour, integrity, or dignity of the engineering profession, andavoid knowingly engaging in business or professional practices of a fraudulent, dishonest or unethical nature;

8. Recognize that the lives, safety, health and welfare of the general public are dependent upon engineering,decision and practices;

9. Continue their professional development throughout their careers and provide opportunities for the professionaldevelopment;

# Proposed Course Structure for Post Graduate Degree Programme M. Tech. in Civil Engineering (Computer Aided Structural Engineering)

## First Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credits | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | CA | Theory | | PR/ OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE101 | Theory of Elasticity and Plasticity | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 02 | CASE102 | Matrix Methods of Structural Analysis | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 03 | CASE103 | Structural Dynamics | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 04 | CASE-E1 | Elective-I | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 05 | CASE-E2 | Elective-II | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 06 | CASE-L01 | CASE-I Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| 07 | CASE-L02 | CASE-II Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| **Total for Semester I** | | | **15** | **03** | **04** | **20** | **200** | **100** | **300** | **100** | **700** |

**Elective-I**

**CASE-E1-01:** Advance Structural Analysis
**CASE-E1-02:** Numerical Methods
**CASE-E1-03**: Design of Steel Concrete Composite Structures
**CASE-E1-04**: Design of Bridges

**Elective-II**

**CASE-E2-01:** Advanced Pre-stressed Concrete
**CASE-E2-02:** Design of Masonry Structures
**CASE-E2-03:** Offshore Structures
**CASE-E2-04:** Structural Stability

**CASE-L01:** Students are expected to develop programs for Analysis & Design of Various Structural Elements by using excel spread sheets or any programming language (minimum 10 Programs)

**CASE-L02:** 3D Analysis and Design of Multistory RCC Structure by using any Software with Modeling of Shear wall

# Second Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credit | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | CA | Theory | | PR/ OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE201 | Theory of Plates and Shells | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 02 | CASE202 | Finite Element Analysis | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 03 | CASE-E3 | Elective-III (Departmental) | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 04 | CASE-E4 | Elective-IV (Departmental) | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 05 | CASE-E5 | Elective-V (Open)* | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 06 | CASE-L03 | CASE-III Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| 07 | CASE-L04 | CASE-IV Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| | | **Total for Semester II** | **15** | **02** | **04** | **19** | **200** | **100** | **300** | **100** | **700** |

**Elective-III**
**CASE-E3-01:** Design of Cold Formed Steel Structures
**CASE-E3-02:** Retrofitting of Structures
**CASE-E3-03:** Glass in Buildings: Design and Applications
**CASE-E3-04:** Earthquake Engineering & Design of Earthquake Resistant Structures

**Elective- IV**
**CASE-E4-01:** Design of Tall Structures
**CASE-E4-02:** Design of Foundation
**CASE-E4-03:** Structural Audits
**CASE-E4-04:** Optimization in Structural Design

**Elective-V (Open)**
**CASE-E5-01:** Research Methodology
**CASE-E5-02:** Soil Dynamics & Machine Foundations
**CASE-E5-03:** Advance Concrete Technology
**CASE-E5-04:** Design of Shells & Folded Plates

**CASE-L03:** Analysis of Various Structural Elements by using Finite Element Software's and Detailing of Structural Elements using various drafting tools

**CASE-L04:** 3D Analysis of Industrial sheds/Transmission or communication towers/Offshore structures/Special structural forms such as shells, etc. with Modeling of Bracing, etc. by using any software

# Third Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credit | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | T | | CA | Theory | | PR/OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE301 | Project Management and Intellectual Property Rights (Self Study) * | - | - | - | 02 | 50 | - | - | 50 | 100 |
| 02 | CASE-S01 | Seminar | - | - | - | 02 | 50 | - | - | 50 | 100 |
| 03 | CASE-PS1 | Project Stage –I # | - | - | - | 08 | 50 | - | - | 50 | 100 |
| **Total for Semester III** | | | - | - | - | **12** | **120** | **20** | **60** | **100** | **300** |

# Fourth Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credit | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | T | | CA | Theory | | PR/OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE-PS2 | Project Stage –II # | - | - | - | 20 | 100 | - | - | 100 | 200 |
| **Total for Semester IV** | | | - | - | - | 20 | 100 | - | - | 100 | 200 |

* Student may select this course either from NPTEL/SWAYAM/MOOC pool or any other reputed source approved by the BoS. The submission of course completion certificate is mandatory. If the course is not available in online mode, University may conduct exam for the same.

# The dissertation shall be related to the intended specialization, i. e. Computer Aided Structural Engineering. The dissertation shall include use of Computers for simulation using any of the languages or tools such as C, C++, FORTRAN, MATLAB, DRAIN 2D/3D, etc which is preferably in open resources for computer programming/algorithm development, etc.

# Detailed Syllabus
# First Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credits | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | CA | Theory | | PR/ OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE101 | Theory of Elasticity and Plasticity | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 02 | CASE102 | Matrix Methods of Structural Analysis | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 03 | CASE103 | Structural Dynamics | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 04 | CASE-E1 | Elective-I | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 05 | CASE-E2 | Elective-II | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 06 | CASE-L01 | CASE-I Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| 07 | CASE-L02 | CASE-II Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| | | **Total for Semester I** | **15** | **03** | **04** | **20** | **200** | **100** | **300** | **100** | **700** |

**Elective-I**

**CASE-E1-01:** Advance Structural Analysis
**CASE-E1-02:** Numerical Methods
**CASE-E1-03**: Design of Steel Concrete Composite Structures
**CASE-E1-04**: Design of Bridges

**Elective-II**

**CASE-E2-01:** Advanced Pre-stressed Concrete
**CASE-E2-02:** Design of Masonry Structures
**CASE-E2-03:** Offshore Structures
**CASE-E2-04:** Structural Stability

**CASE-L01:** Students are expected to develop small programs for Analysis & Design of Various Structural Elements by using excel spread sheets or any programming language (minimum 10 Programs)

**CASE-L02:** 3D Analysis and Design of Multistory RCC Structure by using any Software with Modeling of Shear wall

## Semester I

## CASE101 Theory of Elasticity and Plasticity

**Teaching Schemes:** 3 Lect. + 1 Tut hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

### Course Contents

**Module 1: Analysis of Stresses and Strains**

Concept of Stress at a Point, Stress Tensor, State of Stress at a Point in Cartesian Coordinate System, Derivation of Stress Equilibrium Equations in Cartesian and Polar Coordinate System, Cauchy's Formula, Normal Stress, Shear Stress and Resultant Stress on any Inclined Plane, Transformation of Stresses, Stress Invariants, State of Pure Shear, Principal Stresses, Maximum Shear Stresses, Octahedral Stresses, Decomposition of State of Stress into Pure Shear and Hydrostatic Stress, Mohr's Circles/ Spheres for Various States of Stress, The State of Strain at a Point, Strain Displacement Relations, Strain Compatibility Condition, Volumetric Strain, Problems on Navier Lame's Equilibrium Equations, Problems on Beltrami - Michell Compatibility Equations, Boundary Value Problems in Elasticity.**(08 Lectures)**

**Module 2: Stress-Strain Relationship**

Generalized Hooke's Law, Hooke's Law for Isotropic, Orthotropic, Plane Stress, Plane Strain and Axi-Symmetric Problems, Relations between Elastic Constants, Problems in 2D and 3D Cartesian Coordinate System, Airy's Stress Function, Bending of Beams, Straight Beams & Asymmetrical Bending, Euler Bernoulli Hypothesis, Shear Center or Center of Flexure, Shear Center in Thin-Walled Open Sections and Other Sections. **(08 Lectures)**

**Module 3: Stress Concentration Problems**

Stress Concentration Problems such as Stress Concentration due to Circular Hole in Stressed Plate (Kirsch's Problem), Stresses under Concentrated Load such as Concentrated Load acting on the Vertex of a Wedge (Michell's Problem) and Concentrated Load Acting on the Free Surface of a Plate (Flamant's Problem), Axi-symmetric Problems such as Stresses in Thick Cylinders Subjected to Internal and External Uniformly Distributed Pressures (Lame's Problem). **(06 Lectures)**

**Module 4: Torsion**

Assumptions and Torsion Equation for General Prismatic Solid Bars, Warping of Non-Circular Sections and St. Venant's Theory, Prandtle's Stress Function Approach, Torsion of Circular, Elliptical and Triangular Cross-Section, Torsion of Thin-Walled Structures by Membrane Analogy, Torsion of Rolled Sections and Shear Flow. **(06 Lectures)**

**Module 5: Plasticity**

Basic Equations, Similarities and Differences when Compared with Elasticity, Idealized Material Behaviour, Mechanical Models, Neck Formation, Failure Theories, Modes of Failure, Failure under Static Equilibrium, Buckling, Vibrations, Yielding, Fracture, Ductile and Brittle Failure, Yield Criteria, Rankine's Theory, Saint Venant's Theory, Tresca Criteria, Beltrami's Energy Criteria, Von Mises and Hencky & Huber's Theory, Comparison of Different Theories under Axial Tension and Torsion, VariousEmpirical Stress-Strain Relationships.**(07 Lectures)**

**Module 6: Yield Criteria & Yield Surface**

Use of Factor of Safety in Design, Numerical on Bar subjected to Axial Load, Bending and Torsion, Theories of Plastic Flow, Mohr-Coulomb Yield Criteria, Drucker Prager Yield Criteria, Principal Stress Space & Yield Surface, Pi-Plane, Post Yield Stress Strain Behaviour, Plastic Stress Strain Relations, Prandtl Reuss Equation, Lavy-Mises Relation, Strain Hardening, Introduction to Visco-Elasticity and

Visco-Plasticity, 1 D Models. **(07 Lectures)**

**Guidelines for Assignments:** Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall beperformed by the candidate.

**Guidelines for Class Test:** Class Test shall cover Syllabus of minimum Three Modules.

**References:**


- L. S. Shrinath, Advanced Solid Mechanics, Tata-McGraw Hill Publications.
- Timoshenko & Goddier, Theory of Elasticity & Plasticity, Mc-Graw Hill Publications.
- Martin Sadd, Elasticity Theory, Applications & Numerics, Academic Press.
- M A Kazami, Solid Mechanics, Tata -McGraw Hill Publications.
- Sadhu Singh, Theory of Elasticity, Khanna Publishers, New Delhi.
- Irving Shames, Mechanics of Deformable Solids, Prantice Hall.
- N K Bairagi, Advanced Solid Mechanics, Khanna Publishers, New Delhi.
- Wang, Applied Elasticity, Dover Publications.
- N Dahl and T Lardner, S Crandall, Mechanics of Solids, McGraw Hill Publications.
- Scholer, Elasticity in Engineering, McGraw Hill Publications.


**Outcomes:**

**Upon completion of the course, the student will be able to:**

- Understand concept of stress and strain at a point, Stress equilibrium and Strain compatibility and Analyse Stress and Strain at a point with various perspectives, etc. under in 3D state of stress.
- Establish relation between stress and strain for various materials, Elastic constants, and reduce 3D problems to 2 D problems.
- Formulate and Analyse stress concentration problems due to various complex situations.
- Formulate and Analyse members subjected to Torsion using various classical approaches.
- Able to understand different post yielding behaviour of materials and Plasticity theories.
- Able to understand various yield criteria, and concept of factor of safety in design of various structural members, concept of Viscoelastic and Viscoplastic materials.

## CASE102 Matrix Methods of Structural Analysis

**Teaching Schemes:** 3 Lect. + 1 Tut hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semesterExam 20; Class Assessment 20

**Course Contents**

**Module 1: Introduction**

Introduction and Review of Various Methods for Finding Slopes and Deflections at a Point in Statically Determinate and Indeterminate Structures, Assessment of Deflected Shape of Structures for Different Loading & Support Conditions. **(02 Lectures)**

**Module 2: Direct Flexibility Matrix Method**

Direct Flexibility Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames. **(06 Lectures)**

**Module 3: Generalised Flexibility Matrix Method (12 Lectures)**

Generalised Flexibility Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames.

**Module 4: Direct Stiffness Matrix Method (06 Lectures)**

Direct Stiffness Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames Generalized Stiffness Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames. **(12 Lectures)**

**Module 5: Nonlinear Analysis**

Material and Geometric Non-Linearity, Stiffness Method with Material Non-Linearity and Geometric

Non-Linearity. **(04 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the course shall be performed by the candidate containing numerical analysis of continuous beams, rigid jointed frames and pin jointed frames with all the methods mentioned in the syllabus. Additional analysis of structures with four or more degree of freedom using MATLAB/ Sci LAB/ C / Spreadsheet coding is desired.

**Guidelines for Class Test:** Class Test shall cover syllabus of any three Modules

**References:**


- Weaver W, Gere G. M., Matrix Analysis of Framed Structures, Van Nostrand Reinhold, NewYork.
- Hibbler R. C., Structural Analysis,
- Reddy C. S., Basic Structural Analysis, Tata Mc Graw Hill Publications.
- G. S. Pandit, S. P. Gupta, Structural Analysis – A Matrix Approach, Tata Mc Graw HillPublications.
- Devdas Menon, Structural Analysis, Alpha Science.
- S. Meghare, S. K. Deshmukh, Matrix Methods of Structural Analysis, Charotor PublishingHouse.
- N. Thadani, J. P. Desai, Structural Analysis – A Matrix Approach, Ueinall Publications,Mumbai.


**Outcomes:**

Upon completion of the course, the student will be able to:

- Draw deflected shapes of various structures for different loading and boundary conditions.
- Understand difference in force approach and displacement approach in structural analysis.
- Analyze various plane structural systems using direct and generalized flexibility approach.
- Analyze various plane structural systems using direct and generalized stiffness approach.
- Develop codes for computer-based analysis of plane structures.
- Understand effect of material non linearity and geometric non linearity on force displacementrelation and stiffness matrix.

## CASE103 STRUCTURAL DYNAMICS

**Teaching Schemes:** 3 Lect. + 1 Tut hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semesterExam 20; Class Assessment 20

**Course Contents**

**Module 1: SDoF Systems**

Simple Structures, SDoF System, Force -Displacement Relation, Damping Force, Equation of Motion, External Force, Mass Spring Damper System, Equation of Motion: Earthquake Excitation, Combining Static & Dynamic Responses, Methods of Solution of the Differential Equation, Free Vibration: Un-damped & Viscously Damped Free Vibration, Energy in Free Vibration, Coulomb Damped Free Vibration, Response to Harmonic & Periodic Excitations, Viscously Damped Systems, Systems with Non-Viscous Damping. **(04 Lectures)**

**Module 2: SDoF System under General Loading**

Response to Unit Impulse, Arbitrary Time Varying Force, Response to Step and Ramp Forces, Response to Pulse Excitations, Rectangular Pulse, Half Sine Wave Pulse, Triangular Pulse, Response to Ground Motion, Numerical Evaluation of Dynamic Responses, Time Stepping Methods, Interpolation Methods, Newmark's Beta Method. **(06 Lectures)**

**Module 3: Generalized SDoF and MDoF System**

Generalised SDF Systems, Rigid Body Assemblages, Systems with Distributed Mass & Elasticity, Lumped Mass System, Natural Vibration Frequency by Rayleigh's method, Shape Functions.

MDoF Systems- Simple Systems, Two Story Shear Buildings, General Approach for Linear Systems, Static Condensation, Symmetric and Asymmetric systems subjected to Ground Motion, Symmetric Systems subjected to Torsional Excitations, Multiple Support Excitations, Methods for Solving Equations of Motion. **(08 Lectures)**

**Module 4: Dynamic Analysis and Response of Linear Systems**

Systems without Damping, Natural Vibration Frequencies and Modes, Modal & Spectral Matrices, Orthogonality of Modes, Normalisation of Modes, Modal Expansion of Displacements, Free Vibration Response of Damped and Undamped and Classically Damped Systems, Damping in Structures, Classical Damping Matrix, Non-Classical Damping Matrix, Two DoF Systems, Modal Analysis, Modal Response Contributions. **(08 Lectures)**

**Module 5: Numerical Evaluation of Dynamic Response**

Time Stepping Method, Analysis of Linear and Non Linear Systems, Systems with Distributed Mass and Elasticity, Undamped motions due to Applied Forces, Undamped motion due toSupport Excitation, Natural Vibration Frequencies and Modes, Modal Analysis of Forced Dynamic Response, Rayleigh Ritz Method, Formulation using Conservation of Energy, Virtual Work, Finite Difference Method, Finite Element Method, Element Degree of Freedom and Interpolation Functions, Element Stiffness, Mass and Force Matrix, Comparison of FE Solutionwith Exact Solution. **(10 Lectures)**

**Guidelines for Assignments:** Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References:**


- R. W. Clough & Joseph Penziene, Dynamics of Structures, Mc-Grew Hill Publications.
- A. K. Chopra, Dynamics of Structures: Theory & Application to Earthquake Engineering,Prentice Hall Publications.
- Mario Paz, Structural Dynamics, CBS Publication.
- Roy Craig, Structural Dynamics, John-Wiley & Sons.
- Jagmohan L. Humar, Dynamics of Structures, Swets and Zeitlinger, Netharlands.
- Jaikrisna, A. R. Chandrashekharan, Elements of earthquake Engineering, South AsianPublishers.
- Mukhopadhyay Madhujit, Structural Dynamics: Vibration and systems, Ane Books IndiaPublisher.
- Patrick Paultre, Dynamics of Structures, Wiley India


**Outcomes:**

**Upon completion of the course, the student will be able to**:

- Understand basics of response of structures to forced vibrations and free vibrations.
- Analyse response of SDoF systems to general loading and understand various methods ofevaluation of dynamic response.
- Analyse response of structures to ground excitations, support excitations and torsionalexcitations.
- Understand and Analyse structures for natural frequency and modal analysis.
- Analyse response of structural system by numerical evaluation using various classicalapproaches.
- Understand and implement finite element approach in structural dynamics.

## Elective-I

## CASE-E1-01 ADVANCED STRUCTURAL ANALYSIS

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Influence Line Diagrams for Indeterminate Structures:**

Continuous beams, portal frames and two hinged arches. Muller- Breslau's Principle andMoment Distribution Method. **(06 Lecture)**

**Module 2: Beams**

Beams curved in plan**:** Determinate and indeterminate beams curved in plan. Beams on elastic foundations: Analysis of infinite, Semi- infinite and finite beams. **(08 Lecture)**

**Module 3: Beam columns:** Concept of geometric and material non linearity, Governing differential equation, Analysis of beam columns subjected to different loadings and support conditions, Stiffness and carry-over factors for beam-columns, fixed end actions due to various loads. **(06 Lecture)**

**Module 4: Shear center and Unsymmetrical bending.**

Position of shear center, shear flow, shear center of various sections, unsymmetrical bending, Zpolygon, combined stresses. **(06 Lecture)**

**Module 5: Cables and suppression bridges**

Shape of cable, anchor cable, temperature stresses, moving loads, two hinged and three hingedstiffened bridges. **(06 Lecture)**

**References:**


- Structural Analysis by Negi and Jangid.
- Analysis of structure by Vazirani and Ratwani, Vol. II
- Advanced Theory of Structures by Vazirani and Ratwani.
- Theory of Elastic Stability by Timoshenko and Gere.
- Matrix Analysis of Framed structures by Gere and Weaver.
- Structural Analysis – A Matrix approach by Pandit and Gupta.
- Mechanics of Structures Vol. I, II and III by Junnarkar and Shah.
- Basic structural Analysis by C. S. Reddy.


**Course outcome:**

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

- Draw ILD for indeterminate structures
- Analyze the beams curved in plan
- Analyze the structure resting on elastic foundation
- Analyze the skeleton structures using stiffness method.

## Elective-I

## CASE-E1-02 Numerical Methods

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Introduction**

Introduction and Necessity of Numerical Methods, Number representation and errors, Number in different bases, non integer & Fraction, mantissa, exponent, normalized scientific notations, errors in representing numbers, Inverse error analysis, Loss of Significance. **(04 Lectures) Module 2: Solution of Linear and Non-Linear Algebraic Equations**

Systems of Linear Algebraic Equations, Introduction, ill Conditioning, Methods of Solution (Gauss Elimination Method, LU Decomposition Method, Doolittle Decomposition Method, Gauss-Jordon Elimination Method, Gauss Seidel Method), Symmetric & Banded Coefficient Matrices, Pivoting, Diagonal Dominance, Gauss Elimination with scaled row Pivoting, Roots of Algebraic & Transcendental Equations, Fixed point iteration method, Iterative Search Method, Bisection Method, Geometrical Approach to Root Finding, Convergence towards Roots of Equation, Secant Method, False Secant/ Regula-Falsi Method, Ridder‟s Method, Newton Raphson Method, System of Non-Linear equations (Newton Raphson Method). **(06 Lectures)Module 3: Regression Analysis**

Interpolation and Curve Fitting, Discrete Data, Lagrange‟s Interpolating Polynomial, Newton‟s Polynomial Method, Limitations of Interpolation with Polynomials, Spline Interpolation, Curve Fitting, Least Square Fit, fitting with straight Line, Polynomial Fit, Weighted Linear Regression,Fitting Exponential Function. **(06 Lectures)**

**Module 4: Numerical Integration Methods**

Numerical Differentiation and Integration, Taylor's Series, Finite Difference Method, Error inFinite

Difference Approximation, Richardson Extrapolation, Derivatives by Interpolation, CubicSpline Interpolant, Numerical Integration or Quadrature, Newton Cotes Formula, Trapezoidal &Composite Trapezoidal Rule, Simpson Rule, Recursive Trapezoidal Rule, Romberg Integration, Gaussian Integration, Orthogonal Polynomial, Abscissas and Weights for Gaussian Quadrature,Gauss Legendre Quadrature, Gauss Laguerre & Gauss Hermite Method, Gauss-ChebyshevQuadrature, Gauss Quadrature with Logarithmic Singularity. **(08 Lectures)**

**Module 5: Solution of Differential Equations**

Initial Value Problem, Taylor series approach, Euler‟s Method, Runge-Kutta Method, Second Order Runge-Kutta Method, Forth order Runge-Kutta Method, Stability of Euler‟s Method, Stiffness, Adaptive Runge-Kutta Method, Bulrisch Stoer Method, Numerical Methods in Structural Dynamics, Implicit and Explicit Method, Central Difference Method, Newmark-Beta Method, Wilson-Theta Method.Boundary Value Problem, Eigenvalue Problem in Structural Dynamics, Inverse vector iteration method. **(08 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Assignments covering programming in C or MATLAB for all methods is desirable.

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References:**


- L. Ridgway Scott., Numerical Analysis, Princeton University Press
- S. D. Conte, Carl de Boor, Elementary Numerical Analysis: An Algorithmic Approach, McGraw Hill Publications
- S. R. Otto, J. P. Deneir, An introduction to Programming and Numerical methods in MATLAB,Springer
- Jaan Kiusalaas, Numerical Methods in Engineering with MATLAB, Cambridge UniversityPress.
- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, NumericalRecipes in C, Cambridge University Press.


**Outcomes:**

**Upon completion of the course the students will be able to:**

- Formulate mathematical models of various engineering problems.
- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions.
- Solve non-linear equations, simultaneous linear algebraic equations, Eigen value problems, using numerical methods.
- Perform numerical differentiation and integration and analyze the errors.
- Apply curve fitting techniques to experimental data.
- Implement knowledge of numerical methods in C-programming or MATLAB

## Elective-I

## CASE-E1-03 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

### Course Contents

**Module 1: Introduction**

Introduction to steel - Concrete composite construction - Theory of composite structures - Introduction to steel - Concrete - Steel sandwich construction. **(05Lectures)**

**Module 2: Design of Composite Members**

Behavior of composite beams - Columns - Design of composite beams - Steel – Concretecomposite columns - Design of composite trusses. **(05 Lectures)**

**Module 3: Design of Connections**

Types of connections - Design of connections in the composite structures – Shear connections -Design of connections in composite trusses. **(05 Lectures)**

**Module 4: Composite Box Girder Bridgers**

Introduction - Behavior of box girder bridges - Design concepts. **(05 Lectures)**

**Module 5: General**

Case studies on steel - Concrete composite construction in buildings - Seismic behaviour ofcomposite structures. **(05 Lectures)**

**References:**

1. Johnson R.P., Composite structures of steel and concrete, Blackwell ScientificPublications (Second Edition), UK, 1994.
2. Owens, G.W. and Knowels. P. Steel Designers manual (Fifth edition), Steel ConcreteInstitute (UK), Oxford Blackwell Scientific Publications, 1992.
3. Workshop on Steel Concrete Composite Structures, conducted at Anna University, 2000.

## Elective-I

## CASE-E1-04 Design of Bridges

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semesterExam 20; Class Assessment 20

### Course Contents

**Module 1: Introduction to Bridge Engineering**

Historical Perspective, Introduction, Layout and Planning, Investigations for Bridges, Classification and Components of Bridges, Choice of Type of Bridges and Choice of Materials. General Arrangement of Various Types of Bridges including Arch Type, Slab Type, Slab and Beam Type, Plate Girder Type, Open Web Girder, Cable Stayed Type, etc., Conceptual Bridge Design. Modern Methods of Construction of Concrete, Steel and Composite Bridges, their Impact on Analysis and Design, Study of various types of Joints to be provided during Construction. **(08 Lectures)**

**Module 2: Loading on Bridges (08 Lectures)**

Loading Standards for Roads and Railway Bridges as per IRC Standards and IRS Standards, Analysis of other Loads Like Impact Factor, Centrifugal Forces, Wind Load, Earthquake Load, Hydraulic Forces, Longitudinal Forces, Earth Pressure, Buoyancy Effects, etc. Analysis byPieguad‟s and Courbon‟s Theory.

**Module 3: Structural Behavior of Various Bridges**

Structural behavior of Box Girder Bridges, Arch Bridges, Suspension Bridges, Skew Bridges andCable Stayed Bridges under various loads. **(04 Lectures)**

**Module 4: Design of Bridge Decks**

Load Distribution in Slab and Bridge, Behavior, Analysis and Design RC and Prestressed Deck Slab, Longitudinal and Cross Girders, Design of Long Span Bridge, Slab Culvert and Box Culvert. **(10 Lectures)**

**Module 5: Design of Sub structure and Foundation**

Design of Bearings, Design of Sub Structure and Foundations, Piers and Abutments of Different Types and Shapes, Shallow and Deep Foundation, Wing Walls. **(10 Lectures)**

**Guidelines for Assignments:** Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References**

- Dr. V. K. Raina, Concrete Bridge Practice: Analysis, Design and Economics, Shroff Publishers &Distributors Pvt Ltd.,
- Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Reinforced Concrete Structures, Vol. II,Laxmi Publications**.**
- Jagadish & Jayaram, Design of Concrete Bridges, Tata McGraw Hill.
- Victor, Design of Concrete Bridges, Tata McGraw Hill.
- N. Krishnaraju, Prestressed Concrete Bridges, CBS Publishers & Distributors Pvt. Ltd.
- Ponnuswamy S., Bridge Engineering, Tata McGraw Hill.

- Dr. V. K. Raina., Concrete Bridge Practice: Construction, Maintenance & Rehabilitation, ShroffPublishers & Distrib. Pvt Ltd.
- Dr. V. K. Raina, Field Manual for Highway & Bridge Engineers, Shroff Publishers & DistributorsPvt Ltd.
- Dr. V. K. Raina, Handbook for Concrete Bridges, Shroff Publishers & Distributors Pvt Ltd.
- Victor D. J., Essentials of Bridge Engineering, Oxford & IDH
- David Lee, Bridge Bearing and Expansion Joints.
- Indian Road Congress Codes IRC-6,18,21,112
- Indian Railway Bridge Codes & Manuals.
- Indian Standard Codes (latest Versions) IS 456-2000, IS 1893-2002, IS 1343-2012

**Outcomes:**

**Upon completion of the course the students will be able to:**

- Understand the preliminary concepts, development, various types of bridges and it‟s conceptualdesign
- Study various types of loadings coming on road and railway bridges.
- Study the behaviour of various types of bridges under different loadings.
- Design of slab decks of various types of RC and PSC bridges.
- Perform the design of substructure components like piers, abutments, wing walls and it‟sfoundation.
- Study the provision and importance of joints provided in the structure.
- Know the various construction techniques and practices adopted for different bridges and itsimpact on design.

## Elective-II

## CASE-E2-01 Advanced Prestressed Concrete

**Teaching Schemes:** 3 Lect. Hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Introduction to Prestressed Concrete**

Basic Principle of Prestressing, Methods and Systems of Prestressing, Material Requirements, Losses of Prestressing, Analysis of Rectangular, Symmetrical and Unsymmetrical, Flanged Beams, Concept of Cable Profile, Pressure Line, Thrust Lines, etc. **(04 Lectures)**

**Module 2: Design of Anchor Blocks (08 Lectures)**

Design of Anchor Blocks using Magnel‟s Method, Guyon‟s Method and IS Code Method

**Module 3: Analysis and Design of PSC Members (08 Lectures)**.

Analysis of PSC section for Flexural Strength, Shear Strength and Deflection, Design of Prestressed Concrete section for Flexural Strength by Analytical procedure and Magne's Graphical method, Shear Strength and Deflection, Design of Statically Indeterminate Beams and Single-Story Portal Frame, Concordant Cable Profile.

**Module 4:**

Analysis and Design of Composite Construction of Prestressed and in-situ Concrete Structures, Design of One way and Two-way Slab, Grid Slab. Design of Various PSC Structures- Design of Cylindrical and Non-cylindrical Pipes, Design of Poles, Circular Prestressing forWater Tanks, Design of Sleepers. **(08 Lectures)**

**Module 5: Causes and Remedies of Various Defects in PSC**

Causes of various Defects in Prestressed Concrete like Cracking, Buckling, Deflection, Deterioration, Corrosion of Prestressing Steel, Concrete Crushing at End Anchorages, Grouting of Post Tensioned Tendons, Congested Connections, Dimensional Tolerances etc. and Remedial Measures. **(06 Lectures)**

**Guidelines for Assignments:**

- Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shallbe performed by the candidate.
- One assignment based on visit to any of the prestressed concrete plant or ongoing site involving prestressed concrete activities is desirable.

- Use of IS 456-2000 and IS 1343 is allowed in the theory examination.
- The necessary charts for design of anchor blocks by various methods shall be provided in thequestion paper.

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References:**


- N. Krishnaraju, Prestressed Concrete, Tata Mc Graw-Hill Publishing Company.
- T. Y. Lin & Nedbhurns, Design of Prestressed Concrete Structures, John Wiley & Sons
- S.Ramamruthm, Pretsressed Concrete, Dhanpat Rai and Sons.
- Sinha and Roy, Fundamentals of Prestressed Concrete, S. Chand Ltd.
- N. Rajagopalan, Prestressed Concrete, Narosa Publishing House.
- James R. Libby, Modern Prestressed Concrete, CBS Publishers & Distributors Pvt. Ltd.
- IS 1343: 2012, Indian Standard Code of Practice for Prestressed Concrete.
- IS 784: 2001, Indian Standard Code for Circular Prestressing in prestressed concrete pipes.


**Outcomes:**

Upon completion of the course the students will be able to:

- Understand the preliminary concept, terminologies and methodologies related to prestressedconcrete.
- Analyse and design of the anchor blocks.
- Analyse the PSC member for flexural, shear strength and deflection.
- Design the simple and indeterminate structures like continuous beams and portal frames.
- Analyse and design composite section and various slabs.
- Design various special types of PSC structures like pipes, poles, tanks, sleepers.
- Understand the causes of various defects in PSC structure and remedies for it.

## Elective-II

## CASE-E2-02 Design of Masonry Structures

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Introduction**

Masonry units, Materials and Types, History of Masonry Characteristics of Brick, Stone, Clay Block, Concrete Block, Stabilized Mud Block Masonry units – Strength, Modulus of Elasticity and Water Absorption. Masonry materials, Classification and Properties of Mortars, Selection of Mortar. **(04 Lectures)**

**Module 2: Strength of Masonry in Compression**

Behaviour of Masonry under Compression, Strength and Elastic Properties, Influence of Masonry unit and Mortar Characteristics, Effect of Masonry unit Height on Compressive Strength, Influence of Masonry Bonding Patterns on Strength, Prediction of Strength of Masonry in Indian Context, Failure Theories of Masonry under Compression. Effects of Slenderness and Eccentricity, Effect of Rate of Absorption, Effect of Curing, Effect of Ageing, Effect of Workmanship on Compressive Strength. **(06 Lectures)**

**Module 3: Flexural, Shear and Bond Strength**

Flexural Strength and Shear Strength of Masonry, Bond between Masonry unit and Mortar, Testsfor determining Flexural, Shear and Bond strengths, Factors affecting Bond Strength, Effect of Bond Strength on Compressive Strength, Orthotropic Strength Properties of Masonry in Flexure, Shear Strength of Masonry. **(08 Lectures)**

**Module 4: Design of Load Bearing Masonry Buildings**

Permissible Compressive Stress, Stress Reduction and Shape Reduction Factors, Increase in Permissible Stresses for Eccentric Vertical and Lateral Loads, Permissible Tensile and Shear Stresses, Effective Height of Walls and Columns, Opening in Walls, Effective Length, Effective Thickness, Slenderness Ratio, Eccentricity, Load Dispersion, Arching action, Lintels, Wall Carrying Axial Load, Eccentric Load with Different Eccentricity Ratios, Wall with Openings, Free standing Wall, Design of Load Bearing Masonry for Buildings up to 3 to 8 Storey‟s using BIS Codal Provisions. **(12 Lectures)**

**Module 5: Earthquake Resistant Masonry Buildings**
Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS Codal provisions. Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure.
Structural Aspects of Monuments & Ancient Structures- Evolution of Construction Practices, Materials of Construction, Choice of Structural Framing, Form Design, Geometric Proportions, Choice of Foundations, Footprint Ratio, Study of any FourHistorical Monuments from Structural point of view. **(10 Lectures)**

**Guidelines for Assignments:** Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.
**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.
**References:**

- Hendry A.W., "Structural masonry", Macmillan Education Ltd., 2nd edition
- Sinha B.P & Davis S.R., "Design of Masonry structures", E & FN Spon
- Dayaratnam P, "Brick and Reinforced Brick Structures", Oxford & IBH
- Curtin, "Design of Reinforced and Prestressed Masonry", Thomas Telford
- Sven Sahlin, "Structural Masonry", Prentice Hall
- Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, "Alternative Building Materialsand Technologies", New Age
- International, New Delhi & Bangalore
- IS 1905: 1987 Indian Standard Code of Practice for Structural Use of Unreinforced Masonry,Bureau of Indian Standards, New
- Delhi.
- SP20 (S&T): 1991, Handbook on Masonry Design and Construction, Bureau of IndianStandards, New Delhi.


**Outcomes:**
Upon completion of the course the students will be able to:
- Understand the preliminary information of various masonry structures including materials of construction, basic properties and
- parameters.
- Understand the compressive strength of masonry structures under various conditions andsituation.
- Determine strength of masonry structure in flexure, shear, bond and factors affecting.
- Design the load bearing masonry buildings.
- Design the earthquake resistant masonry structures.
- Understand the structural aspects of monuments and historical buildings.

## Elective-II
## CASE-E2-03 OFFSHORE STRUCTURES

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Wave Theories**
Wave generation process, small and finite amplitude wave theories. **(06 Lectures)**
**Module 2: Forces of Offshore Structures**
Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation. **(06 Lectures)**
**Module 3: Offshore Soil and Structure Modeling**
Different types of offshore structures, foundation modeling, structural modeling. **(06 Lectures)**
**Module 4: Analysis of Offshore Structures**
Static method of analysis, foundation analysis and dynamics of offshore structures. (06 Lectures)

**Module 5: Design of Offshore Structures**

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines. (06 Lectures)

**References:**

1. Chakrabarti, S.K. Hydrodynamics of Offshore Structures, Computational MechanicsPublications, 1987.
2. Thomas H. Dawson, Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983
3. API, Recommended Practice for Planning, Designing and Constructing Fixed OffshorePlatforms, American Petroleum Institute Publication, RP2A, Dalls, Tex.
4.Wiegel, R.L., Oceanographical Engineering, Prentice Hall Inc, Englewood Cliffs, N.J. 1964.
5. Brebia, C.A.Walker, S., Dynamic Analysis of Offshore Structures, New-nes Butterworths, U.K. 1979.
6. Reddy, D.V. and Arockiasamy, M., Offshore Structures, Vol.1, Krieger Publishing Company,Malabar, Florida, 1991.

## Elective-II

## CASE-E2-04 STRUCTURAL STABILITY

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Introduction**

Concept of stability, Static, dynamic and energy criterion of stability. Flexibility and stiffness criteria, Snap-through & post buckling behavior. **(06 Lectures)**

**Module 2: Stability of columns**

Critical load for standard boundary conditions, elastically restrained perfect Columns, effect of transverse shear in buckling, columns with geometric imperfections, eccentrically loaded columns. Orthogonality of buckling modes. Large deformation theory for columns. **(06 Lec)**

**Module 3: Stability of continuous Beams and Frames (06 Lec)**

Moment distribution and stiffness methods for stability analysis of continuous beam & frames. Differential equations for lateral bucking, lateral buckling of beams in pure bending, lateralbuckling of beams subjected to concentrated and uniformly distributed forces. **(06 Lectures)**

**Module 4: In-elastic stability of Columns**

In-elastic buckling, double modulus theory, tangent modulus theory, Shanleys theory of in-elastic buckling, eccentrically loaded in-elastic columns. **(06 Lectures)**

**Module 5: Dynamic Stability of Structure (06 Lectures)**

Discrete systems, Lagrange-Hamilton formulation for continuous systems, Stability ofcontinuous system, general method for conservative and non-conservative systems.

**References:**

1. Concrete Technology & Design by R. N. Swamy, Surrey University Press.
2. Special Structural Concrete by Rafat Siddique, Galgotia pub. Pvt. Ltd.
3. Fiber Reinforced Cement Composites by P.N.Balaguru, S.P.Shah, Mc-Graw Gill
4. Fiber Cement and Fiber Concrete by John Wiley and sons.
5. Fracture Mechanics and Structural Concrete by Bhushan L. Karihal Longman Scientificand Technical John Wiley and sons.

**Course Outcomes**: -

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

1. Determine stability of columns and frames
2. Determine stability of beams and plates
3. Use stability criteria and concepts for analyzing discrete and continuous system.

## Second Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credit | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | CA | Theory | | PR/ OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE201 | Theory of Plates and Shells | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 02 | CASE202 | Finite Element Analysis | 3 | 1 | - | 4 | 20 | 20 | 60 | - | 100 |
| 03 | CASE-E3 | Elective-III (Departmental) | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 04 | CASE-E4 | Elective-IV (Departmental) | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 05 | CASE-E5 | Elective-V (Open)* | 3 | - | - | 3 | 20 | 20 | 60 | - | 100 |
| 06 | CASE-L03 | CASE-III Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| 07 | CASE-L04 | CASE-IV Laboratory | - | - | 2 | 1 | 50 | - | - | 50 | 100 |
| | | **Total for Semester II** | **15** | **02** | **04** | **19** | **200** | **100** | **300** | **100** | **700** |

**Elective-III**

**CASE-E3-01:** Design of Cold Formed Steel Structures
**CASE-E3-02:** Retrofitting of Structures
**CASE-E3-03:** Glass in Buildings: Design and Applications
**CASE-E3-04:** Earthquake Engineering & Design of Earthquake Resistant Structures

**Elective- IV**

**CASE-E4-01:** Design of Tall Structures
**CASE-E4-02:** Design of Foundation
**CASE-E4-03:** Structural Audits
**CASE-E4-04:** Optimization in Structural Design

**Elective-V (Open)**

**CASE-E5-01:** Research Methodology
**CASE-E5-02:** Soil Dynamics & Machine Foundations
**CASE-E5-03:** Advance Concrete Technology
**CASE-E5-04:** Design of shells & Folded Plates

**CASE-L03:** Analysis of Various Structural Elements by using Finite Element Software's and Detailing of Structural Elements using various drafting tool

**CASE-L04:** 3D Analysis of Industrial sheds/Transmission or communication towers/Offshore structures/Special structural forms such as shells, etc. with Modeling of Bracing, etc. by using any software

## Semester II

## CASE201 Theory of Plates and Shells

**Teaching Schemes:** 3 Lect. + 1 Tut hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

**Course Contents**

**Module 1: Introduction to Plate Theory**

Thin and Thick Plates, Small and Large Deflection Theory of Thin Plate, Assumptions in Analysis of Thin Plates, Slope Curvature Relations, Moment - Curvature Relations, Stress Resultants, Governing Differential Equations for Bending of Plates, Various Boundary Conditions. **(08 Lectures)**

**Module 2: Navier's and Levy's Solution**

Rectangular Plates Subjected to Uniformly Distributed Load, Sinusoidal Load for Different Boundary Conditions. **(06 Lectures)**

**Module 3: Circular Plates**

Analysis of Circular Plates under Axis-Symmetric Loading, Moment Curvature Relations, Governing Differential Equation in Polar Co-Ordinates, Simply Supported and Fixed Edges, Distributed Load, Ring Load, a Plate with Hole at Center. **(08 Lectures)**

**Module 4: Introduction to Shell Structures**

Classification of Shells on basis of Geometry, Thin Shell Theory, Equation of Shell Surfaces, Stress Resultants, Stress Displacement Relations, Compatibility and Equilibrium Equations. (08 Lectures)

**Module 5: Membrane Analysis** (**12 Lectures**)

Equation of Equilibrium for Synclastic Shells, Solution for Shells Subjected to Self-Weight and Live Load, Cylindrical Shells -Equation of Equilibrium, Open Shells with Parabolic, Circular, Elliptical Directrix, Simple Problems, Shells with Closed Directrix-Circular, Elliptical-Simple Problems, Problems on Pipes Carrying Fluid/Liquid Under Pressure, Just Filled & Partly Filled. Symmetrically Loaded Circular Cylindrical Shells, Beam Theory, Finsterwalder's Theory, D.K.J. Theory- Donnell's Equation, Characteristic Equation, Schorer's Theory.

**Text Books**

- Theory of Plates and Shells by S. S. Bhavikatti, New Age International Publishers Limited.
- Design of Reinforced Concrete Shells and Folded plates by P.C. Varghese, PHI Learning Private Limited, New Delhi (2010).
- Design and Construction of Concrete Shell Roofs by G.S. Rama Swamy – CBS Publishers & Distributors, Delhi.
- ASCE Manual of Engineering practice No. 31, Design of cylindrical concrete shell roofs ASC, New York.

**References**

- Theory of Plates and Shells by S. P. Timoshenko and S. W-Krieger, Mc-Graw Hill Internationa, London (1959).
- Theory and Analysis of Plates by R. Szilard, Prentice Hall-INC, New Jersey, (1974).
- Theory and Design of Concrete Shells by B.K. Chatterjee, Chapmann& Hall, New York, 3rd Edition.
- Analysis of Thin Concrete Shells by K. Chandrasekhara, Oxford and IBH, Kolkata, 1971.
- Thin Shell Structures by Bandyopadhyay J.N. New Age International Publishers, New Delhi, 1986.
- https://onlinecourses.nptel.ac.in/noc21_ce59/preview

## CASE202 Finite Element Analysis

**Teaching Schemes:** 3 Lect. + 1 Tut hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semesterExam 20; Class Assessment 20

**Course Contents**

**Module 1: Introduction to FEM & Approximate Methods**

Introduction, Overview of Various Methods to Solve Integral & Differential Equations (Point Collocation Method, Method of Least Square, Weighted Residual Method, Galerkin‟s Method), Variational Calculus (Hamilton‟s Variational Principle, Minimum Potential Energy Principle, Euler Lagrange Equation), Partial FEM (Kentorvich Method/ Finite Strip Method/ Semi- Analytical Method), Local & Global Finite Element Methods (Rayleigh-Ritz Method), Stepwise Procedure in FEM. **(08 Lectures)**

**Module 2: One Dimensional FE Analysis**

Application of FEM to Solve various 1-D problems (Shape Functions for 1-D Elements, Properties of Shape Functions, Lagrange Interpolating Polynomials), C0 Continuity, 1-D FE Analysis (Discretization, Selection of Shape Function, Defining Gradients of Primary Unknowns & Constitutive Equations, Derivation of Element Equations, Assembly & Application of Boundary Conditions, Computation of Primary and Secondary Unknowns), Direct Approach for Assembly, Boundary Conditions (Geometric, Natural), Concept of Sub-Structuring (Static Condensation), Stiffness Matrix for Basic Bar & Beam Element, Representation of Distributed Loading, The Assembly Process within the PMPE Approach, Element Stresses), FE Analysis of 1-D Non-Prismatic Members, Solution of Differential Equation using FEM, Solution of BIVP using Galerkin‟s MWR (1-D Transient Analysis). **(10 Lectures)**

**Module 3: FE Analysis by Direct Approach** **(06 Lectures)**

C1 Continuity, Formulation of 1-D Beam Element, Classical Beam Theory, Element Equation Formulation (Galerkin‟s Approach, Rayleigh-Ritz Approach), Derivation of Scalar Functional from Differential Equation and Vice Versa, Application to Fixed and Continuous Beams.

**Module 4: Two-Dimensional FE Analysis** **(10 Lectures)**

Conditions of Symmetry & Anti Symmetry (Applications), 2-D FE Analysis, Review of Theoryof Elasticity, CST Element (3- Node Triangular Element), Pascal‟s Triangle and Pyramid, Area Co-ordinate, Stepwise Formulation, Equivalent Load Vector, Plane Stress Problems using CSTElements, 2-D Stress Analysis using 4-noded Rectangular Element, Stepwise Formulation, Effect of Aspect Ratio, Explicit & Implicit Iso-parametric Formulation, Iso-parametric Elementsfor Plane Problems (Quadrilateral Element, Bilinear Element, Para-linear Element, Bi-Quadrilateral Element, Serendipity Elements, Lagrange Element), Numerical Integration, (1-DDomain, 2-D Domain, n-point Gauss Rule), Formulation of Transition Element.

**Module 5: Three-Dimensional FE Analysis** **(06 Lectures)**

3-D Stress Analysis using FEM, Iso-parametric Formulation, 3-D Brick Element, Application to 3-D Analysis, FEA of Axisymmetric Solids Subjected to Axi-symmetric and Asymmetric Loads (Application of Partial FEM). Computer Implementation of FEM, Application of FEM to Time Dependent Problems, Partial FEM, h-version of FEM, p-version of FEM, Adaptive Meshing, Exposure to Hybrid FEM (Mixed/ Hybrid Formulation, Unidirectional Composites), Introduction to ANSYS, Static & Dynamic Analysis of 1-D, 2-D and 3-D structures using ANSYS. **(08 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the course shall be performed by the candidate.

**Guidelines for Class Test:** Class test shall cover syllabus of any three Modules.

**References:**


- M. Mukhopdhyay, Concept and Application of Finite Element Analysis, Oxford and IBHPublishing Co. Pvt. Ltd.
- O.C.Zienkiewicz & R.L.Taylor, The Finite Element Method Vol .I & II, Tata McGraw Hill
- J.N. Reddy, An introduction to the Finite Element Method , Tata McGraw Hill Pub.
- R. D. Cook, Concept and Application of Finite Element Analysis, John Wiley & sons
- Hutton D.V., Fundamentals of Finite Element Analysis, Tata McGraw Hill Pub.
- C. S. Desai & J. F. Abel, Introduction to the Finite Element Method, CBS Pub.
- C. S .Krishnamoorthy, Programming in the Finite Element Method, Tata McGraw Hill
- T.R.Chandrupatla and Belegundu, Introduction to the Finite Element in Engineering PrenticeHall of India, pvt.ltd
- Bathe K.J., Finite Element Procedures, PHI learning pvt.ltd
- Y. M. Desai, T.I Eldho, Finite Element Method with application in Engineering, Pearson , Delhi
- S. S. Bhavikatti., Finite Element Analysis, New Age International Publication.


**Outcomes:**

Upon completion of the course the students will be able to:

- Understand the different energy methods in structural analysis and basic concepts of finiteelement method.

- Analyse 1-D problems related to structural analysis like Bars, Trusses, Beams and Frames usingfinite element approach.
- Find solution to problems using direct approach methods like Rayleigh – Ritz or Galerkin‟sMethod.
- Solve 2-D problems using knowledge of theory of elasticity.
- Students will be able to implement the knowledge of numerical methods in FEM to find thesolution to the various problems in statics and dynamics.
- Analyse 1D, 2D, and 3D structures using different software packages based on FEM.
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## Elective III

## CASE-E3-01 Design of Cold Formed Steel Structures

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Introduction**

General, Types of Cold-Formed Steel Sections and Their Applications, Standardized MetalBuildings and Industrialized Housing, Methods of Forming, Research and Design Specifications,General Design Considerations of Cold-Formed Steel Construction, Economic Design andOptimum Properties, Yield Stress, Tensile Strength, and Stress–Strain Curve, Modulus ofElasticity, Tangent Modulus, and Shear Modulus, Ductility, Weldability, Fatigue Strength andToughness, Influence of Cold Work on Mechanical Properties of Steel, Utilization of Cold Workof Forming, Effect of Temperature on Mechanical Properties of Steel, Testing of Full Sectionsand Flat Elements, Residual Stresses Due to Cold Forming, Effect of Strain Rate on Mechanical Properties. **(08 Lectures)**

**Module 2: Strength of Thin Elements & Design Criteria**

Definitions of Terms, Design Basis, Serviceability, Structural Behaviour of Compression Elements and Design Criteria, Perforated Elements and Members, Plate Buckling of Structural Shapes, Design Examples. **(07 Lectures)**

**Module 3: Design of Axially Loaded Members**

Design of axially loaded tension members, Flexural Column Buckling, Torsional Buckling and Flexural–Torsional Buckling, Effect of Local Buckling on Column Strength, Distortional Buckling Strength of Compression Members, Effect of Cold Work on Column Buckling, North American Design Formulas for Concentrically Loaded Compression Members, Effective Length Factor *K*, Built-Up Compression Members, Bracing of Axially Loaded Compression Members, Design Examples. **(10 Lectures)**

**Module 4: Design of Flexural Members**

Bending Strength and Deflection, Design of Beam Webs, Bracing Requirements of Beams,Torsional analysis of Beams and Combined Bending and Torsional Loading, Design Examples. (06 Lectures)

**Module 5: Design of Members under Combined Axial Load & Bending**

Combined Tensile axial load and Bending, Combined Compressive axial load and Bending (Beam–Columns), North American Design Criteria, Design Examples, Second-Order Analysis. Types of Connectors, Welded Connections, Bolted Connections, Screw Connections, OtherFasteners, Rupture Failure of Connections, I or Box-Shaped Compression Members Made by Connecting Two C-Sections, I-Beams Made by Connecting Two C-Sections, Spacing of Connections in Compression Elements. **(10 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References:**


- W.W. Yu, "Cold-Formed Steel Design", John Wiley & Sons.

- IS 801: 1975, Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members inGeneral Building Construction.
- BS 5950-5:1998, Structural Use of Steelwork in Building: Code of Practice for Design of ColdFormed Thin Gauge Sections.

**Outcomes:**

Upon completion of the course the students will be able to:

- Understand the types of cross sections, mechanical and thermal properties and applications ofcold formed steel structures.
- Understand the design criteria and strength of thin elements and analyse various cross section forstrength in tension, compression, flexure, etc.
- Design the CFS flexural members.
- Design the CFS compression members.
- Design the CFS members subjected to axial load and bending.
- Study and design various types of connections in cold formed steel structures.

## Elective III

## CASE-E3-02 RETROFITTING OF STRUCTURES

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course ContentsModule 1: Serviceability and Durability**

Quality Assurance for Concrete Construction, Permeability, Thermal Properties and Cracking, Distress Monitoring, Causes for Distress, Effects of Climate, Temperature, Chemicals, Wear and Erosion, Design and Construction Errors, Corrosion Mechanism, Effects of Cover Thickness andCracking, Non-Destructive Testing: Ultrasonic and Sonic Test, Rebound Hammer Test, Strength Evaluation of Existing Structures. **(06 Lectures)**

**Module 2: Cracks in Structures**

Causes, Thermal and Shrinkage cracks, Cracks due to Vegetation and Trees, Foundation Movements, Types and their Fatality, Diagnosis Techniques for Repair. Moisture Penetration - Sources of Dampness, Moisture Movement from Ground, Reasons for Ineffective Damping, Leakage in Concrete Slabs, Pitched Roofs, Dampness in Solid Walls, Condensation, Remedial treatments, Chemical Coatings. **(06 Lectures)**

**Module 3: Steel Structures and Masonry**

Types and Causes of Deterioration, Preventive Measures, Repair Procedure, Brittle Failure, Defects in Connections, Welded Joints: Test for Defects; Mechanism of Corrosion , Methods of Corrosion Protection, Corrosion Inhibitors, Corrosion Resistant Steels, Coatings, Cathodic Protection. Design and Fabrication Errors, Distress during Erection.

Masonry Structures Discoloration and Weakening of Stones, Preservation, Chemical Preservatives, Brick Masonry Structures, Distress and Remedial Measures. **(06 Lectures)**

**Module 4: Materials for Repairs**

Essential Parameters for Repair Material, Premixed Cement Concrete and Mortar, Sulphur Infiltrated Concrete, Fiber Reinforced Concrete, Special Elements for Accelerated Strength Gain,Expansive Cement, Polyester Resin. Polymer Concrete**:** Physical and Mechanical Properties, General Guidelines and Precautions for Use, Field Application Polymer Modified Concrete**:** Physical and Mechanical Properties, General Guidelines and Precautions for Use, Field Application, Epoxy Concrete and Mortar: Epoxies, Physical and Mechanical Properties, General Guidelines and Precautions for Use, Field Application. Surface Coatings**:** Essential Parameters, Types, Characteristics. **(06 Lectures)**

**Module 5: Maintenance and repair strategies**

Definitions: Maintenance, Repair and Rehabilitation, Facets of Maintenance, Importance of Maintenance, Preventive Measures on Various Aspects Inspection, Assessment Procedure for Evaluating a Damaged Structure, Causes of Deterioration, Testing Techniques. Repairs using Mortars and Dry Packs**,** Concrete Replacement, Surface Impregnation, Rust Eliminators and Polymers Coating for Rebar During Repair Foamed Concrete, Vacuum Concrete, Gunite and Shotcrete, Injection: Epoxy, Resin, Polymer Modified Cement Slurry;

Shoring and Underpinning. Strengthening of Super Structures (Beam, Column, Slab including Joints) for Tension, Compression, Flexural, and Shear respectively, Jacketing (RCC, Plate, Fiber, Wrap), Bonded Overlays, Reinforcement Addition, Strengthening the Substructures, Increasing the Load Capacity of Footing, Strengthening of Masonry Structure. **(10 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.
**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References:**


- Johnson. S.M., "Deterioration, maintenance and repair of structures", McGraw-Hill bookcompany, New York, 1965.
- R. T. Allen and S. C. Edwards, "Repair of concrete structures", Blakie and Sons, UK, 1987.
- Denison Campbell, Allen and Harold Roper, "Concrete structures", Materials, Maintenance andRepair, Longman Scientific and technical UK, 1991.
- SP25-84, "Hand book on causes and prevention of cracks on buildings", Indian standards.
- M. S. Shetty, "Concrete Technology- Theory and Practice", S. Chand and Company, New Delhi,1992.
- Gambhir, "Concrete Technology".
- Santhakumar, A.R., " Training Course notes on Damage Assessment and repair in Low CostHousing "," RHDC–NBO " Anna University, July, 1992.
- Raikar, R.N., "Learning from failures – Deficiencies in Design ", Construction and Service – R& D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.


**Outcomes:**

Upon completion of the course the students will be able to:

- Understand factors of Serviceability and Durability of Structures.
- Determine crack width, effect of crack on materials, effect of moisture on structures.
- Understand methods for protection of steel structures and masonry structures.
- Understand various materials and methodologies used for repairing of structures.
- Understand and implement techniques used for repairing and maintenance of structure.
- Understand procedure to strengthen the existing structures and structural elements.

## ELECTIVE – III
## CASE-E3-03 GLASS IN BUILDING: DESIGN AND APPLICATION

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Introduction**

Introduction – Glass the Building Material, Float Glass Manufacturing Process, coatings on glass, glass design for coating, sustainability and aesthetics **(06 Lectures)**

**Module 2: Design Tools for Glass Selection**

Structural Control and Design for Energy efficiency, Design Tools for Glass Selection, BuildingEnvelope Design, Innovations in Glass Future Facades, Standards Related to Glass (06 Lectures)

**Module 3: Useful Daylighting in Building**

Fundamentals of Daylighting, Daylighting Strategies Techniques, ECBC and Green Building Requirements, Introduction to Daylight Simulation, Daylighting Controls, Achieving Acoustics Through Glass **(08 Lectures)**

**Module 4: Glass Processing**

Glass Processing Overview, Interior Glazing Program, Interior Glazing Applications Shower Enclosure, Glass in Passive Fire Protection, Glazing Choices for Project Segment, National Building Code 2016 **(06 Lectures)**

**Module 5**

Glass in Passive Fire Protection, Glazing Choices for Project Segment Silicone for Structural Glazing, Role of

Windows in Building Design, Fire Resistant Glazing, Interior Glazing Applications, Design and application of sealant. Facade Fundamentals, Glass Application on Facades, Energy Efficiency Facade System, Structural Design of Facades, Facade Factory Operations, Performance Testing for Facades, Sustainable Building and Facades **(10 Lectures)**

**References:**


- Structural Glass: Hugh Dutton, Peter Rice: 9780419199403
- Structural Glass Facades and Enclosures, Mic Patterson; ISBN: 978-0-470-93185-1
- Joseph S. Amstock‟s Glass in Construction (McGraw-Hill, 1997)
- Envelope Design for Buildings ISBN 0750628545 by William Allen
- Thomas Herzog, "Facade Construction Manual." Birkhauser, 2004
- Glass in Architecture ISBN 0714829226 by Michael Wigginton
- FOSG Architectural Guide
- Glass Academy Foundation Manual Volume – I
- Glass Academy Foundation Manual Volume – II
- Glass Academy Foundation Manual Volume - III


**Course outcome:**

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

- Understand Glass as a building material, its various applications and benefits.
- Design and analyze the suitable façade based on drawings.

## Elective III

### CASE-E3-04 Earthquake Engineering& Design of Earthquake Resistant Structures

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semesterExam 20; Class Assessment 20

**Course ContentsModule 1: Introduction to Seismology**

Elements of Seismology, Terminology, structure of Earth, causes of an earthquake, seismicwaves, magnitude and intensity, seismograph, strong motion earthquake, strong motionearthquake, accelerogram, Elastic Rebound Theory, Theory of Plate Tectonics and Movement ofIndian Plate, Seismic Zoning Maps of India and Comparative Study, Response Spectra, Strong Motion Characteristics. **(06 Lectures)**

**Module 2: Earthquake Response of Systems**

Structural dynamics: Free and forced vibrations of single degree of freedom systems, un-dampedand viscously damped vibrations, equations of motion, Duhamel integral. Response Spectrum Theory: construction of Design Response Spectrum, effect of foundation and structural damping on design spectrum, design spectrum of IS 1893, evaluation of lateral loads. **(06 Lectures)**

**Module 3: Earthquake Risk Analysis**

Earthquake Effects on the Structures, Classification of Loads, Seismic Methods of Analysis, Seismic Design Methods, Seismic Damages during Past Earthquakes and Effect of Irregularities and Building Architecture on the Performance of RC Structures, Mathematical Modeling of Multi-Storied RC Buildings with Modeling of Floor Diaphragms and Soil-Foundation, Winkler model. **(06 Lectures)**

**Module 4:**

Analysis of Seismic Forces on Building as per latest IS: 1893 by Equivalent Static Lateral Load Method and Response Spectrum Method, Introduction to Time History Method and Performance Based Analysis. **(06 Lectures)**

**Module 5:**

Introduction to Ductility, Factors Affecting Ductility, Ductility Requirements, Types of Ductility, Provisions as per latest IS 13920, Seismic Design and Ductile Detailing of Beam, Column, Beam Column Joint, Shear Wall, Elevated RC Circular Water Tanks. Seismic Retrofitting, Sources of Weakness in RC Framed Buildings, Classification of Retrofitting Techniques, Conventional and Non-Conventional Methods, Comparative Study of

Various Methods and Case Studies, Introduction to Base Isolation Systems, IS Code Provisions for Retrofitting of Masonry Structures, Failure Modes of Masonry Structures and Repairing Techniques. **(06 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.
**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References**


- P. Agarwal and M. Shrikhande – Earthquake Resistant Design of Structures, Prentice-HallPublications.
- IS:1893 – Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau ofIndian Standards, New Delhi.
- IS:13935 – Repair and Seismic Strengthening of Buildings – Guidelines, 1993
- IS:4326 – Earthquake Resistant Design and Construction of Buildings – Code of Practice, 1993
- IS:13828 – Improving Earthquake Resistance of Low Strength Masonry Buildings, 1993
- IS:13827 - Improving Earthquake Resistance of Earthen Buildings, 1993
- IS:13920 – Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force,1993
- IS: 3370- Indian Standard code of practice for concrete structures for storage of liquids, Bureauof Indian Standards, New Delhi.
- Clough and Penzin – Dynamics of Structures, Mc-Graw Hills Publications.
- Jai Krishna, A.R. Chandrashekharan and B Chandra – Elements of EarthquakeEngineering,South Asian Publishers Pvt. Ltd.
- Joshi P S et al. - Design of Reinforced Concrete Structures for Earthquake
- Resistance Published by Indian Society of Structural Engineers, 2001.


**Outcomes:**

- Upon completion of the course the students will be able to:
- Understand Engineering Seismology and Seismic zones in India.
- 2. Understand earthquake response of SDoF Linear systems and instrumentation in measurementof earthquakes.
- Understand factors resisting earthquake forces, and earthquake risk analysis.
- Perform Seismic Analysis of buildings as per IS 1893.
- Understand, analyse and Design structural elements and its ductile detailing using IS 13920.

Understand Various Retrofitting methods for RC framed structure and masonry structures

## Elective IV
## CASE-E4-01 DESIGN OF TALL STRUCTURES

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

### Course Contents

**Module 1: Design Loads**
Gravity Loads, Dead Load and Live Load Reduction, Construction Loads, Wind Load, Equivalent Lateral Force, Combination of Loadings, Design Philosophy: Working Stress Design and Limit State Design **(06 Lectures)**

**Module 2: Structural Systems and its Behaviour**
Height and Structural Forms, Rigid Frames, Braced Frames, In-Filled Frames, Shear Walls, Coupled Shear Walls, Tubular Structures, and Hybrid Mega Systems. **(06 Lectures)**

**Module 3: Tall Buildings**
Approximate Analysis, Detail Analysis and Reduction Techniques, Analysis of Member Forces, Drift, and Twist, Buckling Analysis, P-Delta Analysis, Translational and Torsional Instability, Design for Differential Movements, Creep and Shrinkage, Structural Control and Energy Dissipation Devices. **(06 Lectures)**

**Module 4: Chimneys**

Design Factors, Thermal Stresses, Components, Platform and Safety Ladders, Steel Stacks, Refractory Linings, Caps and Foundations. **(06 Lectures)**

**Module 5:**

Cooling Towers - Types, Components, Analysis and Design. Transmission Towers - Types of Loads, Tower Configuration, Analysis and Design. **(06 Lectures)**

**Guidelines for Assignments:** Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References**


- B. S. Taranath, Structural Analysis and Design of Tall Building, CRC press, 2011.
- B. S. Smith and A. Coull, Tall Building Structures: Analysis and Design, Wiley, 1991.
- S. N. Manohar, Tall Chimneys: Design and Construction, Tata Mcgraw-Hill, 1985.
- R. Shanthakumar and S. S. Murthy, Transmission Line Structures, Tata Mcgraw-Hill, 1990.
- IS: 6533 (Part 2): 1989, - Code of Practice for Design and Construction of Steel Chimneys
- IS 4998 (Part 1): 1992, -Criteria for Design of Reinforced Concrete Chimneys.


**Outcomes:**

Upon completion of the course the students will be able to:

- Identify and calculate magnitude of various loads acting on tall buildings.
- Understand various forms of structures, moment and force resisting systems in a structure.
- Identify various factors causing movements /twists in the building and their analysis and design.
- Understand various types of chimneys, their components, Analyse and design of chimneys.
- Understand various types of Cooling Towers, their components & feasibility, analyse and designa Cooling Tower.
- Understand various types of transmission towers, their components and suitability, analyse anddesign a transmission tower.

## Elective IV

## CASE-E4-02 DESIGN OF FOUNDATION

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course Contents**

**Module 1: Bearing capacity**

Empirical equations for bearing capacity (Terzaghi, IS code, Skempton‟s Meyerhof, Hansen, Vesic). Bearing capacity of footing with inclined load, eccentric load. Effect of water table on bearing capacity. Bearing capacity of rocks. Settlement - Immediate and consolidation settlements in cohesive soil, settlement prediction in non-cohesive soil. Allowable settlement. **(08 Lectures)**

**Module 2: Shallow Foundation**

Proportioning of footing (isolated, wall footing, combined rectangular and combined trapezoidal, strap footing) Mat foundation, types of mats, design consideration and various methods of analysis of mat. Floating raft concept and design. **(06 Lectures)**

**Module 3: Deep foundation:**

Mechanics of load transfer in piles, determination of capacity of single pile, rock socketing, negative skin friction, design of axially loaded pile, design of pile groups, design of pile group subjected to eccentric load (Axial load and moment) Design of pile cap. Settlement of pile group. (08 Lectures)

**Module 4:**

Sheet piles and braced excavations: Types and uses of sheet piles, design of cantilever sheet pile walls, design of anchored bulkhead, Anchorage method, Design of Braced sheeting in cuts.

Introduction to expansive soil, Types of damage and cracks in buildings on expansive soil. Principles of design of foundations in expansive soil. **(06 Lectures)**

**Module 5:**

Introduction to Machine Foundation: Soil behavior under dynamic loads, Permissible amplitude, criteria for satisfactory machine foundations, introduction to analysis and design of simple machine foundations using I. S. Code method. **(06 Lectures)**

**Course outcome:**

At the end of the course, the student will be able to

- Compute bearing capacity and settlement of foundation
- Design shallow and deep foundation
- Suggest remedial measure for foundation on expansive soil.
- Analyse and design sheet piles
- Design simple machine foundation by using IS code method

**Reference book**

- Foundation Engineering by P.C. Varghese (Prentice hall of India)
- Analysis and Design of Substructures by Swami Saran (Oxford and IBH Publishing)
- Foundation Analysis and Design Bowles J.E. (McGraw Hill Book Company)
- Design Aids in Soil Mechanics and Foundation Engineering Shenbage R Kaniraj, TATA Mc-Grawhill
- Design of Foundation Systems- Nainan P Kurian, Narosa publication house
- Design of Reinforced Concrete Foundations by Varghese P.C (Prentice hall of India)
- Design of Reinforced Concrete Structures by N Subramanian
- Limit state theory and Design of Reinforced concrete – Dr. V. L. Shah and Dr. S R Karve (Structures Publications)

## Elective-IV
## CASE-E4-03 STRUCTURAL AUDITS

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course content**

**Module 1: Introduction to Structural Audit**

Introduction to Structural Audit, Objectives, Bye-laws, Importance, Various Stages involved, Visual inspection: scope, coverage, limitations, Factors to be keenly observed.

Detailed Study of: RC frame and Masonry building: Structural and non structural system, Structural elements concrete and its texture, sag and deflection in members, cracks: types and its fatality, Architectural features like balconies, cornices, etc their vulnerabilities, Probable damages in Structural and non structural walls, Plaster and paint Leakages and seepages, Plinth importance and how it affects suitability of building, Electric wiring: various damages and their fatality.

Steel Structures: Corrosion, Connection defects, Connection strength, yielded member. **(06 Lectures)**

**Module 2: Causes and types of deterioration in Structures**

Causes of deterioration in RC frame and Masonry building: Permeability of concrete, capillary porosity, air voids, Micro cracks and macro cracks, corrosion of reinforcing bars, sulphate attack, alkali silica reaction,.

Causes of deterioration in Steel Structures: Uniform deterioration, pitting, crevice, galvanic, laminar, Erosion, cavitations, fretting, Exfoliation, Stress, Causes of corrosion in various members, causes of defects in connection (bolted and welded), Cracks. **(06 Lectures)**

**Module 3: Non Destructive Testing**

Concrete Strength Assessment: Rebound hammer, Ultrasonic Pulse velocity, Penetration resistance, Pull out test, Chemical test: Carbonation test, Chloride test, Corrosion potential assessment: Cover meter survey, half cell potential, resistivity measurement, Fire damage assessment: Differential thermal analysis, X ray diffraction, Structural Integrity and soundness assessment: Radiography, Impact echo test, dynamic testing of structure, Interpretation and evaluation of test results. **(06 Lectures)**

**Module 4: Strength Evaluation of Existing Structure**

Reserve strength, identification of critical sections, structural system and its validation, evaluation of damage in concrete and reinforcement, evaluation of building configuration. **(06 Lectures)**

**Module 5: Approach to conduct Structural Audits**

Guidelines of Statutory Bodies, Legal aspects, Responsibility of calling Structural Audit, Scope of Investigation, Involvement of Original Consultants & Representatives of Statutory Bodies, Frequency of Structural Audits. **(06 Lectures)**

**Module 6: Structural Audit Report**

Draft Structural audit report for up-gradation of existing building, Audit for continuation of usage of old Buildings, Audit for Buildings damaged due to Flood, Earthquakes, Fire, Storms/cyclones, Landslides, Cloud Burst, Tsunamis and accidental events such as blasts/ wilful damages. **(06 Lectures)**

**References**

· Indian Standard codes related with non destructive testing, Government Resolutions related to Structural Audits (BMC Act, etc.), Field manuals and reports by Expert Consultants.

**Outcomes:**

Upon completion of the course the students will be able to:

- Gain the knowledge of Bye laws, procedure of Structural audit and study the typical problems in structures.
- Aware of causes and types of deterioration in structures.
- Develop skills for use of various Non destructive tests required during auditing of structures.
- Strength evaluation of existing structures.
- Acquire knowledge of legal procedure to conduct structural audits.
- Prepare a Structural audit report.

## ELECTIVE-IV
## CASE-E4-04 OPTIMIZATION IN STRUCTURAL DESIGN

**Teaching Schemes:** 3 Lect. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20;Class Assessment 20

**Course content**

**Module 1:** Objective optimization, problem formulation, problem types, constrained and unconstrained problems, implications of risk & uncertainly mathematical programming, general problems of linear and nonlinear programming. **(06 Lectures)**

**Module 2:** Linear Programming-Standard linear programming form, definitions and theorem, simplex method-Algorithm canonical form, improving the basis, identifying an optimal solution, locating initial basic feasible solution, examples. **(06 Lectures)**

**Module 3:** Application of Linear Programming-Problems on structural design trusses, plastic analysis of frame, weight minimization, transportation problem, duality, decomposition, parametric linear programming, integer linear programming examples. **(06 Lectures)**

**Module 4:** Non-linear optimization-classical optimization techniques differential calculus- Language multipliers, Newtons Raphson approximation, Kuhn Tucker conditions, examples**. (06 Lectures)**

**Module 5:** Geometric programming- Calculus viewpoint, polynomials, orthogonality conditions, degree of difficulty, geometric inequality, primal-dual relations, inequality constraints, examples. Search techniques-altering, one dimensional or sectioning search, transforming nonlinear problem into linear cutting –plane method, logarithmic transformation, graphical optimization, examples. Examples on minimum route problem, minimum cost, minimum weight, optimum design of R.C.C. sections, Structural design-frame, trusses. **(06 Lectures)**

**References:**

- Foundation of Optimization by Wilde & Beighter
- Optimization Theory & Applications by S.S. Rao
- Optimization in Structures by Hemp.
- Mechanical foundation for design by Stark and Nicholls, Mc Graw Hill

**Course Outcomes**: -

At the end of the course, student will be able to,

- Use variational principle for optimization
- Apply optimization techniques to structural steel and concrete members
- Apply Linear and nonlinear optimization technique

## Elective V (OPEN)

## CASE-E5-01 RESEARCH METHODOLOGY

**Teaching Schemes:** 3 Pract. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam20; Class Assessment 20

### Course Contents

**Module 1:**

Introduction, meaning of research, objectives, types and role of scientific and engineering related research in advancing the knowledge, defining a research problem, formulation of a hypothesis, research design and features of good design, methods of data collection, approaches and techniques for data acquisition, processing, analyses and synthesis, Designing a questionnaire, Interpretation of results, Report Writing, Aspects of literature review, Different ways of communication and dissemination of research results. (06 Lectures)

**Module 02:**

Descriptive Statistics, Probability and Distribution: Basic statistical concepts, Measures of central tendency and dispersion, Elements of Probability, Addition and multiplication theorems of probability, Examples, probability distributions, Binomial, Poisson and normal distributions.Sampling Techniques: Random sampling, simple random sampling and stratified random sampling, Non-sampling errors. (06 Lectures)

**Module 03:**

Correlation and Regression: Product moment correlation coefficient and its properties. Simple linear regression and multiple linear regressions, Statistical Inference: Statistical hypotheses, Error Types, level of significance, Chi-square Test and F distributions. Central limit theorem, Tests for the mean, equality of two means, variance, large sample tests for proportions, Confidence interval. (06 Lectures)

**Module 04:**

Design of Experiments: Analysis of variance. Data Classification, completely randomized, randomized block, Factorial experiments, Yates technique. (06 Lectures)

**Module 05:**

Multivariate Data Analysis: Multivariate normal distributions. Mean vector, variance, covariance matrix and correlation matrix, Step wise regression, Selection of best subject of variables,Classification and discrimination problems, Factor analysis, Principal component analysis. Data analysis using software's. (06 Lectures)

**Term Work**

Student shall critically read recent three to four journal articles within the broader field of their prospective specializations to identify research and knowledge gaps and accordingly formulate specific research questions. On the basis of these research questions student will retrieve additional relevant information and prepare well-articulated and content rich introductory problem description as well as proposed research methodology notes. This shall be assessed jointly by the subject teacher and research guide of the student.

**References**

- Gupta S. C. and Kapoor V. K, “Fundamentals of Mathematical Statistics”, Sultan Chand &Company New Delhi.
- Gupta S. C. and Kapoor V. K, “Fundamentals of Applied Statistics”, Sultan Chand & Com.N. Delhi.
- Montogomery D. C., “Probability and Applied Statistics for Engineers”, Wiley Int. StudentEdition
- Walpole Ronald E, Myers Raymond H and Myers Sharon L, “Probability & Statistics forEngineers and Scientists”, 6th Edition, Prentice Hall.
- Ross S. M., “Introduction to Probability and Statistics for Engineers and Scientists”, 3 rd Edi,Elsevier
- Miller and Freund: Probability and Statistics for Engineers”, EEE
- Johnson R. and Wichern, “Applied Multivariate Statistical Analysis”, 3 rd Edi, Prentice Hall India
- Douben K. J., “Research Methodologies – Principles and Guidelines of Applied Scientific Research”, UNESCO-IHE Lecture Notes LN0317/06/01, Delft, the Netherlands.
- Holtom D. and E. Fisher, “Enjoy Writing Your Science Thesis - a Step by Step Guide to Planning and Writing Dissertations and Theses for Undergraduate and Graduate Science Students”, Imperial College Press. ISBN 1-86094-207-5, London, UK.
- Kumar R., “Research Methodology- a Step-by-step Guide for Beginners”, Sage Publi.. ISBN 0-7619-6213-1. London, UK.

**Outcomes:**

Upon completion of the course the students will be able to:

- Understand concept of research, its types, methods, detailed procedure to identify and solve aresearch problem.
- Understand various mathematical techniques useful in research work.
- Understand various sampling techniques useful in research work.
- Understand various techniques for correlating and predicting different parameters with eachother based on data collected.
- Design the experiments for research work.
- Analyse and interpret the data, results and to conclude the final results.

## Elective V (OPEN)

## CASE-E5-02: SOIL DYNAMICS & MACHINE FOUNDATION

**Teaching Schemes:** 3 Pract. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam20; Class Assessment 20

**Course Contents**

**Module 1: Theory of Vibrations**

Basic Definitions- Free and Forced Vibrations with and without Damping for Single Degree Freedom Systems-Resonance and its Effect, Magnification, Logarithmic Decrement, Transmissibility, Natural Frequency of Foundation – Soil system, Barkan‟s and IS methods, pressure bulb concept, Pauw‟s Analogy. (06 Lectures)

**Module 2: Wave Propagation**

Elastic Waves in Rods, Waves in Elastic Half Space, Dynamic Soil Properties, Field andLaboratory Methods of Determination – Up hole, Down Hole and Cross Hole Methods, Cyclic Plate Load Test, Block Vibration Test, Determination of Damping Factor. (**06 Lectures**)

**Module 3:**

Machine Foundations: Types, Design criteria, permissible amplitudes and bearing pressure. Block foundation: Degrees of freedom - analysis under different modes of vibration. **(06 Lectures)**

**Module 4: Two DoF Systems**

Analysis of Two Degree freedom systems under free and forced vibrations -Principles of Design of Foundations for reciprocating and impact machines as per IS code. (06 Lectures)

**Module 5: Vibration Isolation**

Vibration Isolation: Types and methods, Isolating materials and their properties. (06 Lectures) Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate

**Guidelines for Class Test:** Class Test shall cover Syllabus of any Three Modules.

**References:**


- P. Srinivasulu, G. V. Vaidyanathan, Handbook of Machine Foundations, Tata McGraw Hill.
- Barken, Dynamics of Bases and Foundations, McGraw Hill Publishing Co., New York.
- Richart, Hall and Woods, Vibration of Soils and Foundations, Prentice Hall, Eaglewood Cliffs,New Jersy, USA.


**Outcomes:**

Upon completion of the course the students will be able to:

- Understand the fundamentals of wave propagation in soil media.
- Apply theory of vibrations to solve dynamic soil problems & to calculate the dynamicproperties of soils using laboratory and field tests.
- Analyze the behaviour of a machine foundation resting on the surface and embeddedfoundation.
- Analyze the block foundation under different modes of vibrations.
- Understand the principles of design of foundations for reciprocating and impact machines asper IS code.
- Acquainted with types, methods & materials for vibration isolation systems.

## ELECTIVE V (OPEN)
## CASE-E5-03: ADVANCE CONCRETE TECHNOLOGY

**Teaching Schemes:** 3 Pract. hrs./week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam20; Class Assessment 20

**Course content**

**Module 1:**

**Aggregates**: Review of types; sampling and testing; effects on properties ofconcrete, production of artificial aggregates.**Cements**: Review of types of cements, chemical composition; properties and tests, chemical and physical process of hydration, Blended cements (06 Lectures)

**Module 2: Properties of fresh concrete** - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing, segregation and bleeding Chemical Admixtures: types and classification; actions and interactions; usage; effects onproperties of concrete. Mineral Admixtures**:** Fly ash, ground granulated blast furnace slag, metakaolin, rice- husk ash and silica fume; chemical composition; physical characteristics; effects on properties of concrete; advantages and disadvantages. Proportioning of concrete mixtures: Factors considered in the design of mix BIS Method, ACI method. **(06 Lectures)**

**Module 3: Properties of hardened concrete**: Strength- compressive tensile and flexure -Elastic properties - Modulus of elasticity - Creep-factors affecting creep, effect of creep - shrinkage- factors affecting shrinkage, plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage (06 Lectures)

**Module 4: Durability of concrete**: Durability concept; factors affecting, reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; concrete in sea water, statistical quality control, acceptance criteria as per BIS code. Non-destructive testing of concrete: Surface Hardness, Ultrasonic, Penetration resistance, Pull- out test, chemical testing for chloride and carbonation- core cutting - measuring reinforcement cover. (06 Lectures)

**Module 5: Special concretes** - Lightweight concrete- description of various types -High strength concrete - Self compacting concrete -Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete

Special processes and technology for particular types of structure - Sprayed concrete; underwaterconcrete, mass concrete; slip form construction, Prefabrication technology (06 Lectures)

**Text books:**


- Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2012

- Job Thomas., “Concrete Technology”, Cenage learning,
- R. Santhakumar „ Concrete Technology‟, Oxford Universities Press, 2006
- Shetty M. S., Concrete Technology‟, S. Chand & Co., 2006

**References:**

- Mehta and Monteiro, „Concrete-Micro structure, Properties and Materials‟, McGraw HillProfessional
- Neville A. M. and Brooks J. J., Concrete Technology, Pearson Education, 2010
- Lea, Chemistry of Cement and Concrete‟, Butterworth-Heinemann Ltd, 5e, 2017
- Bungey, Millard, Grantham – Testing of Concrete in Structures- Taylor and Francis, 2006

**Outcomes:**

The students will be able to:

- Understand the testing of concrete materials as per IS code
- Know the procedure to determine the properties of fresh and hardened of concrete
- Design the concrete mix using ACI and IS code methods
- Select and Design special concretes depending on their specific applications
- Gain ideas on non-destructive testing of concrete.

## ELECTIVE-V (OPEN)
## CASE-E5-04: DESIGN OF SHELLS & FOLDED PLATES

**Teaching Scheme**: 3 Pract. hrs./week; Evaluation Scheme: Theory: 60; Mid-semester Exam 20; Class Assessment 20

### Course content

**Module 1: Design of Shell Roofs, Spherical Domes and Conical Roofs (08-Lectures)**

Introduction, Selection of dimensions of shells, Structural design of shell roofs by Working Stress Method, Detailing of Steel as per IS code, Spherical domes, Design of Ring Beam (Edge Member), Design for Shear between Bottom ring Beam and Dome, Detailing of Steel, Conical Shell, Conical dome roof with ring beams, umbrella roof.

**Module 2: Detailing of Steel in Cylindrical Shells (06-Lectures)**

Introduction, General arrangement of steel, Minimum amount of steel recommended in shells, Longitudinal steel for $T_x$ forces and for edge beams, Transverse steel for $T_\Phi$ and $M_\Phi$ Forces, Steel for shear S, Detailing of junction between shell and transverse and edge beam, Consumption of steel.

**Module 3: Design of Transverse Stiffeners of Cylindrical Shells (06-Lectures)**

Introduction, Design of Transverse Stiffeners (Diaphragms) of Long Shells, Supports on Long Shells on T or L Beams Design of Supporting Frames, Detailing Junction of Shell and Transverse.

**Module 4: Design of Paraboloid Shells (08-Lectures)**

Introduction, Types of Hyperbolic Paraboloids, Equation of Hypar Shells with Straight Rectangular Edges, Types Of H.P. Shell Roofs with Straight Edges, Shallow and Deep H.P. Shells, Analysis of The Shell Part of Shallow Hypar Shells with Straight Edges, Analysis of The Edge Members, Supporting Dead Weight of Edge Members, Detailing of Steel in Hypar Shells, Oblique Hypar Shells Elliptical and Circular Paraboloids, Action of Elliptical Paraboloids, Shallow Elliptical Paraboloids Curvature and Radius Nature of Variation of Membrane Forces.

**Module 5: Design of Reinforcements in Folded Plates and Supporting Diaphragms (08-Lectures)**

Structural behaviour of trough type folded plate roofs – slab-beam analysis of folded plates – reinforcement in folded plates. Introduction, Shear in Folded Plates, Design of steel for Transverse moments, Design of Longitudinal Steel, Design of Diaphragm, Detailing of Steel.

**Text Books**

- Design of Reinforced Concrete Shells and Folded plates by P.C. Varghese, PHI Learning Private Limited, New Delhi (2010).
- Design and Construction of Concrete Shell Roofs by G.S. Rama Swamy – CBS Publishers & Distributors, Delhi.
- Theory and Design of Concrete Shells by B.K. Chatterjee, Chapmann & Hall, New York, 3rd Edition

**References**

- IS 2210 : 1988 (Reaffirmed 2017) Criteria for design of reinforced concrete shell structures and folded plates [CED 38: Special Structures]

- Theory of Plates and Shells by S. P. Timoshenko and S. W-Krieger, Mc-Graw Hill International, London (1959).
- Theory and Analysis of Plates by R. Szilard, Prentice Hall-INC, New Jersey, (1974).
- Analysis of Thin Concrete Shells by K. Chandrasekhara, Oxford and IBH, Kolkata, 1971.
- Thin Shell Structures by Bandyopadhyay J.N. New Age International Publishers, New Delhi, 1986.
- ASCE Manual of Engineering practice No. 31, Design of cylindrical concrete shell roofs ASC, New York.
- https://onlinecourses.nptel.ac.in/noc21_ce59/preview

## Third Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credit | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | T | | CA | Theory | | PR/OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASE301 | Project Management and Intellectual Property Rights (Self Study) * | - | - | - | 02 | 50 | - | - | 50 | 100 |
| 02 | CASE-S01 | Seminar | - | - | - | 02 | 50 | - | - | 50 | 100 |
| 03 | CASEPS1 | Project Stage –I # | - | - | - | 08 | 50 | - | - | 50 | 100 |
| | | **Total for Semester III** | - | - | - | **12** | **120** | **20** | **60** | **100** | **300** |

## Fourth Semester

| Sr. No. | Subject Code | Name of Subject | Teaching Scheme | | | Credit | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | P | T | | CA | Theory | | PR/OR | Total |
| | | | | | | | | MSE | ESE | | |
| 01 | CASEPS2 | Project Stage –II # | - | - | - | 20 | 100 | - | - | 100 | 200 |
| | | **Total for Semester IV** | - | - | - | 20 | 100 | - | - | 100 | 200 |

* Student may select this course either from NPTEL/MOOC pool or any other approved reputed source. The submission of course completion certificate is mandatory. If the course is not available in online mode, University may conduct exam for the same.

# The dissertation shall be related to the intended specialization, i. e. Computer Aided Structural Engineering. The dissertation shall include use of Computers for simulation using any of the languages or tools such as C, C++, FORTRAN, MATLAB, DRAIN 2D/3D, etc which is preferably in open resources for computer programming/algorithm development etc.

## Semester III

### CASEPS1 PROJECT STAGE I

**Evaluation Scheme:** Class Assessment 50; Oral Examination 50

The dissertation shall be related to the intended specialization, i. e. Computer Aided Structural Engineering. The dissertation shall include use of Computers for simulation using any of the languages or tools such as C, C++, FORTRAN, MATLAB, DRAIN 2D/3D, etc which is preferably in open resources for computer programming/algorithm development etc.

**Dissertation Stage I and Synopsis Approval Presentation:**

It is a course requirement under the guidance of faculty Supervisor. PG student from second year is required to do innovative and research oriented applied work related to various theory and laboratory courses. Dissertation work may cover analytical formulation, experimentation or survey-based project or combination of these. Student are encouraged to undertake an interdisciplinary type project.

**Synopsis:**

It is expected from the student to carry out exhaustive literature survey with consultation of his/her supervisor for not less than 15 reputed national, international journal and conference papers. Student should present the Synopsis Submission Presentation (SSP) with literature survey report to justify about the research gap, innovativeness, applicability, relevance and significance of the work. Student shall undertake project work after approval of synopsis.

**Dissertation Stage I presentation:**

It is expected that student shall present preliminary results from his/her work during the semester with report as per prescribed format. If student is not showing satisfactory performance, then he/she will be given grace period of 2 weeks. After 2 weeks student will be again evaluated with grade penalty. Minimum 02 ISE presentations should be delivered by the student during semester.

## Semester IV

## CASEPS2 PROJECT STAGE II

**Evaluation Scheme**: Class Assessment 100; Oral Examination 100

Based on the guidelines and progress of stage II works, all the desired work should be completed and final dissertation report will be prepared and presented during examination. It is desirable that student presents/publishes the research paper in peer reviewed conference/research journals. If student is not showing satisfactory performance, then he/she will be given grace period of 4 weeks. After 4 weeks student will be again evaluated with grade penalty.

The dissertation shall be related to the intended specialization, i. e. Computer Aided Structural Engineering. The dissertation shall include use of Computers for simulation using any of the languages or tools such as C, C++, FORTRAN, MATLAB, DRAIN 2D/3D, etc which is preferably in open resources for computer programming/algorithm development etc.