Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Curriculum for

M. Tech. (Structure)

(Civil Engineering)

Department of

Civil Engineering

Vision:

Excellence in Civil Engineering Education

Mission:

M1: Make competent Civil Engineers with high level of professional, moral and ethical values

M2: Impart highest standards in theoretical as well as practical knowledge and skill set

M3: Establish Center of Excellence in major areas of Civil Engineering to respond to the current and future needs of the industry, higher studies as well as research

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Vishwakarma Institute of Information Technology, Pune-48

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Department of Civil Engineering

First Year M. Tech. (FYMT) Structures (Civil Engineering)
Semester I (Pattern 2018)

Course Code	Course	Course Type	Teaching Scheme		Examination Scheme					Total	Credits
					Formative Assessment			Summative Assessment			
			L	P	ISE		CE	ESE	OR		
					T1	T2					
CVPB11181	Theory of Elasticity	TH	3	-	20	10	20	50	-	100	3
CVPB11182	Critical Review of Design of Concrete Structures	TH	3	-	20	10	20	50	-	100	3
CVPB11183	Program Elective I	TH	3	-	20	10	20	50	-	100	3
CVPB11184	Program Elective II	TH	3	-	20	10	20	50	-	100	3
CVPB11185	Laboratory I	CE-OR	-	4	-	-	50	-	50	100	2
CVPB11186	Laboratory II	CE-OR	-	4	-		50	-	50	100	2
CVPB11187	Research Methodology and IPR	CE	2	-	-	-	50	-	-	50	2
AP1	Audit Course	-	-	-	-	-	-	-	-	-	-
	Total		**14**	**8**	**80**	**40**	**230**	**200**	**100**	**650**	**18**

Subject Code	Elective – I	Subject Code	Elective - II
CVPB11183A	Plastic Analysis of Steel Structures	CVPB11184A	Finite Element Analysis
CVPB11183B	Soil Structure Interaction	CVPB11184B	Theory of Plates and Shells
CVPB11183C	Structural Dynamics	CVPB11184C	Nonlinear Analysis of Structures

Audit Courses

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

BOS Chairman Dean Academics Director

Department of Civil Engineering

First Year M. Tech. (FYMT) Structures (Civil Engineering)
Semester II (Pattern 2018)

Course Code	Course	Course Type	Teaching Scheme		Examination Scheme					Total	Credits
					Formative Assessment			Summative Assessment			
			L	P	ISE T1	ISE T2	CE	ESE	OR		
CVPB12181	Dynamics and Earthquake Engineering	TH	3	-	20	10	20	50	-	100	3
CVPB12182	Advanced Design of Steel Structures	TH	3	-	20	10	20	50	-	100	3
CVPB12183	Program Elective III	TH	3	-	20	10	20	50	-	100	3
CVPB12184	Program Elective IV	TH	3	-	20	10	20	50	-	100	3
CVPB12185	Laboratory III	CE-OR	-	4	-	-	50	-	50	100	2
CVPB12186	Laboratory IV	CE-OR	-	4	-		50	-	50	100	2
CVPB12187	Mini Project	CE-OR	-	4	-	-	50	-	50	100	2
AP2	Audit Course	-	-	-	-	-	-	-	-	-	-
	Total		**12**	**12**	**80**	**40**	**230**	**200**	**150**	**700**	**18**

Subject Code	Elective – III	Subject Code	Elective - IV
CVPB12183A	Design of Pre-stressed Structures	CVPB12184A	Design of RCC Bridges
CVPB12183B	Advanced Analysis of Steel Frames	CVPB12184B	Advanced Earthquake Engineering
CVPB12183C	Design of High-rise Structures	CVPB12184C	Design of Foundations

Audit Courses

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

BOS Chairman Dean Academics Director

Semester – I

First Year M. Tech-Civil-Structures Semester I

Theory of Elasticity (CVPB11181)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite: Strength of Materials, Engineering Mathematics, Structural Analysis

Course Objectives:

- To analyze representative problems and to formulate the conditions of theory of elasticity application
- To execute a reasonable choice of parameters of the model (geometry, material properties, boundary conditions)
- To solve and appraise the state of stress and strains in different conditions

Course Outcomes:

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

1. Identify the state of stress and strains for different boundary value problems
2. Comprehend the boundary value problems (2D and 3D) in Cartesian Coordinate System
3. Comprehend the boundary value problems (plane problems) in Polar Coordinate System
4. Appraise the concept of failure criteria and understand the effect of stress concentration due to circular hole in a stressed plate
5. Understand and apply the state of stress and strains for plates
6. Apply the concept to evaluate the practice problem related to rectangular plates

Unit I : Analysis of Stresses and Strain

Concept of stress at a point, stress tensor, stress on inclined plane, stress components on a Rectangular parallelepiped in Cartesian coordinate system, derivation of stress equilibrium equations, transformation of stresses, stress invariants. The state of strain at a point, strain displacement relations, strain compatibility condition and stress compatibility conditions.
Hands on Self-pressure test, Drawing Sketches, Demonstrations.

Unit II : Stress-Strain Relationship

Relations between Elastic Constants, Problems on Navier Lame's Equilibrium Equations, Problems on Beltrami-Michell compatibility equations, Boundary value problems in Elasticity.
Generalized Hook's law for Isotropic, Orthotropic, plane stress, plane strain and axisymmetric problems, Problems in 2D and 3D Cartesian coordinate system, Airy's stress function, bending of beams.
Hands on Drawing Sketches, Discussion based on technical video / documentaries, Failure case studies, Mini experiments.

Unit III : Polar Coordinate System

Relationship between Cartesian and Polar coordinate system, Equilibrium equations, Strain displacement relations, Stress-strain relationship, Strain-displacement relationship for plane stress and plane strain

conditions.
Hands on Drawing Sketches, Demonstrations, Model making.

Unit IV: Stress Concentration Problems

Stress concentration problems such as stress concentration due to circular hole in stressed plate (Kirsch's Problem), failure criterion- von mises.
Hands on Discussion based on technical video / documentaries, Drawing Sketches, Failure case studies, Mini experiments.

Unit V: Plates

Introduction: Thin and thick plates, small and large deflections. Small deflection theory of thin plates: Assumptions, Moment Curvature relations. Stress resultants. Governing differential equation in Cartesian co-ordinates, various boundary conditions. Pure bending of Plates.
Hands on Discussion based on technical video / documentaries, Drawing Sketches, Application Case studies.

Unit VI : Analysis of Rectangular Plates

Analysis of Rectangular Plates: Navier solution for plates with all edges simply supported.
Hands on Discussion based on technical video / documentaries, Application Case studies, Mini experiments.

Text books:

1. Irving Shames, Mechanics of deformable solids, Prentice Hall
2. Sadhu Singh – Theory of Elasticity, Khanna Publishers
3. L.S. Sreenath – Advanced Mechanics of Solids, Tata McGraw-Hill Publications
4. N. K. Bairagi- Advanced Solid Mechanics- Khanna Publishers, New Delhi
5. S. Crandall, N. Dahl and T. Lardner - Mechanics of Solids, McGraw Hill Publications

Reference books:

1. Timoshenko and Goodier - Theory of Elasticity, McGraw-Hill Publications
2. Wang - Applied Elasticity, Dover Publications
3. Enrico Volterra and J. H. Gaines – Advanced Strength of Materials, Prentice Hall
4. S M A Kazimi – Solid Mechanics, Tata McGraw-Hill Publications

Critical Review of Design of Concrete Structures (CVPB11182)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Pre-requisite: Design of Structures – I & Design of Structures - II

Course Objectives :

- To appraise the basics of reinforced concrete design
- To comprehend and apply the knowledge of composite behaviour
- To solve design problem

Course Outcomes : Students will be able to

1) Demonstrate the performance requirements for the design of the RC elements considered by IS code
2) Appraise the flexure design using working stress method
3) Establish and demonstrate the various performance states on M-phi curve (serviceability, cracking, yielding, ultimate)
4) Demonstrate the limit state of serviceability design for flexure member
5) Demonstrate the limit state method of shear design for flexure member
6) Establish the P-M curve for the column under uniaxial load case

Unit I : Preliminary considerations

Stress strain curve (characteristics and design) for concrete, steel and composite (RCC elements). Performance requirements – compressive strength, tensile strength, flexural strength, modulus of rupture, modulus of elasticity (initial, secant and tangent), Ductility and durability aspects. Various failure modes (axial, flexure, shear, torsion and combinations), Loads, load combinations for various limit states.
Hands On Demonstrations, Drawing Sketches, Interactions with Experts on specific course content

Unit II : Working Stress Method

Introduction and assumptions, Transformed section philosophy, Plot the working stresses in steel and concrete and marked WSM limits specified by IS 456, Design procedure for flexure (singly and doubly)
Hands On Discussion based on technical video/documentaries for understanding the concept of modular ratio, illustrative examples

Unit III : Limit State Method - Flexure

Introduction –assumptions and Philosophy, Performance limit states, Flexure section analysis, M-phi curve Demark the various performance states on M-phi curve (serviceability, cracking, yielding, ultimate)

Unit IV : Limit State Method – Serviceability

Crack width and depth analysis for flexure (singly reinforced section), Short term and long term deflection calculations
Hands On Illustrative examples using IS 456.

Unit V : Limit State Method - Shear

Shear stresses in beams, modes of cracking in shear, Shear transfer mechanisms in RC beams, Shear failure modes: effect of a/d ratio, Critical sections for shear, Review of examples
Hands On Illustrative examples using IS 456

Unit VI : Limit State Method – Column

Introduction and assumptions, Section analysis- under compression and uni-axial bending, Distribution of strains at ultimate limit states, Design strength – axial load and moment interaction (P-M curve)
Hands On Illustrative examples using IS 456.

Text Books:

1. Dr. V. L. Shah, Late. Dr. S. R. Karve, Limit State Theory & Design of Reinforced Concrete, Structures Publications, Pune.
2. Ashok Jain, Reinforced Concrete – Limit State Design, Nemchand & Bros. Roorkee.
3. Dr. V. L. Shah, Late. Dr. S. R. Karve, Illustrated Design of Reinforced Concrete Buildings, Structures Publications, Pune.

Reference Books:

1. Pillai and Menon, Reinforced Concrete Design, McGraw Hill Publication, New Delhi
2. S.S. Bhavikatti, Advance R.C.C. Design, New Age International Publishers
3. B.C. Punmia, Ashok K. Jain, Arun K. Jain – Reinforced Concrete Structures Vol. II, Laxmi Publications, New Delhi
4. N.C. Sinha, S.K. Roy – Fundamentals of Reinforced Concrete, S. Chand & Co. Ltd, New Delhi
5. P.C. Varghese – Advanced Reinforced Concrete Design, Prentice Hall of India Pvt. Ltd., New Delhi
6. Dr. H. J. Shah, Reinforced Concrete design, Charotar publishing house
7. S. Ramamruthum, Design of R.C.C, Dhanpat Rai publications
8. Park and Paulay, Reinforced Concrete Structures, John Wiley and Sons Inc., New York
9. IS: 456-2000 Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.

Elective I
Plastic Analysis of Steel Structures (CVPB11183A)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Structural Analysis-I, Structural Analysis-II

Course Objectives :

- To recognize the concept of plastic analysis of steel frames.
- To identify the effect of additional stresses interacting with bending stresses in steel members.
- To employ the design concepts of steel frames with and without haunches along with connections.

Course Outcomes:

By the end of the course, Students will be able to

1) Demonstrate the behavior of steel structures in plastic state of deformation.
2) Analyze various steel frames using plastic analysis method.
3) Asses the importance of plastic analysis and employ the concept for design of steel structures.
4) Design the various components of steel structures and their connections.
5) Analyze the effect of support sinking on portal frames
6) Assess the stability of steel frames for various load combination.

Unit I : Rectangular portal frames

Introduction, Shape factor, performance states and modes of failure, various mechanisms (formation of plastic hinge with regards to material behavior), Analysis of single bay – single story rectangular frames.
Hands on Illustrative examples, Drawing Sketches

Unit II : Plastic Analysis of multi bay rectangular frame

Analysis of Multi Bay- Multi Storey rectangular portal frame, Joint & Various mechanisms, (Two bays - Three stories)
Hands on Discussion based on technical video, Consultancy projects

Unit III : Connection to foundation

Types of connections viz. Pinned, fixed and partial fixed, Effects of base connections on portal frame Detailing of various base conditions (arrangements of anchor bolts)
Hands on Model making, Drawing Sketches, Discussion based on technical video

Unit IV: Braced portal frames

Types of bracings, Function, Importance of bracing. Effect of various joints and end conditions, Analysis of frame with and without bracing
Hands on Model making, Gamefication (Mechano), Visits

Unit V : Secondary considerations
Effect of support Sinking on portal frames considering various load combinations, Consideration of fatigue **Hands on** Illustrative examples, Animated video for support sinking, Discussion with expert based on technical video/documentaries/case study for fatigue consideration
Unit VI : Secondary considerations
Effect of lateral torsional buckling, Stability analysis for various load combinations **Hands on** Illustrative examples, Failure case studies
Text books: 1. S K Duggal "Limit state Design of Steel Structures", McGraw Hill education, 2010 2. Dr. M R Shiyekar, "Limit State Design of Steel Structures", PHI Publication, 3rd Print 3. e-Recourses: Teaching Resource for Structural Steel Design – INSDAG Kolkata
Reference books: 1. B.G. Neal – Plastic Method of Structural Analysis, Chapman & Hall 2. L.S. Beedle – Plastic Design of Steel Frames, John Willey & Sons 3. A.S. Arya and J.L. Ajmani – Design of Steel Structures, Nemchand & Bros., Roorkee 4. Ramchandra – Design of Steel Structures Vol. – II, Standard Book House, Delhi 5. Salwar Alam Raz, Structural design in steel, New Age International Publishers 6. Steel Designers Manual – ELBS

Elective I
Soil Structure Interaction (CVPB11183B)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Theory of Structures, Engineering Mathematics III

Course Objectives:

- To introduce and analyze SSI problem
- To introduce knowledge in principles for design of soil structure interaction.

Course Outcomes:

By the end of the course, the students will be able to:

1. Analyze Contact pressure and settlement under foundations
2. Understand the various theories applicable for SSI
3. Understand the soil behavior
4. Understand the soil structure interaction problem in axially an laterally loaded pile
5. Analyze earth pressure on different retaining structures
6. Understand the Soil-Structure Interaction under dynamic loads

Unit I : Soil – Foundation Interaction

Introduction, Importance and Applications of Soil Structure Interaction **(**SSI), Effects of structure roughness/smoothness on soil behavior, General soil-structure interaction problems – Shallow Foundations, Sheet piles, Mat/Raft foundations etc., Contact pressures and soil-structure interaction for shallow Foundations, Fixed/Flexible Base.

Unit II : Soil Structure Interaction - Parameters

Concept of sub grade modulus, effects/parameters influencing sub grade modulus, Flexible and Rigid Foundations – Rigidity calculations, Static and Dynamic Spring Constants – Winkler Model, Estimation of soil spring constants/stiffness for foundations design.
Elastic Continuum, Winkler Model, Multi-Parameter Models, Hybrid Model. Structure Contact Interface.

Unit III : Soil Behavior

Elastic and plastic analysis of stress distribution on yielding bases. Analysis of conduits/pipes in soils. Beams on elastic foundation concept, introduction to the solution of beam problems. Arching in soils.

Unit IV: Soil-Pile Behavior

Introduction, axial and laterally loaded piles, load-displacement behavior, Modified Ramberg Osgood Model, pile group, interaction effect in pile group, soil-pile modeling in FEM.

Unit V: Soil Structure Interaction in Retaining Structures

SSI in Retaining Structures: Mohr-Coulomb envelope and circle of stresses. Earth pressure computations by friction circle method. Earth pressure distribution on walls with limited/restrained deformations, Earth pressures on sheet piles, braced excavations. Design of supporting system for excavations.

Unit VI : Seismic Soil-Structure Interaction
Fundamentals of Seismic Soil-Structure Interaction,- Dynamic response of soil, strain-compatibility, and damping characteristics of soil-structure. Shake-table tests
Text books: 1. Selvadurai, A. P. S. - Elastic Analysis of Soil-Foundation, Elsevier Scientific Publishing Company, Interaction, 1979 2. Rolando P. Orense, Nawawi Chouw, Michael J. Pender, Soil-Foundation-Structure Interaction, CRC Press, 2010 Taylor & Francis Group, London, UK
Reference books: 1. Bowels J.E., "Analytical and Computer Methods in Foundation", McGraw Hill Book Co. 2. Desai C.S. and Christian J.T., "Numerical Methods in Geotechnical Engineering" McGraw Hill Book Co. New York. 3. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering 4. Scott, R.F. Foundation Analysis, Prentice Hall, 1981 5. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978 6. Soil Structure Interaction, the real behavior of structures, Institution of Structural Engineers

Elective I
Structural Dynamics (CVPB11183C)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite: Theory of Structures, Engineering Mathematics III

Course Objectives:

- To introduce and analyze SDOF and MDOF systems
- To introduce Lumped mass and Distributed Mass systems

Course Outcomes:

By the end of the course, the students will be able to:

1. Analyze damped and undamped SDOF systems subjected to free and forced harmonic vibrations
2. Analyze response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration
3. Comprehend the generalized single degree of freedom system
4. Comprehend the lumped mass multi degree of freedom (MDOF) system
5. Analyze and appraise the lumped mass multi degree of freedom (MDOF) system
6. Understand the dynamic behavior of a beam with distributed mass system

Unit I : Single Degree of Freedom Systems - I

Introduction to structural dynamics, definition of basic problem in dynamics, static versus dynamic loads, different types of dynamic loads.
Introduction to single degree of Freedom (SDOF) systems- Un-damped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, forced vibration. Resonance.
Hands on Discussion based on technical video, Model making

Unit II : Single Degree of Freedom Systems - II

Duhamel's integral, response of structure subjected to general dynamic load, numerical evaluation of dynamics response of SDOF systems, response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration, use of Fourier Series for periodic forces, response of SDOF system subjected to ground motion.
Hands on Discussion based on technical video / documentaries, Drawing Sketches

Unit III : Generalized Single Degree of Freedom System

Generalized Single Degree of Freedom System-Generalized properties: Assemblages of Rigid Bodies, Systems with distributed mass and elasticity, expressions for generalized system properties.
Hands on Drawing Sketches, Software

Unit IV: Multi - Degree of Freedom Systems – I
Lumped mass multi degree of freedom (MDOF) system- Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods. **Hands on** Software, Discussion based on technical video, Lab demos
Unit V: Multi - Degree of Freedom Systems – II
Concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, application to multi-storey rigid frames subjected to lateral dynamic loads. **Hands on** Illustrative examples, Software, Discussion based on technical video, Lab demos
Unit VI : Distributed Mass System
Structure with distributed mass system- Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads **Hands on** Illustrative examples
Text books: 1. Mario Paz, Structural Dynamics- Theory and Computations, CBS Publications 2. Anil K. Chopra, Dynamics of Structures, Prentice Hall, India.
Reference books: 1. R. C. Roy, Structural Dynamics-An Introduction to Computer Methods, John Wiley & Sons. 2. R. W. Clough and J. Penzien, Dynamics of Structures, Tata McGraw Hill. New Delhi

Elective II
Finite Element Analysis (CVPB11184A)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Structural Analysis I, Structural Analysis II, Engineering Mathematics I, Engineering Mathematics II, Engineering Mathematics III

Course Objectives :

- To analyze some real problem and to formulate the conditions of FEA application
- To execute a reasonable choice of parameters and variables of the FEA model (geometry, material properties, boundary conditions)
- To analyze the result FEA model solution by standard computational programs

Course Outcomes :

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

1. Recognize the importance and limitations of FEA
2. Understand the displacement function and its synthesis with type of elements
3. Execute the generalized stiffness matrix for various boundary value problems
4. Identification of various type of elements for Two and Three Dimensional Solids
5. Execute the analysis concepts using Computational methods for Two Dimensional Solids
6. Execute the analysis concepts using Computational methods for Three Dimensional Solids

Unit I : Introduction

Introduction to Finite Element Analysis: Background of Finite Element Analysis, Numerical Methods, Concepts of Elements and Nodes, Degrees of Freedom, Steps in Finite Element Analysis

Basic Concepts of Finite Element Analysis: Discretization of Technique Basic, Concepts of Finite Element Analysis, Advantages of FEA, Disadvantages of FEA, Limitations of the FEM, Errors and Accuracy in FEA through examples and importance.

Introduction to Elasticity: Strain-Displacement Relations, Linear Constitutive Relations

Unit II : Finite Element Formulation Techniques

Choice of Displacement Function: Convergence criteria, Compatibility, Geometric invariance, Shape Function, Degree of Continuity, Isoparametric Elements, Various Elements.

Unit III : Stiffness Matrix and Boundary Conditions

Element Stiffness Matrix, Global Stiffness Matrix, Boundary Conditions, Stiffness of Truss Members: Introduction, Element Stiffness of a Truss Member, Member Stiffness with Varying Cross Section, Generalized Stiffness Matrix of a Plane Truss Member: Analysis of Truss, Element Stiffness of a 3 Node Truss Member

Stiffness of Beam Members: Introduction, Derivation of Shape Function, Derivation of Element Stiffness Matrix, Generalized Stiffness Matrix of a Beam Member

Unit IV : FEM for Two and Three Dimensional Solids
Constant Strain Triangle: Element Stiffness Matrix for CST, Nodal Load Vector for CST Linear Strain Triangle: Element Stiffness Matrix for LST, Nodal Load Vector for LST, Numerical Example using CST Shape functions in Cartesian & natural coordinate systems
Unit V: FEM for Two Dimensional Solids
Working of FEM, Steps, algorithm flow charts etc. demo through examples, common mistakes, validation study with available experts and case study
Unit VI : FEM for Three Dimensional Solids
Working of FEM, Steps, algorithm flow charts etc. demo through examples, common mistakes, validation study with available experts and case study
Text books: 1. S.S. Bhavikatti - Finite Element Analysis – New Age International Publishers, Delhi 2. Thompson---Introduction to the Finite Element, Method: Theory, Programming and Applications, Wiley, India 3. S.S. Rao - The Finite Element Method in Engineering 4th Edition – Elsevier Publication 4. G.R. Buchanan – Finite Element Analysis Schaum's outlines - Tata McGraw Hill Publishing Co. Ltd 5. Iriving Shames & Clive Dym, Energy & Finite Element Methods in Structural Mechanics, New Age International Publishers, Delhi 6. NPTEL Notes
Reference books: 1. Zienkiewicz and Taylor - The Finite Element Method 4th Edition – Vol – I & II – McGraw Hill International Edition 2. Robert D. Cook, D.S. Malkus, M.E. Plesha – Concepts & Applications of Finite Element Analysis –Wiley, India. 3. J.N. Reddy – An Introduction to the finite element method – Tata McGraw Hill Publishing Co. Ltd 4. Segerlind L.J. – Applied Finite Element Analysis - John Wiley & Sons. 5. C.S. Krishnamoorthy – Finite Element Analysis – Theory & Programming – Tata McGraw Hill Publishing Co. Ltd

Elective II
Theory of Plates and Shells (CVPB11184B)

Teaching Scheme
Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Theory of Elasticity, Advanced Solid Mechanics

Course Objectives: The course will help students

- To identify the application of basic concepts of analysis of 2-D plates and shells.
- To interpret the behavior of plate and shell structure under various loads.
- To understand and compare various analysis methods for plates and shells.
- To analyze plates and shells subjected to various loads based on its application.

Course Outcomes:

By the end of the course, Students will be able to

1) Demonstrate the concept of analysis of 2-D plates using various analysis methods.
2) Analysis of thick plates subjected to various loads.
3) Analysis of circular plates subjected to various loads.
4) Demonstrate the concept of analysis of 2-D shells using various analysis methods.
5) Analysis of circular shells subjected to various loads.
6) Recognize the behavior of plate and shell structures through software applications.

Unit I : Thin plates

Introduction: Theory of thin plates: Assumptions, Moment Curvature relations. Navier and Levy's solution for plates with distributed loads. Raleigh- Ritz approach for simple cases in rectangular plates.
Hands on Illustrative examples.

Unit II : Shear deformation theories

Introduction to shear deformation theories. Reissener - Mindlin Theory, Moment curvature relationship for First order shear deformation theory.
Hands on Illustrative examples.

Unit III : Circular Plates

Circular Plates: Analysis of circular plates under axi-symmetric loading. Moment Curvature relations. Governing differential equation in polar co-ordinates. Simply supported and fixed edges. Distributed load, ring load, a plate with a central hole.
Hands on Illustrative examples.

Unit IV : Thin Shells

Shells of Revolution: Membrane theory, equilibrium equations, strain displacement relations, boundary conditions, cylindrical, conical and spherical shells.
Hands on Illustrative examples.

Unit V : Shell bending and beam theory

Bending Theory: Equilibrium equation, strain displacement relations, governing differential equation, solution for a simply supported cylindrical shell, various boundary conditions. Application to pipes and pressure vessels. Beam theory of cylindrical shells: Principles of Lundgren's beam theory, beam

analysis, arch analysis, application to cylindrical roof shells. **Hands on** Illustrative examples.
Unit VI : Circular cylindrical Shells
Circular cylindrical shells: Membrane theory: Equilibrium equations, strain displacement relations, boundary conditions. **Hands on** Illustrative examples.
Text books: 1. Chandrashekhara K., Analysis of Concrete Shells, New Age International Edition 2. Chandrashekhara K., Analysis of Plates, New Age International Edition
Reference books: 1. S. Timoshenko and W. Krieger, Theory of Plates and Shells, McGraw Hill. 2. Ansel C. Ugural, Stresses in Plates and Shells, McGraw Hill

Elective II

Nonlinear Analysis of Structures (CVPB11184C)

Teaching Scheme
Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Strength of Materials, Structural Analysis

Course Objectives:

- To recognize the concept of non-linear analysis of steel frames.
- To identify the effect of various non-linearity in analysis.
- To employ the non-linear analysis concepts for various structures like columns, trusses, plates.

Course Outcomes:

By the end of the course, Students will be able to

1) Demonstrate the behavior of structures by considering material and geometric non-linearity.
2) Analyze and columns demonstrate the behavior of using non-linear analysis concept.
3) Analyze trusses using nonlinear stiffness matrix method.
4) Analyze frames using nonlinear stiffness matrix method.
5) Analyze plates using various nonlinear analysis approaches.
6) Asses the importance of non-linear analysis and employ the concept for design of various structures.

Unit I : Concept of nonlinear analysis

Types of Nonlinearities - Geometric Nonlinearity, Material Nonlinearity, Nonlinear Governing Equation for Beams: Moment-curvature Nonlinearity, Geometric Nonlinearity Due to Stretching, Material Nonlinearity, Geometrically Nonlinear Beam Problems - Moment-Curvature Nonlinearity-Cantilever Beam, Centrally Loaded beam with two supports, Cantilever Beam subjected to Tip Load.
Hands on Illustrative examples

Unit II : Nonlinear Analysis of Columns

Nonlinear Analysis of Columns- Post buckling of cantilever column, Large deflection of column with both ends hinged.
Hands on Illustrative examples

Unit III : Nonlinear Analysis of Trusses

Nonlinear Analysis of Trusses - Derivation of nonlinear stiffness matrix, Matrix displacement method for nonlinear analysis of structures.
Hands on Illustrative examples

Unit IV : Nonlinear Elastic Analysis of Frames

Nonlinear Elastic Analysis of Frames - Derivation of nonlinear stiffness matrix, Matrix displacement method for nonlinear analysis of structures.
Hands on Illustrative examples

Unit V : Concept of Nonlinear Analysis of Plates
Nonlinear Static Analysis of Plates - Geometric and Material Nonlinearities, Governing Nonlinear Equations of Plates: Stress Function Approach, Displacement Equations Approach. **Hands on -** Illustrative examples
Unit VI : Nonlinear Static Analysis of Plates
Nonlinear Static Analysis of Plates - Boundary Conditions and method of solution, Large Deflection of Rectangular Plates. **Hands on** Illustrative examples
Text books: 1. M. Sathyamoorthy, Nonlinear Analysis of Structures, CRC Press, New York 2. K.I. Majid, Non Linear Structures, Butter worth Publishers, London.
Reference books: 1. N G R Iyengar, Elastic Stability of Structural elements, Macmillan India Ltd.

Lab I (Theory of Elasticity) (CVPB11185)

Teaching Scheme

Credits : 2
Laboratory Work : 4 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Objectives :

- To prepare students for practice and hands on assignments on course works.
- Introduce the students to independent thinking.
- Exposure to practical considerations.

Outcomes :

By the end of the course, Student will be able to,

1. Identify and assess practical parameters in the study domain.
2. Criticize and evaluate the research work.

Lab - I :

The oral exam for Lab -I should be based on completion of assignments/review of technical documentaries/review of case studies / research paper review/failure case studies/observation and group discussion on case studies / applications confined to the Theory of Elasticity course.

The file will consist of -

One Assignment each on every unit (total 6 assignments). (3-4 questions in each assignment)

A brief five page report on each hand's on as described in the respective units. (total six hands on short reports)

Technical review and critique of a research article/paper on any topic from the refereed journal paper related to the course content.

Lab II (Critical Review of Design of Concrete Structures) (CVPB11186)

Teaching Scheme

Credits : 2
Laboratory Work : 4 hrs./week

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Objectives :

- To prepare students for practice and hands on assignments on course works.
- Introduce the students to independent thinking.
- Exposure to practical considerations.

Outcomes :

By the end of the course, Student will be able to,

1. Identify and assess practical parameters in the study domain.
2. Criticize and evaluate the research work.

Lab - II :

The oral exam for Lab -II should be based on completion of assignments / review of technical documentaries / review of case studies / research paper review / failure case studies / observation and group discussion on case studies / applications confined to the course.

The file will consist of -

One Assignment each on every unit (total 6 assignments). (3-4 questions in each assignment)

A brief five page report on each hand's on as described in the respective units. (total five hands on short reports)

Technical review and critique of a research article/paper on any topic from the refereed journal paper related to the course content.

Research Methodology & IPR (CVPB11187)

Teaching Scheme
Credits: 2
Lecture: 2 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment : 50 Marks

Prerequisite: Basis statistical tools

Course Objectives :

- To introduce to the concept of research and research problem
- To understand research ethics
- Get introduced to the concept of Intellectual property rights
  To understand developments in IPR

Course Outcomes : The students will be able to:

1. Define research and formulate a research problem
2. Write a research proposal to a suitable funding agency
3. Define concept of Intellectual property rights.
   Select Patents/ Designs/ Trademarks/ Copyright and analyze them through case studies.

Unit I : Introduction to Research and Research problem

Meaning of research, types of research, process of research, Objectives of research, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, defining a research problem (Real life example or case study). Literature Review: objectives, Significance, sources (Review of journal paper/s).
Research hypotheses, Qualities of a good Hypothesis, Null Hypothesis & Alternative Hypothesis. Hypothesis Testing -Logic & Importance.

Unit II: Report, Research proposal and funding agencies

Need of effective documentation, types of reports, report structure, Format of research proposal, Individual research proposal, Institutional research proposal, Funding for the proposal, Different funding agencies. Plagiarism and its implications. Research briefing, presentation styles, elements of effective presentation, writing of research paper, presenting and publishing paper.

Unit III : Introduction to IPR and Patenting

Introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR in abroad, Some important examples of IPR. Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development, patenting under PCT, patent license, patentable and non-patentable inventions. Drafting of a patent, Filing of a patent.

Unit IV: Patent Rights and Development

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. International cooperation on Intellectual Property. Administration of Patent System. New developments in IPR; IPR of Biological Systems, Traditional knowledge Case Studies, understanding of IPR issues in cyber world

Text books:

1. Dr. C. R. Kothari, Research Methodology: Methods and Trends', New Age International
2. Publishers.
3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction'
4. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners'
5. Prabuddha Ganguly, "Intellectual Property Rights", Tata Mc-Graw Hill.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley "Intellectual Property in New"

Reference books:

1. Deepak Chawla and Neena Sondhi, Research Methodology**:** concepts and cases, Vikas Publishing House Pvt. Ltd. (ISBN 978-81-259-5205-3)
2. Louis Cohen, Manion, Morrison , Research Methods in Education, Routledge(Taylor & Francis Group) /Cambridge University Press India Pvt. Ltd.-ISBN-978-0-415-58336-7
3. Sekaran Uma and Roger Bougie, Research Methods for Business, Wiley, India.
Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007

Semester - II

Dynamics and Earthquake Engineering (CVPB12181)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite: Engineering Mechanics, Theory of Structures, Engineering Mathematics III, Structural Design II

Course Objectives:

- Introduce students to the fundamentals of dynamics and it application
- Introduce students to analyze building structure under earthquake loads

Course Outcomes:

By the end of the course, the students will be able to:

1. Analyze damped and undamped SDOF systems subjected to free and forced harmonic vibrations
2. Analyze response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration
3. Analyze and appraise the lumped mass multi degree of freedom (MDOF) system
4. Understand the concept of various types response spectrum
5. Apply mathematical model for the seismic analysis of multistoried buildings
6. Apply Equivalent Static Method and Response Spectrum Method for the seismic analysis of multistoried buildings

Unit I : Vibration analysis- SDOF systems

Vibrations and the nature of time dependent phenomena, inertia, dynamic equilibrium and mathematical models of physical systems.
Introduction to structural dynamics, definition of basic problem in dynamics, static versus dynamic loads, different types of dynamic loads.
Introduction to single degree of Freedom (SDOF) systems- Un-damped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, forced vibration. Resonance.
Hands on Discussion based on technical video, Model making

Unit II : Single Degree of Freedom Systems

Duhamel's integral, response of structure subjected to general dynamic load, numerical evaluation of dynamics response of SDOF systems, response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration, use of Fourier Series for periodic forces, response of SDOF system subjected to ground motion.
Hands on Discussion based on technical video / documentaries, Drawing Sketches

Unit III : Multi - Degree of Freedom Systems
Lumped mass multi degree of freedom (MDOF) system- Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods. **Hands on** Software, Discussion based on technical video, Lab demos
Unit IV : Earthquake Inputs
Time History Records and Frequency Contents of Ground Motion; Power Spectral Density Function of Ground Motion; Concept of Response Spectrums of Earthquake; Combined D - V- A Spectrum and Construction of Design Spectrum; Site Specific, Probabilistic and Uniform Hazard spectrums; Predictive Relationships for earthquake parameters. **Hands on** Discussion on Tutorial Problems, Discussion based on technical video
Unit V : Modeling of Multistoried Buildings
Deterministic earthquake response: types of earthquake excitation, lumped SDOF elastic systems, translational excitation, lumped MDOF elastic systems, distributed-parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQCC combination of modal responses. **Hands on** Model making, Discussion on Tutorial Problems, Discussion based on technical video/ animations
Unit VI : Analysis of Multistoried Buildings
Equivalent lateral load method of analysis Response spectra method of analysis **Hands on** Discussion on Tutorial Problems.
Text books: 1. A.K. Chopra, Dynamics of Structures - Theory and Application to Earthquake Engineering, Prentice Hall 2. Pankaj Agarwal and Manish Shrikhande, 'Earthquake Resistant Design of Structures', PHI, 2008
Reference books: 1. Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992 2. Paulay, Seismic Design of Reinforced Concrete and Masonry Buildings, Wiley India

Advanced Design of Steel Structures (CVPB12182)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Strength of Materials, Structural Analysis, Structural Design

Course Objectives: The course will help students

- To identify the application of basic concepts of design of steel structures.
- To recognize the purpose of specific steel structure and interpret its behavior under various loads.
- To recognize the behavior of thin components of steel structures subjected to various loads.
- To analyze various steel structures subjected to various loads based on its application.
- To design various steel structures having specific application.

Course Outcomes:

By the end of the course, Students will be able to

1) Demonstrate the use of IS Codes and standards related to design of hoarding structures.
2) Analyze and design castellated beams using Indian Standard provisions.
3) Analyze and design microwave and transmission tower structures using Indian Standard provisions
4) Analyze and design tubular structures using Indian Standard provisions
5) Recognize the behavior of light gauge sections and design of light gauge sections for various loading conditions.
6) Analyze and design gantry girders subjected to various types of loads.

Unit I : Hoarding Structures

Analysis and design of hoarding structures under dead, live and wind load conditions as per codal provisions by limit state method, introduction to fatigue failure.
Hands on Illustrative examples, site visits, failure case studies.

Unit II : Castellated beams

Concepts, fabrication of the castellated beam from rolled steel section, design of castellated beam for bending and shear as per codal provisions by limit state method
Hands on Illustrative examples.

Unit III : Microwave and Transmission Towers

Introduction, structural configuration, function, analysis and design
Hands on Illustrative examples, failure case studies.

Unit IV: Tubular Structures

Design of tubular Trusses and scaffoldings using circular hollow, rectangular hollow sections as per codal provisions, detailing of joints
Hands on Illustrative examples.

Unit V : Cold form / light gauge section
Type of cross section, stiffened, multiple stiffened and un-stiffened element, flat-width ratio, effective design width, design of light gauge compression, tension and flexural members as per codal provisions. **Hands on** Illustrative examples, Interactions with Experts on specific course content
Unit VI : Design of gantry girder
Selection of gantry girder, design of cross section, check for moment capacity, buckling resistance, bi-axial bending, deflection at working load and fatigue strength. **Hands on** Illustrative examples.
Text books: 1. S K Duggal, Limit state design of steel structures, Tata McGraw Hill Education. 2. Punmia and Jain, Comprehensive Design of steel structure, Laxmi Publication, Delhi.
Reference books: 1. N Subramanian, Design of steel structures, Oxford University Press. 2. Sarwar Alam Raz—Structural Design in Steel---New Age International Publishers 3. IS: 800 - 2007, Code of Practice for General Construction in Steel, BIS, New Delhi. 4. IS: 800 - 1984, Code of Practice for General Construction in Steel, BIS, New Delhi. 5. IS: 801 - 1975, Code of Practice for use of cold formed light gauge steel structural members in general building construction, BIS, New Delhi.

Elective III
Design of Prestressed Structures (CVPB12183A)

Teaching Scheme
Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite: Strength of Materials, Analysis of structures, Design of structures

Course Objectives:

- To prepare civil engineering graduates who can analyze and design prestressed concrete structures.
- To use IS: 1343 in the design of prestressed concrete structures.
- To understand various aspects of maintenance and rehabilitation of prestressed concrete structures

Course Outcomes:

By the end of the course, the students will be able to:

1. To comprehend the concept of prestress and losses in prestress
2. To appraise the prestressed flexure section for strength and deflection using limit state method
3. To evaluate the losses in prestressed system
4. To design the prestressed concrete beams
5. To design the pre-stressed and post-tensioned concrete slabs
6. To recognize the aspects of maintenance and rehabilitation of prestressed concrete structures

Unit I : Introduction to prestressed concrete

Introduction to basic concept and general principle of prestressed concrete. Materials used in prestressed concrete. Prestressing systems. Concepts of prestressing. Losses in prestress. Cable profile and cable zone.
Hands on Discussion based on technical video, Model making

Unit II : Analysis of prestressed concrete

Analysis of prestressed concrete section for flexure. Philosophy of limit state design for prestressed concrete members. Efficiency of a section. Permissible stresses in concrete and steel. Deflections of prestressed concrete members. Anchorage zone stresses in prestressed concrete members.
Hands on Illustrative examples.

Unit III : Losses in Prestressed systems

Introduction to prestressed losses and its Significance, Estimation of prestressed losses in pretensioned and post tensioned systems as IS code.
Hands on Illustrative examples, Discussion based on technical video, Model making

Unit IV : Design of prestressed concrete beams

Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure, shear, bond and bearing including end block.
Hands on Discussion on Tutorial Problems, Discussion based on technical video

Unit V: Design of prestressed concrete slabs
Design of one way and two way pre-tensioned and post tensioned slabs. **Hands on -** Illustrative examples.
Unit VI : Maintenance and rehabilitation of prestressed concrete structures
General aspects of maintenance and rehabilitation. Inspection of structures. Use of NDT equipments in the inspection. Cracks in prestressed concrete structures- remedy and repair. Repair and rehabilitation of prestressed concrete structures. Strengthening of prestressed concrete structures. **Hands on** Discussion based on technical video, Case study.
Text books: 1. T. Y. Lin, Design of Prestressed concrete structures, John Wiley Publishers. 2. N. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publication Co. 3. S. Ramamrutham, Prestressed Concrete, Dhanpat Rai and Sons. 4. IS: 1343-2012: Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.
Reference books: 1. Y. Guyon, Prestressed Concrete, Contractors Record Ltd. 2. R. H. Evans and E.W. Bennett, Prestressed Concrete, McGraw Hill Book Co.

Elective III

Advanced Analysis of Steel Frames (CVPB12183B)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Strength of Materials, Structural Analysis-I, Structural Analysis-II

Course Objectives: The course will help students

- To identify the application of basic concepts of stability of structures.
- To recognize the purpose of specific steel structure and interpret its behavior under various loads.
- To recognize the behavior of steel frames structures subjected to various loads.
- To analyze various steel frame components subjected to various loads based on its application.

Course Outcomes:

By the end of the course, Students will be able to

1) Demonstrate the concept of structural stability and to analyze columns having different boundary conditions.
2) Analyze the rectangular portal frames using first order elastic and inelastic analysis methods.
3) Analyze the rectangular portal frames using second order elastic and inelastic analysis methods.
4) Demonstrate use of appropriate method of analysis of steel structures.
5) Demonstrate concept of pre-engineered buildings
6) Recognize the behavior of steel structures as a whole through software applications.

Unit I : Stability of structures

Elastic stability & structural Instability, Review of critical loads of long columns for various boundary conditions; beam-columns, critical load of simple rectangular frames. Columns with initial imperfection.
Hands on Illustrative examples.

Unit II : First order elastic and inelastic analysis

First order elastic (FOE) & first order inelastic (FOIE) (Plastic) analysis of rectangular portal frames. Elastic & limit state of strength of frame.
Hands on Illustrative examples.

Unit III : Second order elastic analysis

Second order considerations in elastic analysis of frames P-δ & P- effect. Critical load of single bay, single story portal frame using P-δ & P-effect; classical & semi geometrical approach. Direct second order elastic analysis (SOE), international codal provisions, application for simple frame.
Hands on Illustrative examples.

Unit IV : Second order inelastic analysis
Second order inelastic (SOIE) analysis of frames, elastic plastic hinge analysis, plastic zone method, use of finite element method Refined plastic hinge analysis, reduction in stiffness of member due to plasticity at hinge. Advantages of advanced analysis. **Hands on -** Illustrative examples.
Unit V : Pre-Engineered Buildings
Introduction, basic concept of pre-engineered building, advantages and disadvantages, analysis and design of purlins and structural frame. **Hands on** Illustrative examples.
Unit VI : Software application
Design of frame using advanced analysis. Use of suitable software illustrating difference in analytical results among all methods such as FOE, FOIE, SOE, SOIE. Software application for pre-engineered building. **Hands on** Illustrative examples.
Text books: 1. M.L. Gambhir, Stability Analysis and design of Structures, Springer, SIE. 2. M. R. Shiyekar, Limit State Design in Structural Steel, PHI publication.
Reference books: 1. W F Chen, S.Toma, Advanced Analysis of steel frames, Theory Software and application, CRC press, Tokyo. 2. W F Chen, S. Kim, LRFD steel design using Advanced Analysis, CRC press, Tokyo.

Elective III

Design of High-rise Structures (CVPB12183C)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Structural Analysis, Matrices, Design of Structures (basic courses), Analysis of High-Rise Structures , Earthquake Engineering

Course Objectives:

- Be able to design some real problem of High-rise building structures application
- Be able to design and analyze the result of high-rise structures model solution by standard computational programs

Course Outcomes:

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

1. Comprehend the codal provisions with reference to stability, serviceability and strength states for design of high-rise building
2. Recognize the various parameters which affect the performance of the building
3. Evaluate the structural behavior of shear walled building using mathematical model
4. Comprehend the various special aspects in analysis of multi-storied building with reference to the normal low height building
5. Review of IS code provisions from ductility provisions in high-rise buildings
6. Evaluate and design the multi-storied building using bracing and infills

Unit I : Codal Provisions

Review of Codal provisions with reference to stability, serviceability and strength states (latest IS codes, IBC codes)
Hands on Illustrative examples.

Unit II : Performance of Buildings in Past Earthquakes

Performance of buildings, behaviors of various type of buildings in past earthquakes, modes of failures, influence of asymmetry, infill walls, foundations, soft story and detailing of reinforcements in buildings.
Hands on Drawing Sketches, Discussion based on technical video

Unit III : Shear Wall Building

Frames shear walled buildings, mathematical modeling of building with different structural systems.
Hands on Software, Illustrative examples, Discussion based on technical video

Unit IV : Multi-storied Buildings

Special aspects in Multi-story buildings, Effect of torsion, flexible first story, P-delta effect, drift limitation.
Hands on Software, Failure case studies.

Unit V: Ductility Considerations

Strength, ductility and energy absorption, ductility of reinforced members subjected to flexure, axial loads and shear. Detailing of RCC members, beam, column, Beam-column joints for ductile behaviors, IS code provisions.

Hands on Illustrative examples, Failure case studies.
Unit VI : Effect of bracings and infills
Design of multi-story buildings with bracings & infills. **Hands on** Illustrative examples.
Text books: 1. Paulay, T. &Prestiley, M.J.N., Seismic design of R C & Masonry Buildings, John Willey & Sons; 2nd Edition, 1999 2. FarzadNaeim, Handbook on Seismic Analysis and Design of Structures, Kluwer Academic Publisher, 2001 3. Booth, E., Concrete Structures in Earthquake Regions, Longman Higher Education, 1994
Reference books: 1. Response of Multistory Concrete Structures to Lateral Forces, SP–36, ACI Publication. 2. Response of Buildings to Lateral Forces, ACI Task Committee Report 442. 3. Schuellar, W, High Rise Building Structures 4. M. Fintal, Handbook of Concrete Structures 5. B.S. Taranath, Structural Analysis & Design of tall Buildings 6. B. Stafford Smith & A. Coule, Tall Building Structures: Analysis & Design, 7. Advances in Tall Buildings, CBS Publishers and Distributors Delhi, 1986.

Elective IV
Design of RCC Bridges (CVPB12184A)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Prerequisite : Strength of Materials, Structural Analysis, Structural Design

Course Objectives: The course will help students

- To identify the application of basic concepts of design of RC Bridge structures.
- To recognize the purpose of specific type of RC Bridge structure and interpret its behavior under various loads.
- To understand the various types of vehicles and its application on various types of road bridges.
- To make aware the relevant IRC codal requirements related to bridge structures.

Course Outcomes:

By the end of the course, Students will be able to

1) Demonstrate the use of IRC Codes and standards related to design of slab culvert, box culvert and skew bridge
2) Analyze and design of T-beam bridge using Courbon's method
3) Analyze and design rigid frame bridge
4) Comprehend the use of bearings and evaluate the forces acting on the abutments and piers
5) Analyze and design the wing walls of the RC bridges
6) Recognize the suitability of the various types of bridge foundations

Unit I : Introduction to Bridge Engineering

Classification and components of bridges, layout, planning. Structural forms of bridge decks, beam and slab decks, cellular decks. Design of slab culvert, box culvert and skew bridge.
Hands on Model making, site visits

Unit II : Design of T-Beam Bridge

Introduction to Courbon's method, Henry-Jaegar method and Guyon - Massonet method. Design of T-beam bridge using Courbon's method
Hands on Illustrative examples.

Unit III : Design of Rigid Frame Bridge

Structural classification of Rigid Frame bridge, analysis and design of Rigid Frame bridge.
Hands on Illustrative examples, failure case studies.

Unit IV: Bearings

Classification and design of bearings. Expansion joints. Forces acting on abutments and piers.
Hands on Discussion based on technical video / documentaries.

Unit V : Wing walls

Analysis and design, types and design of wing walls.
Hands on Illustrative examples

Unit VI : Design of Bridge Foundations
Bridge foundations introduction, design of open well, pile and caisson foundation. **Hands on** Illustrative examples, Discussion based on technical video / documentaries.
Text books: 1. T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India 2. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi 3. David Lee – Bridge Bearings and Expansion Joints,E & FN Spon 4. IRC Codes – IRC: 5, IRC: 6, IRC -21, IRC: 18, IRC: 27, IRC: 45, IRC: 78, IRC: 83 5. Nainan P. Kurian – Design of Foundation Systems, Narosa Publishing House
Reference books: 1. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi 2. V.K. Raina – Concrete Bridge Practice Analysis, design and Economics, Tata McGraw Hill 3. Joseph E. Bowles – Foundation Analysis and Design, McGraw-Hill International Edition

Elective IV

Advanced Earthquake Engineering (CVPB12184B)

Teaching Scheme
Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Theory of Structures, Engineering Mathematics III

Course Objectives:

- To introduce Response Spectrum and Time History Analysis for earthquake induced loads
- To introduce seismic soil structure interaction
- To introduce base isolation techniques

Course Outcomes:

By the end of the course, the students will be able to:

1. To understand the various parameters associated to definition of the earthquake response
2. To synthesis the response spectrum characterization
3. To recognize the various parameters affect the building response
4. To design a building with shear wall
5. To understand the retrofitting of a structures
6. To understand the application of base isolation techniques

Unit I : Earthquake Inputs

Time History Records and Frequency Contents of Ground Motion; Power Spectral Density Function of Ground Motion; Concept of Response Spectrums of Earthquake; Combined D-V-A Spectrum and Construction of Design Spectrum; Site Specific, Probabilistic and Uniform Hazard spectrums; Predictive Relationships for earthquake parameters.
Hands on Discussion on Tutorial Problems, Discussion based on technical video

Unit II : Response Spectrum Analysis Method

Characterization of ground motion: earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics.
Hands on Discussion on Tutorial Problems

Unit III : Analysis of Multistoried Buildings

Deterministic earthquake response: types of earthquake excitation, lumped SDOF elastic systems, translational excitation, lumped MDOF elastic systems, multistoried buildings with symmetric plans, multistoried buildings with unsymmetric plans, torsional response of symmetric plan building, distributed-parameter elastic systems.
Hands on Discussion on Tutorial Problems

Unit IV : RC building with Shear Walls

Design of RC building with Shear Walls. Ductile detailing as per latest IS:13920.
Hands on Illustrative examples.

Unit V : Retrofitting of structures
Retrofitting of Structures, Sources of weakness in framed buildings, Classification of retrofitting techniques, Conventional and non-conventional methods, Comparative study of various methods and case studies. **Hands on** Discussion based on technical video, failure case study.
Unit VI : Base Isolation Techniques
Base isolation concept, isolation systems and their modeling; linear theory of base isolation; stability of elastomeric bearings; codal provisions for seismic isolation, practical applications. **Hands on** Discussion based on technical video.
Text books: 1. A.K. Chopra, Dynamics of Structures - Theory and Application to Earthquake Engineering, Prentice Hall 2. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, PHI, 2008
Reference books: 1. Clough R.W. and Penzien J., Dynamics of Structures, McGraw-Hill, 2nd edition, 1992 2. Ellis L. Krinitzsky, J.M. Gould and Peter H. Edinger, Fundamentals of Earthquake Resistant Construction, John Wiley, 1993

Elective IV
Design of Foundations (CVPB12184C)

Teaching Scheme

Credits : 3
Lectures : 3 hrs./week
Practical : NA
Tutorial : NA

Examination Scheme

Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

Prerequisite : Strength of Materials, Geotechnical and Foundation Engineering

Course Objectives:

- To analyze and design various foundations
- To introduce knowledge in principles for design of retaining wall.

Course Outcomes:

By the end of the course, the students will be able to:

1. Identify a suitable foundation system for a structure
2. Evaluate the importance of raft foundation and principles of design
3. Comprehend the parameters associated with the pile foundation design including lateral loads
4. Demonstrate the use of Indian Codes for design of RC cast-in-situ and precast pile and pile cap
5. Analyze and design sheet pile system
6. Analyze the laterally loaded pile, raft foundation and sheet pile using software tool

Unit I : Soil – Foundation Interaction

Foundation objectives and their importance, Classification of foundations, Soil classification. Geotechnical design parameters, bearing capacity, settlements and factors affecting settlement. Loads for design, depth of foundation and depth of soil exploration. Parameters for design of foundation on various types of soil, soil structure interaction.
Hands on Discussion based on technical video, Engineering sketches, case study

Unit II : Design of Raft Foundations

Types of rafts, Design of Flat slab raft foundation .Design of beam and slab raft foundation.
Hands on Illustrative examples and case studies.

Unit III : Pile Foundation –I

Function and Classification of piles, Concrete piles, Precast and cast-in-situ piles. Static point and skin resistance capacity of a Pile, Pile settlements. Laterally loaded Piles. Various pile group patterns, Efficiency of Pile in group, Negative skin friction.
Hands on Illustrative examples.

Unit IV: Pile Foundation –II

IS code recommendations for structural design for various piles. Design of RC cast-in-situ and precast pile by IS code method. Pile group analysis by rigid and flexible methods, Design of pile cap.
Hands on Illustrative examples

Unit V: Design of Sheet Pile

Earth pressure diagram, determination of depth of embedment in sands and clays, timbering of trenches, Earth pressure diagrams, forces in struts
Hands on Illustrative examples, Model making

Unit VI : Software application

Software application on laterally loaded pile, raft foundation and sheet pile.
Hands on Software.

Text books:

1. IS 1904: 1986 Code of practice for design and construction of foundations in soils: general requirements (Third Revision)
2. IS 2911: Part 1 : Sec 1 to3 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles
3. IS 2911: Part 1: Sec 4 : 1984 Code of practice for design and construction of pile foundations: Part 1 Concrete piles
4. IS 2911: Part 3: 1980 Code of practice for design and construction of pile foundations: Part 3 Under-reamed piles
5. IS 2950: Part 1: 1981 Code of Practice for design and construction of raft foundations: Part 1: Design
6. IS 2974: Part 1to 5: 1982 Code of practice for design and construction of machine foundations

Reference books:

1. Kurain N.P, Modern Foundations: Introduction to Advance Techniques: TataMcGraw
2. Kurain N. P, Design of foundation systems Principles and Practice, Narosa Publishing house, New Delhi, 2005
3. Dr. H.J.Shah, Reinforced Concrete, Vol II, Charotar Publishing House
4. Winterkorn H.F. and Fang H.Y. Ed., Foundation Engineering Hand Book, Van-NostrandReynold, 1975
5. Bowles J.E., Foundation Analysis and Design (4th Ed.), Mc.Graw –Hill, NY, 1996
6. Poulose H.G. and Davis E.H., Pile foundation Analysis and Design, John-Wiley Sons, NY
7. Leonards G. Ed., Foundation Engineering, Mc.Graw-Hill, NY, 1962
8. ShamsherPrakash, Soil Dynamics, McGraw Hill
9. Sreenivasalu and Varadarajan, Handbook of Machine Foundations, Tata McGraw Hill

Lab III (Dynamics and Earthquake Engineering) (CVPB12185)

Teaching Scheme

Credits : 2
Lecture : NA
Practical: 4 hrs./week
Tutorial : NA

Examination Scheme

Formative Assessment: 50 Marks
Summative Assessment: 50Marks

Objectives :

- To prepare students for practice and hands on assignments on the course works.
- Introduce the students to independent thinking.
- Exposure to practical considerations.

Outcomes : By the end of the course, Student would able to,

1. Identify and assess practical parameters in the study domain.
2. Criticize and evaluate the research work.
3. Write Proposal/Report.

Lab III :

The oral exam for Lab –III should be based on completion of assignments/review of technical documentaries/review of case studies / research paper review/failure case studies/observation and group discussion on case studies/applications confined to the course.

The file will consist of --

i.	Determination of natural frequencies of metal frames using Horizontal Shake Table
ii.	Determination of natural frequencies of metal frames using Vertical Shake Table
iii.	One Assignment each on every unit (total 6 assignments). (3-4 questions in each assignment)
iv.	A brief five page report on each hand's on as described in the respective units. (total six hands on short reports)
v.	Technical review and critique of a research article/paper on any topic from the refereed journal paper related to the course content.

Lab IV (Advanced Design of Steel Structures) (CVPB12186)

Teaching Scheme

Credits : 2
Lecture : NA
Practical: 4 hrs./week
Tutorial : NA

Examination Scheme

Formative Assessment: 50 Marks
Summative Assessment: 50Marks

Objectives :

- To prepare students for practice and hands on assignments on the course works.
- Introduce the students to independent thinking.
- Exposure to practical considerations.

Outcomes :

By the end of the course, student will be able to:

1. Identify and assess the practical parameters in the study domain.
2. Criticize and evaluate the research work.
3. Demonstrate use of software for analysis of various steel structures
4. Prepare professional proposal along-with detailed drawings and report writing.

Lab IV :

The oral exam for Lab –IV should be based on completion of assignments/review of technical documentaries/review of case studies/research paper review/failure case studies/observation and group discussion on case studies/applications confined to the course.

The file will consist of --

i.	One Assignment each on every unit (total 6 assignments). (3-4 questions in each assignment)
ii.	Technical review and critique of a research article/paper on any topic from the refereed journal paper related to the course content.
iii.	Software applications of any two of following cases using either STAAD-Pro / Ansys / Etabs / SAP a) Hoarding structures b) Microwave / Transmission tower structures c) Tubular Structures
iv.	Prepare Professional Bidding proposal with detail drawings and specifications of any one topic from (iii)- (a), (b) & (c).

Mini Project (CVPB12187)

Teaching Scheme
Credits : 2
Lecture : NA
Practical: 4 hrs./week
Tutorial : NA

Examination Scheme
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

Course Objectives:

- To enable the students to apply fundamental knowledge for understanding state of the art information about any topic relevant to curriculum
- To enhance communication skills of the students

Course Outcomes: By the end of the course, the students will be able to

1. Demonstrate a solution to the problem selected.
2. Demonstrate an ability to present and defend their research work to a panel of experts

Seminar/Mini Project shall be on any topic of student's own choice approved by the faculty. The continuous evaluation will be based on the continuous work of the student to achieve set objectives, technical contents of the topic to assess understanding of the student about the same. Students should prepare a power point presentation for its delivery in 15 minutes. The student should submit duly certified spiral bound report having the following contents.

- Introduction
- Literature Survey
- Theoretical contents/fundamental topics
- Relevance to the present national and global scenario (if relevant)
- Merits and Demerits
- Field Applications / case studies / Experimental work / software application / Benefit cost/ feasibility studies
- Conclusions
- References

A. Report shall be typed on A4 size paper with line spacing 1.5 on one side of paper.
Left Margin : - 25 mm
Right Margin : - 25 mm
Top Margin : - 25 mm
Bottom Margin : - 25 mm
B. Size of Letters
Chapter Number: - 12 font size in Capital Bold Letters- Times New Roman
Chapter Name: - 12 Font size in Capital Bold Letters- Times New Roman
Main Titles (1.1, 3.4 etc):- 12 Font size in Bold Letters- Sentence case. Times New Roman
Sub Titles (1.1.4, 2.5.3 etc):- 12 Font size in Bold Letters-Sentence case. Times New Roman
All other matter: - 12 Font size sentence case. Times New Roman
C. No blank sheet be left in the report
D. Figure name: - 12 Font size in sentence case-Below the figure.
E. Table title -12 Font size in sentence case-Above the table.

Continuous Evaluation: Will be monitored by the respective guides.

Summative Assessment: An oral presentation of the mini project will be held at the end of semester