Draft copy of Course Structure for Post Graduate Degree Programme
M. Tech. in Civil Engineering
with
Specialization in
Computer Aided Structural Engineering (CASE)

(First Semester wef 2021-22)

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

Detailed Syllabus

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 to Support 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.

§§§§§§§§§§§§§§§§§§§§§§§§§§§§§§