Maratha Vidya Prasarak Samaj's

Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering

An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune

Udoji Maratha Boarding Campus, Gangapur Road, Nashik - 422 013, Maharashtra, India

Syllabus of Post-Graduate Program

First Year M.Tech. Civil Engineering (Structural Engineering)

(2024 Pattern)

As per NEP 2020

Academic Year 2025-26

(Copy for Student Circulation Only)

First Year M.Tech. Civil Engineering (Structural Engineering)

Curriculum Structure (2024 Pattern) Semester - I

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
210101	**PCC-1**	Design of Prestressed Concrete Structures	3	2	-	50	50	50	-	-	**150**	3	1	-	**4**
210102	**PCC-2**	Advanced Solid Mechanics	3	-	-	50	50	-	-	-	**100**	3	-	-	**3**
210103	**PCC-3**	Structural Dynamics and Earth Quake Engineering	3	-	-	50	50	-	-	-	**100**	3	-	-	**3**
201104	**MLC**	Research Methodologies and IPR@	4	-	-	50	50	-	-	-	**100**	4	-	-	**4**
210105X	**PEC-I**	Elective-I*	4	2	-	50	50	25	-	-	**125**	4	1	-	**5**
210106	**VSEC- I**	Skill Development Laboratory – I	-	2	-	-	-	25	-	-	**25**	-	1	-	**1**
Total			**17**	**06**	**-**	**250**	**250**	**100**	**-**	**-**	**600**	**17**	**03**	**-**	**20**

Abbreviations: **TH:** Theory **PR:** Practical **TU:** Tutorial **CCE:** Continuous Concrete Evaluation
ESE: End-Semester Examination **TW:** Term Work **OR:** Oral **TOT:** Total

@ common to all branches

First Year M.Tech. Civil Engineering (Structural Engineering)

Curriculum Structure (2024 Pattern) Semester - II

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
210201	PCC-4	Finite Element Methods	4	-	-	50	50	-	-	-	100	4	-	-	4
210202	PCC-5	Design Prefab and Pre-engineering Building	3	2	-	50	50	25	-	25	150	3	1	-	4
210203	PCC-6	Structural Audit and Retrofitting	4	-	-	50	50	-	-	-	100	4	-	-	4
210204X	PEC-II	Elective-II**	4	2	-	50	50	25	-	-	125	4	1	-	5
210205	VSEC- II	Skill Development Laboratory – II	-	2	-	-	-	25	-	-	25	-	1	-	1
210206	ELC -I	Seminar	-	4	-	-	-	50	-	50	100	-	2	-	2
Total			15	10	-	200	200	125	-	75	600	15	05	-	20

Abbreviations: **TH:** Theory **PR:** Practical **TU:** Tutorial **CCE:** Continuous Concrete Evaluation
ESE: End-Semester Examination **TW:** Term Work **OR:** Oral **TOT:** Total

Second Year M.Tech. Civil Engineering (Structural Engineering)

Curriculum Structure (2024 Pattern) Semester - III

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
210301	**SBC-I**	Dissertation Phase -I	-	20	-	-	-	100	-	100	**200**	-	10	-	**10**
210302	**ELC-II**	Research Seminar	-	8	-	-	-	50	-	50	**100**	-	4	-	**4**
210303	**SLC**	MOOC Courses	-	4	-	-	-	50	-	-	**50**	-	2	-	**2**
210304	**OJT**	Internship / On-Job Training	-	8	-	-	-	100	-	50	**150**	-	4	-	**4**
Total			**-**	**40**	**-**	**-**	**-**	**300**	**-**	**200**	**500**	**-**	**20**	**-**	**20**

Abbreviations: **TH:** Theory **PR:** Practical **TU:** Tutorial **CCE:** Continuous Concrete Evaluation
ESE: End-Semester Examination **TW:** Term Work **OR:** Oral **TOT:** Total

Second Year M.Tech. Civil Engineering (Structural Engineering)

Curriculum Structure (2024 Pattern) Semester - IV

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
210401	**SBC-II**	Dissertation Phase -II	-	40	-	-	-	200	-	100	**300**	-	20	-	**20**
Total			**-**	**40**	**-**	**-**	**-**	**200**	**-**	**100**	**300**	**-**	**20**	**-**	**20**

Abbreviations: **TH:** Theory **PR:** Practical **TU:** Tutorial **CCE:** Continuous Concrete Evaluation
ESE: End-Semester Examination **TW:** Term Work **OR:** Oral **TOT:** Total

Program Elective Course - I and II

Course Code	* Elective -I	Course Code	** Elective -II
210105A	Advanced Design of RCC Structure	**210204A**	Advanced Design of Steel Structures
210105B	Design of High-Rise Structures	**210204B**	Design of Bridges and Flyover
210105C	Advanced Foundation Engineering	**210204C**	Soil Structure Interaction
210105D	Theory of Elasticity and Plasticity	**210204D**	Advanced Concrete Technology
210105E	Design of Formwork	**210204E**	Theory of Plates and Shells

Course Code	Skill Development Laboratory – I	Course Code	Skill Development Laboratory – II
210106	Software Skills	**210205**	Oral and Written Communication

List of Abbreviations Used with Percentage of Credits

Abbreviations	Course Type	Number of Courses	Credits	% of Credits
PCC	Program Core Course	06	21	25.0
PEC	Program Elective Course	02	08	10.0
PLC	Program Laboratory Course	04	04	5.0
ELC	Experiential Learning Course	02	06	7.5
MLC	Mandatory Learning Course	01	04	5.0
VSEC	Vocational and Skill Enhancement Course	02	02	2.5
SBC	Skill Based Course	02	30	37.5
SLC	Self-Learning Course	02	06	7.5
Total		**21**	**80**	**100%**

- **Summary of Credits and Total Marks:**

Semester	Credits	Marks
I	20	600
II	20	600
III	20	500
IV	20	300
Total	**80**	**2000**

• Definition of Credit :

The Post Graduate (P.G.) programmes will have credit system. The details of credit will be as follow.

1 Credit = 1 hour/week for lecture
= 2 hours/week for practical
= 1 hour/week for tutorial

Semester – I

Course Code: 210101		Course Name: Design of Prestressed Concrete Structures
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE :** 50 Marks **ESE :** 50 Marks **TW :** 50 Marks

Prerequisite Courses:

- Engineering Mechanics, Mechanics of Structures, Design of RCC structures.

Course Objectives:

- To introduce the students to the basic concepts and principles of prestressed concrete structures.
- Develop an insight into the behavior of prestressed concrete structural members both at service loads and overloads.
- To understand the applications of precast prestressed components in civil infrastructure.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Know system and components of prestressed members.

CO2: Determine the stresses and various losses in prestressed concrete members.

CO3: Design the prestressed concrete structures.

CO4: Design the prestressed concrete slab.

CO5: Design the prestressed concrete flat slab.

Course Contents

UNIT-I: Prestressing Systems, Material Properties and Composite Sections 08 Hours

Basic concept, early attempts of prestressing, brief history, development of building materials, definitions, advantages of prestressing, limitations of prestressing, types of prestressing, prestressing systems and devices, introduction of composite sections of prestressed concrete beam and cast in-situ RC slab.

UNIT-IIAnalysis of Prestressed Members and Losses in Prestress 08 Hours

Analysis of prestressed concrete member, stress calculations and concept of cable profile and losses in prestressed concrete long-term losses (creep, shrinkage, relaxation).

UNIT-III: Design of Determinate Beam 08 Hours

Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure and shear including end block, design and detailing of anchorage zones, using bursting tension concept.

UNIT-IV: Design of Slab 08 Hours

Design of one way and two way post tensioned slabs, design of prestressed two way flat slab by direct design method.

UNIT-V: Statically Indeterminate PSC Beams 08 Hours

Analysis and design of two span continuous beams, choice of cable profile, linear transformation and concordance, conceptual design of box girder segmental construction and prestressing.

Learning Resources:

Text Books:

1. Advanced Design of Structures, Krishnaraju, Mc Graw Hill.
2. Prestressed Concrete, N. Krishna Raju, Tata Mc Graw Hill Publication Co.
3. Earthquake Resistant Design of Structures, Agarwal and Shrikhande, PHI learning.

Reference Books:

1. Prestressed Concrete: A Fundamental Approach, Edward Nawy, PHI
2. Design of Prestressed Concrete Structures, T Y Lin and N H Burns.

Web link for MOOC / NPTEL Links:

1. https://archive.nptel.ac.in/courses/105/106/105106118/
2. https://nptel.ac.in/courses/105106117

Indian Standards:

1. IS: 1343: 2012 Indian Standard Code of Practice for Prestressed Concrete, Bureau of Indian Standard, New Delhi.
2. IS: 456: Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standard, New Delhi.
3. IS: 1893: Indian Standard Code of Practice for Criteria for Earthquake Resistant Design ff Structures, Bureau of Indian Standard, New Delhi.
4. IS 13920: 2016 Reaffirmed in 2021, Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice (First Revision), Bureau of Indian Standards, New Delhi.

List of Assignments

1. Study and Comparative Report on Prestressing Systems and Materials
2. Analytical Study on Cable Profiles and Prestress Losses.
3. Flexural and Shear Design of PSC Beam.
4. Design of One-way and Two-way Post-tensioned Slabs.

5. Software-Aided Analysis and Design of Two-Span PSC Beam.
6. Field visit to study drawing & execution of post-tension beam and box girder.

Course Code: 210102	Course Name: Advanced Solid Mechanics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE : 50 Marks** **ESE : 50 Marks**

Prerequisite Courses:

- Engineering Mechanics, Mechanics of Structures.

Course Objectives:

- An objective of this course is to learn principles of analysis of stress and strain.
- To predict the stress-strain behavior of continuum.
- To evaluate the stress and strain parameters and their inter relations of the continuum

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze the stresses and strains under different loading and boundary conditions using fundamental principles of elasticity.

CO2: Interpret and differentiate the behavior of isotropic and orthotropic materials under plane stress and plane strain conditions.

CO3: Formulate and solve problems involving plane stress and strain using equilibrium equations, compatibility conditions, and constitutive relationships.

CO4: Apply analytical solutions such as Kirsch's, Michell's, Flamant's, and Lame's problems to real-world stress analysis in engineering components.

CO5: Analyze curved structural elements such as circular arcs, ring beams, and crane hooks using relevant elasticity theories and structural mechanics concepts.

Course Contents

UNIT-I: Analysis of Stresses and Strains **08 Hours**

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, Relations between Elastic Constants, Problems on Navier Lame's Equilibrium Equations, Problems on Beltrami-Michell compatibility equations, Boundary value problems in Elasticity.

UNIT-II: Stress-Strain Relationship **08 Hours**

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. Principal stresses and strains, maximum principal stress, maximum shear stress, maximum distortion energy (von mises).

UNIT-III: Polar Coordinate System 08 Hours

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.

UNIT-IV: Stress Concentration Problems 08 Hours

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), Axisymmetric Problems such as stresses in thick cylinders subjected to internal and external uniformly distributed pressures (Lame's Problem).

UNIT-V: Beams Curved in Plan and Elevation 08 Hours

Analysis of beams curved in plan such as cantilever circular arc, semicircular beams fixed at two ends and subjected to central concentrated load, simply supported semicircular beam subjected to UDL supported on three equally spaced columns, analysis of circular ring beam. Analysis of beams curved in elevation, application to curved circular and elliptical rings and crane hooks.

Learning Resources:

Text Books:

1. Swaroop Adarsh---Mechanics of Materials, New Age International Publishers.
2. S. Crandall, N. Dahl and T. Lardner - Mechanics of Solids, McGraw Hill Publications.
3. S. S. Bhavikatti – Structural Analysis-II Vikas Publishing House, Pvt Ltd.
4. Enrico Volterra and J. H. Gaines – Advanced Strength of Materials, Prentice Hall.
5. Nautiyal, B.D.--Introduction to Structural Analysis, New Age International Publishers.
6. S M A Kazimi – Solid Mechanics, Tata McGraw-Hill Publications.
7. Irving Shames, Mechanics of deformable solids, Prentice Hall 8. Scholer, Elasticity in Engineering, McGraw-Hill Publications.
8. Sadhu Singh – Theory of Elasticity, Khanna Publishers.
9. L.S. Sreenath – Advanced Mechanics of Solids, Tata McGraw-Hill Publications.
10. N. K. Bairagi- Advanced Solid Mechanics- Khanna Publishers, New Delhi.
11. Timoshenko and Goodier - Theory of Elasticity, McGraw-Hill Publications.
12. Wang - Applied Elasticity, Dover Publications.

13. Dr. Kumar Niraj Jha, Formwork for Concrete Structures, McGraw Hill Publication.

Reference Books:

1. Arthur P. Boresi and Richard J. Schmidt - Advanced Mechanics of Materials
2. Timoshenko and Goodier -Theory of Elasticity
3. David J. Nash -Applied Solid Mechanics. .

Weblink for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/105106049

Course Code: 210103	Course Name: Structural Dynamics and Earthquake Engineering.	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE : 50 Marks** **ESE : 50 Marks**

Prerequisite Courses:

- Engineering Mechanics, Structural Analysis, Advanced Mathematics.

Course Objectives:

- To understand dynamic behavior of structures subjected to various dynamic loads including earthquakes.
- To analyze single and multi-degree of freedom systems under dynamic excitation.
- To apply seismic design codes and ductile detailing for earthquake-resistant structures.
- To use software tools for modeling, analysis, and design of structures under seismic loads.
- To integrate sustainability, resilience, and lifecycle concepts in earthquake engineering.

Course Outcomes:

After successful completion of the course, the learner will be able to:

CO1: Understand principles of structural dynamics and develop equations of motion.

CO2: Analyze SDOF and MDOF systems subjected to dynamic loading.

CO3: Evaluate structural responses under earthquake ground motions using response spectra.

CO4: Design earthquake-resistant buildings using IS 1893 and IS 13920.

CO5: Use software for dynamic analysis and develop sustainable earthquake-resistant designs. Integrate seismic resilience and SDGs in disaster risk reduction and structural planning.

Course Content:

UNIT-I: Introduction to Structural Dynamics **08 Hours**

Dynamic loads: wind, blast, earthquake, D'Alembert's principle, types of damping, SDOF systems: free and forced vibration, resonance, Energy methods and damping characteristics.

UNIT-II: Multi-Degree of Freedom (MDOF) Systems **08 Hours**

Matrix formulation of Multi-Degree of Freedom (MDOF) systems, Mode shapes and natural frequencies, Modal superposition technique, Numerical methods for solving equations of motion.

UNIT-III: Earthquake Ground Motion and Seismic Response 08 Hours

Seismic sources, faults, and wave propagation, site response and soil-structure interaction response spectra and design spectrum, time-history, and frequency domain analysis.

UNIT-IV: Codal Provisions and Earthquake-Resistant Design 08 Hours

IS 1893:2016 seismic analysis procedures, IS 13920:2016 ductile detailing of RC structures

Base shear calculation, lateral load distribution Design of shear walls, torsional irregularities, soft storey.

UNIT-V: Software Applications and Sustainability Integration 08 Hours

Modeling & analysis using ETABS, SAP2000, STAAD.Pro, Introduction to Open Sees for nonlinear dynamic analysis with base isolation, energy dissipation systems, and pushover analysis. Seismic vulnerability assessment and retrofitting, Resilient cities, lifecycle design, and disaster mitigation.

Learning Resources:

Text Books:

1. Chopra, A.K., Dynamics of Structures, Pearson Education.
2. Clough & Penzien, Dynamics of Structures, McGraw-Hill.
3. S.K. Duggal, Earthquake Resistant Design of Structures, Oxford University Press.

Reference Books:

1. IS 1893 (Part 1): 2016 – Criteria for Earthquake-Resistant Design of Structures
2. IS 13920: 2016 – Ductile Detailing of RC Structures
3. Eurocode 8 – Design of Structures for Earthquake Resistance
4. Paulay & Priestley – Seismic Design of Reinforced Concrete and Masonry Buildings.

Web link for MOOC / NPTEL Links:

1. NPTEL Course: https://nptel.ac.in/courses/105101004
2. NPTEL Course: https://nptel.ac.in/courses/105108069
3. MOOC (edX): Earthquake Engineering for Developing Countries – https://www.edx.org
4. Coursera: Seismic Design and Risk Assessment – https://www.coursera.org
5. NICEE (IIT Kanpur): https://www.nicee.org
6. Earthquake Engineering Research Institute (EERI): https://www.eeri.org
7. IAEE – International Association for Earthquake Engineering: https://www.iaee.or.jp

Software Tools:

1. ETABS – Earthquake load simulation and design

2. SAP2000 – Time history & response spectrum analysis
3. STAAD.Pro – Modal and dynamic load analysis
4. OpenSees – Advanced dynamic simulation
5. GIS + HAZUS – Seismic risk mapping and resilience planning

List of Assignments

1. Model and analyze an SDOF system subjected to harmonic loading. Study damping effects and resonance.
2. Perform modal analysis of a 3-storey building frame using hand calculations and verify with software
3. Use IS 1893 (Part 1): 2016 to generate design response spectra and apply it to a real building.
4. Assess an existing building's seismic vulnerability and propose sustainable retrofitting techniques
5. Simulate earthquake loading on a building using OpenSees or ETABS and analyze lifecycle performance.

Course Code: 201104	Course Name: Research Methodology and IPR	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week	**4**	**CCE : 50 Marks** **ESE : 50 Marks**

Prerequisite Courses:

- Students should complete undergraduate courses in engineering/technology.

Course Objectives:

- To provide an overview of the research problem and describe the functions of literature survey in research.
- To explain the statistical and probability analysis.
- To explain the art of writing research reports and papers.
- To understand the patenting process and its commercial aspects.
- To explain patent rights and new developments in IPR.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand research problem formulation, approaches of investigation of solutions for research problems and literature survey.

CO2: Apply the principles of statistics and probability analysis in research.

CO3: Acquire skills in research proposal/paper writing.

CO4: Discover the importance of IPR.

CO5: Understand patent rights and new developments in IPR.

Course Content:

UNIT-I: Research Problem and Literature Survey 11 Hours

Research Problem: Meaning of research problem, sources of research problem, characteristics of a good research problem, and errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problems, data collection, benchmarking, analysis, interpretation

Literature survey: Effective literature studies approaches, analysis, Plagiarism, its importance and software's, research ethics, research gap, writing objectives of research studies.

UNIT-II: Statistics and Probability Analysis 10 Hours

Statistical Analysis: Introduction, Sources of error and uncertainty, One-Dimensional Statistics:

combining errors and uncertainties, t-test, ANOVA statistics.

Probability Analysis: Classical and empirical probability, axioms of probability, conditional probability, Bayes' rule, law of total probability and law of total expectation.

UNIT-III: Technical Writing **11 Hours**

Characteristics of effective technical writing, developing a Research proposal, format of the research proposal, financial heads of the research project, research paper writing, abstracting and indexing of journals, impact factor, h index, research paper submission and review process, writing responses to reviewer's comments, Publications.

UNIT-IV: Intellectual Property **10 Hours**

Patents, designs, trade and copyright, the process of filing patents, designs, trade and copyright, examination, examination report, writing responses to the examination report, patent grant, commercialization, patenting under PCT and its advantages, case studies.

UNIT-V: Patent Rights and New Developments in IPR **10 Hours**

Scope of patent rights, Licensing and transfer of technology, patent information and databases, geographical Indications. Administration of patent system, new developments in IPR, IPR of biological systems, computer software etc.

Learning Resources:

1. Research Methodology: Methods and Trends, by Dr. C. R. Kothari.
2. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville.
3. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition.
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd.
5. Mayall, Industrial Design, McGraw Hill.
6. Niebel, Product Design, McGraw Hill.
7. T. Ramappa, Intellectual Property Rights under WTO, S. Chand.
8. Paul L. Meyer, Introductory probability and statistical applications, Addison-Wesley Publishing Company, 1970.

Web link for MOOC / NPTEL Links:

1. www.ipindia.gov.in
2. www.nptel.ac.in/courses/121106007

Course Code: 210105A	Course Name: Advanced Design of Steel Structures	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical :** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Engineering Mechanics, Structural Analysis, Design of Steel Structures.

Course Objectives:

- To impart advanced knowledge of structural steel design under complex loading and support conditions.
- To ensure comprehensive understanding of limit state and plastic design philosophies.
- To promote design practices that contribute to sustainability, efficiency, and resilience.
- To integrate modern design tools and global standards (IS, AISC, Eurocode) in advanced structural steel systems.
- To address sustainability principles and SDG-aligned engineering practice.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Design of tension, compression, and flexural members using IS 800:2007.

CO2: Apply design strategies to prevent structural buckling and failure by integrating principles of stability, slenderness, and critical load analysis.

CO3: Design of bolted and welded connections using practical detailing considerations.

CO4: Design industrial structures such as trusses, portal frames, gantry girders, and plate girders for functional and sustainable performance.

CO5: Utilize software tools for analysis and detailing, integrating sustainable and BIM-based practices.

Course Contents

UNIT-I: Introduction to Advanced Steel Design and Limit States 11 Hours

Review of Limit State Design (IS 800:2007), Classification of cross-sections, Design of tension and compression members, Slenderness limits and effective length, Sustainability in material selection (recycled/low-carbon steel).

UNIT-II: Flexural Members and Stability Design 11 Hours

Design of laterally supported/unsupported beams, lateral-torsional buckling, built-up members and stiffeners, plastic analysis: shape factors, collapse mechanisms, structural optimization for sustainability.

UNIT-III: Advanced Design of Connections 10 Hours

Rigid, semi-rigid, pinned connections, design of bolted and welded connections, moment-resisting connections, software-aided detailing (BIM).

UNIT-IV: Industrial Structures and Special Steel Systems 10 Hours

Design of trusses, portal frames, bracings, Gantry girders and fatigue considerations, plate girders: shear buckling and stiffeners, lifecycle assessment in structural steel design, design of chimney and transmission towers.

UNIT-V: Software Tools and Sustainable Design Practice 10 Hours

STAAD.Pro and ETABS modeling and design, Tekla Structures & IDEA StatiCa for detailing Case study of sustainable steel building, ISO 14040 and LCA, LEED/IGBC for steel design.

Learning Resources:

Text Books:

1. Subramanian, N. – Design of Steel Structures, Oxford University Press.
2. Duggal, S.K. – Limit State Design of Steel Structures, McGraw Hill.
3. Sinha, S. K. – Sustainable Construction Materials and Technologies, Elsevier.

Reference Books:

1. Salmon, C.G., Johnson, J.E. – Steel Structures: Design and Behavior, Pearson.
2. AISC Manual of Steel Construction, AISC.
3. IS 800:2007 – General Construction in Steel – Code of Practice, BIS.
4. IS 875 (Parts 1 to 5) – Loading Standards, BIS.
5. LEED Green Building Design Guide, USGBC.
6. Eurocode 3 (EN 1993) – Design of Steel Structures.

Weblink for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/105105113
2. https://nptel.ac.in/courses/105106118
3. https://nptel.ac.in/courses/105105162
4. https://nptel.ac.in/courses/105105248
5. https://www.edx.org/course/structural-steel-design
6. https://www.coursera.org/learn/structural-steel
7. https://www.udemy.com/course/staadpro-structural-analysis-and-design-of-building/

List of Assignments:

1. **Assignment 1: Structural Member Design Using IS 800:2007**

   Objective: Design tension and compression members using IS 800:2007

   Classify cross-sections for given steel profiles. Design a tension and a compression member for a specified load and length. Check slenderness limits and effective length. Justify material selection based on sustainability (e.g., recycled steel).

   Deliverable: Design report with hand calculations, IS code references, and sustainability rationale.

2. **Assignment 2: Flexural Member Analysis and Plastic Design**

   Objective: Analyze and design a laterally unsupported beam with LTB and plastic design principles,

   Design an I-section beam subjected to bending (with and without lateral restraint). Calculate lateral-torsional buckling capacity. Perform plastic analysis to determine collapse mechanism and shape factor. Propose weight optimization strategies.

   Deliverable: Design calculations, LTB analysis, plastic mechanism diagrams, optimization proposal.

3. **Assignment 3: Steel Connection Design and BIM Detailing**

   Objective: Design bolted and welded steel connections using software tools

   Design a bolted beam-to-column connection and a welded base plate. Model the connection in Tekla Structures or IDEA StatiCa. Classify connection type (rigid/semi-rigid). Include detailing (bolt layout, weld size, edge distances).

   Deliverable: Design sheets, connection models, exported detail drawings (PDF or screenshots)

4. **Assignment 4: Analysis and Design of Industrial Frame Structure**

   Objective: Design a steel portal frame or truss using STAAD.Pro or ETABS

   Model a 2D/3D portal frame or roof truss. Apply DL, LL, WL as per IS 875. Design key members and connections (manually or software-assisted). Consider fatigue if dynamic or cyclic loads are given.

   Deliverable: Model file, output reports, member design sheets, and sustainability review (LCA snapshot or embodied carbon estimate).

5. **Assignment 5: Case Study – Sustainable Steel Building Design**

   Objective: Conduct a case study on a real or hypothetical green steel building

   Select a steel structure (real or conceptual). Perform lifecycle assessment using ISO 14040 principles. Analyze steel selection based on embodied carbon and recyclability. Map the project to LEED or IGBC criteria. Suggest sustainable design improvements.

   Deliverable: PPT presentation + written report with case study insights, LCA summary, and certification alignment.

Course Code: 210105B	Course Name: Design of High-Rise Structures	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical :** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Engineering Mechanics, Mechanics of Structures, Design of steel and R.C.C. structures.

Course Objectives:

- To equip students with the knowledge and skills necessary for the structural analysis and design of high-rise buildings.
- To integrate of contemporary materials, construction techniques, and safety considerations in compliance with relevant codes and standards.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Describe the development of tall building structure including loading and other serviceability parameters.

CO2: Discuss about various types of loads, combinations and its influence on tall buildings.

CO3: Demonstrate various types of structural forms and its application.

CO4: Modelling for analysis of Rigid frame building structure.

CO5: Analyse shear wall system, wall frame system of tall building.

Course Contents

UNIT-I: Tall Buildings **11 Hours**

Introduction, factors affecting growth, height and structural form, tall building structure: philosophy, design criteria: design process, design philosophy, loading, strength and stability, stiffness and drift limitations, human comfort criteria, creep, shrinkage and temperature effects, fire, foundation settlement and soil-structure interaction.

UNIT-II: Loading of Tall Buildings **11 Hours**

Introduction, gravity loading including live load and its reduction, Impact load due to elevators, Construction loads. Wind loading, load combinations as per BIS-methods of design, wind tunnel testing concepts and load testing protocols.

UNIT-III: Structural Form **10 Hours**

Introduction, braced frame structures, rigid frame structures, in-filled frame structures, flat plate and flat slab structures, shear wall structures including coupled walls, dual structures (wall frame structures), framed-tube structures, outrigger-braced structures, suspended structures, core structures, space structures, hybrid structures, diagrid and outrigger systems and different R.C. floor systems.

UNIT-IV: Modelling for Analysis **10 Hours**

Introduction, approaches to analysis, assumptions, high-rise behavior, modeling for approximate analysis, modeling for accurate analysis, P-Delta effects, wide column, deep beam analogies, foundation soil structure interaction in tall structures, etc.

UNIT-V: Rigid Frame Structures **10 Hours**

Introduction, rigid frame behavior, approximate determination of member forces caused by gravity loading, approximate analysis of member forces caused by horizontal loading, approximate analysis for drift, computer analysis of rigid frames (only for practice and not included in exam).

Learning Resources:

Text Books:

1. Taranath, B.S. (2016), Structural Analysis and Design of Tall Buildings: Steel and Composite Construction, CRC Press.
2. Smith, B.S. and Coull, A. (1991), Tall Building Structures: Analysis and Design, Wiley.

Reference Books:

1. Lynn Beedle (Ed.), Advances in Tall Buildings, CBS Publishers.
2. Bryan Stafford Smith & Alex Coull, Tall Building Structures: Analysis and Design, Wiley-Interscience.
3. IS Codes: IS 875 (Part 3), IS 1893 (Part 1), IS 456, IS 800, NBC .

Weblink for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/105106205
2. https://www.edx.org/course/seismic-design-of-buildings
3. https://nptel.ac.in/courses/105108123

List of Practicals:

1. Load combination workshop using IS codes.
2. Drift and deflection analysis using ETABS.
3. Diaphragm action simulation.
4. Foundation system case study.
5. P-Δ effect and stability analysis.

Course Code: 210105C	Course Name: Advanced Foundation Engineering	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical :** 2 Hours/Week	**4** **1**	**CCE** : 50 Marks **ESE** : 50 Marks **TW** : 25 Marks

Prerequisite Courses:

- Fundamentals Soil Mechanics, Mathematics, Engineering Mechanics, Fluid Mechanics.

Course Objectives:

- The objectives are to equip the student with the knowledge of how to explore the soil, design the foundations for different conditions and check the stability of structures.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Identify a suitable foundation system for a structure.

CO2: Evaluate the importance soil structure interaction.

CO3: Analyze and design raft foundations.

CO4: Analyze and design pile foundations.

CO5: Analyze and design of retaining wall.

Course Contents

UNIT-I: Sub–Soil Investigation and Sampling 11 Hours

Introduction, methods of exploration, methods of boring, soil samples, soil samplers and sampling, number and disposition of trial pits and borings, depth of exploration, ground water observations, field test, laboratory tests, plate load test, Penetrometer tests, geophysical methods.

UNIT-II: Soil Structure Interaction 11 Hours

Foundation objectives and their importance, classification of foundations, soil classification. Geotechnical design parameters, bearing capacity, settlements and factors affecting settlement. Loads for design, parameters for design of foundation on various types of soil, soil structure interaction. Concept of foundations; types of foundations and their applicability; general requirements of foundations; location and depth of foundation, bearing capacity & settlement methods for bearing capacity estimation, total and differential settlements of footing and raft, code provisions. Design of individual footings, strip footing, combined footing.

UNIT-III: Design of Raft Foundations **10 Hours**

Types of rafts, design of flat slab raft foundation. Design of beam and slab raft foundation.

UNIT-IV: Pile Foundations **10 Hours**

Estimation load carrying capacity of single and pile group under various loading conditions. Pile load testing (static, dynamic methods and data interpretation), settlement of pile foundation, code provisions, design of single pile and pile groups and pile caps Well Foundations. Types, components, construction methods, design methods (Terzaghi, IS and IRC approaches), check for stability, base pressure, side pressure and deflection.

UNIT-V: Lateral Earth Pressure & Retaining Walls **10 Hours**

Introduction, effect of wall movement on Earth pressure, Earth pressure at rest; Rankine's theory of Earth pressure; Coulomb's theory of earth pressure; Culmann's graphical method for active earth pressure, types of retaining walls, design of cantilever retaining wall.

Learning Resources:

Text Books:

1. Manoj Datta, Shashi K Gulhati, Geotechnical Engineering, Tata McGraw – Hill Education (2005)
2. K.R. Arora, Soil Mechanics and Foundation Engineering, 7th ed., Standard Publishers and Distributors, Delhi, 2009.
3. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Soil Mechanics and Foundation, 16th ed., Laxmi Publications Pvt. Ltd., New Delhi, 2005.
4. Dass, B.M, Principles of Geotechnical Engineering, 5th ed., Thompson books, Singapore, 2002.
5. P. Srinivasalu, C. V. Vaidyanathan, Handbook of Machine Foundations 1st Ed. Tata McGraw - Hill Education (2004).

Reference Books:

1. B. J. Kasmalkar; Foundation Engineering, 6th ed., Pune Vidyarthi Griha Prakashan, Pune, 1989.
2. Bowles, J.E., Foundation Analysis and Design, 4th ed., McGraw-Hill Publishing company, Newyork, 1988.

Weblink for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/105105039
2. https://nptel.ac.in/courses/105108069

List of Practicals:

1. Comparative study of soil exploration techniques and field testing.
2. Design and analysis of shallow foundations considering soil-structure interaction.
3. Raft foundation design for a multi-storey commercial building.
4. Load capacity and settlement analysis of pile foundations.
5. Earth pressure calculations and retaining wall design.
6. Site visit to study drawing and detailing of Raft and pile foundation work.

Course Code: 210105D	Course Name: Theory of Elasticity and Plasticity	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical :** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Advanced Strength of Materials, Engineering Mathematics / Applied Mathematics, Basic Structural Analysis, Basics of Finite Element Method.

Course Objectives:

- To provide a strong theoretical foundation in elasticity and plasticity for structural materials.
- To develop mathematical formulations and analytical skills for solving problems involving complex stress states and deformations.
- To equip students with the ability to analyze structural components and materials under elastic and plastic conditions.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Understand fundamental assumptions, equations, and boundary conditions in the theory of elasticity for 2D and 3D bodies.

CO2: Apply Airy's stress function and plane stress/strain concepts to solve practical elasticity problems.

CO3: Use complex variable methods and torsion theory to solve advanced structural problems.

CO4: Analyze the behavior of materials under plastic deformation using yield criteria and plastic flow rules.

CO5: Conduct plastic analysis and compute ultimate load capacities of structural components.

Course Contents

UNIT-I: Theory of Elasticity **11 Hours**

Stress and strain tensors in 2D and 3D, notations, sign conventions, generalized Hooke's Law for isotropic and orthotropic materials, strain-displacement relations, compatibility conditions for strain, equilibrium equations in Cartesian and cylindrical coordinates, boundary conditions, Von Mises and Tresca yield criteria.

UNIT-II: Solution Techniques in Elasticity 11 Hours

Airy's stress function and its properties, Biharmonic equations and boundary value problems, plane stress and plane strain assumptions, applications to rectangular beams, circular disks, and thick-walled cylinders, Axisymmetric problems and stress distribution in rotating disks.

UNIT-III: Complex Variables and Torsion 10 Hours

Kolosov-Muskhelishvili complex variable formulation, solution of 2D problems using complex stress functions, stresses around circular and elliptical holes in infinite plates, Saint-Venant's theory of torsion, torsion of circular, elliptical, and non-circular sections, membrane analogy for torsion.

UNIT-IV: Fundamentals of Plasticity 10 Hours

Elastic vs plastic behavior, stress-strain curves for ductile and brittle materials, yield criteria: Von Mises, Tresca, Mohr-Coulomb, plastic flow rules and hardening behavior, plastic stress-strain relations, plastic potential and associated flow rule (normality condition), incremental plasticity and consistency condition.

UNIT-V: Plastic Analysis of Structures 10 Hours

Introduction to limit analysis, theorems of plastic collapse: upper bound and lower bound, formation of plastic hinges in beams and frames, shape factor and load factor, collapse mechanisms in beams, frames, slabs, moment redistribution and design considerations.

Learning Resources:

Text Books:

1. Timoshenko & Goodier, Theory of Elasticity, McGraw-Hill.
2. J. Chakrabarty, Theory of Plasticity, Butterworth-Heinemann.
3. Hill, R., The Mathematical Theory of Plasticity, Oxford University Press.
4. Sadd, M. H., Elasticity: Theory, Applications, and Numerics, Academic Press.

Reference Books:

1. S. P. Timoshenko & J. N. Goodier, Elasticity Theory.
2. Ugural & Fenster, Advanced Strength and Applied Elasticity, Pearson.
3. Chen & Han, Plasticity for Structural Engineers, J. Ross Publishing.

Weblink for MOOC / NPTEL Links:

1. https://archive.nptel.ac.in/courses/105/105/105105177/
2. http://www.digimat.in/nptel/courses/video/105105177/L01.html

List of Practicals:

1. **Stress Transformation in 2D using MATLAB/Python.**

Plotting Mohr's circle and validating theoretical transformations.

2. **Airy's Stress Function in FEM Software (e.g., ANSYS)**

   Solve a beam or plate problem under given boundary conditions.

3. **Torsion Problem Analysis using ANSYS or ABAQUS**

   Compare results for circular vs. non-circular sections.

4. **Yield Surface Visualization using MATLAB**

   Plot and compare Tresca and von Mises yield surfaces in 2D and 3D.

5. **Plastic Hinge Formation in Beams**

   Use load-deflection curves to study moment-curvature behavior.

6. **Collapse Mechanism Analysis**

   Determine the collapse load and shape factor of a beam or frame using limit analysis.

7. **Finite Element Analysis of a Plate with Hole**

   Analyze stress concentration and compare with analytical solutions.

8. **Custom UMAT (User Material) in ABAQUS.**

Course Code: 210105E	Course Name: Design of Formwork	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical :** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Basic of structural analysis, Design of Structures.

Course Objectives:

- To provide a comprehensive understanding of various formwork systems.
- To develop the ability to plan, design, and monitor formwork systems using design principles, preparation of working drawings.
- To analyse formwork behaviour in multi-story construction, focusing on shoring techniques, load distribution, striking time, cycle time, and concrete strength evaluation at early ages.
- To equip students with practical skills for assembling, erecting, inspecting, and maintaining formwork systems.
- To expose students to advanced and special formwork methods and to understand common causes of formwork failures along with preventive safety and design strategies.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Classify various types of formwork systems, including their components, materials, and accessories, and explain their suitability for constructing structural elements such as foundations, walls, columns, slabs, and stairs.

CO2: Apply planning and design principles to develop safe, economical, and efficient formwork systems, including the preparation of working drawings, Bill of Quantities (BOQ), and quality control checklists.

CO3: Analyze the performance and behavior of formwork systems in multi-storey construction, focusing on load transfer mechanisms, shoring strategies, cycle time optimization, and early-age concrete strength assessment.

CO4: Demonstrate the ability to plan, assemble, erect, and inspect formwork systems using suitable equipment and machinery while ensuring compliance with safety regulations and contractual specifications.

CO5: Evaluate and implement specialized formwork techniques for complex structures such as

bridges, tunnels, and precast components, and identify causes of formwork failures with emphasis on design and safety best practices.

Course Contents

UNIT-I: Introduction to Formwork 11 Hours

Formwork classification, benefits, objectives, areas of competitiveness, selection of formwork, formwork materials, accessories and consumables, application of tools. Formwork for foundation, wall, columns, slab and beam. Conventional drawings. Vertical application of conventional foundation formwork, formwork components. Components, assembly and de-shuttering of formwork system, flex system, heavy duty tower system, safety of work, formwork for stairs, load bearing tower.

UNIT-II: Planning and Design of formwork 11 Hours

Formwork planning and monitoring, basics of formwork design, design assumptions and design methods. Design of wall formwork, slab formwork and checks. Formwork drawing concept and preparation guidelines, BOQ calculation and checklist.

UNIT-III: Formwork in Multi-Storey Building Construction 10 Hours

Shoring, reshoring, back shoring and pre-shoring; striking and cycle time; simplified analysis and their assumptions and limitations; load distribution on shores and slabs in multi-story building frames; calculating the strength of the concrete slab at a given point in time.

UNIT-IV: Formwork Building and Erection 10 Hours

Formwork assembly for wall and column panels, equipment and layout, plant and machinery, formwork erection and safety, inspection and corrections, plant and machinery, code and contractual requirements.

UNIT-V: Special formwork, Formwork Failures 10 Hours

Flying formwork: table forms, tunnel formwork, column mounted shoring systems, gang forms, slip formwork, formwork for precast concrete, formwork for bridge structures.

Formwork Failures: Causes, design deficiency, safety in formwork, prevention of formwork failures.

Learning Resources:

Text Books:

1. Hurd, M.K., Formwork for Concrete, 7th Edition, American Concrete Institute, 2005.
2. Robert L. Peurifoy and Garold D. Oberlender, Formwork for Concrete., Structures, 4thEdition, McGraw Hill Professional, 2010

3. Jha, K.N. (2012). Formwork for Concrete Structures (1st ed.). McGraw Hill.
4. Peurifoy, R.L., & Oberlender, G.D. (2011). Formwork for Concrete Structures. McGraw Hill.
5. IS Codes:
   a. IRC 87, Guidelines for the design and erection of falsework for road bridges, The Indian Road Congress, New Delhi, 1984, Reprinted 1996.
   b. IS 456, Plain and reinforced concrete - Code of practice, Bureau of Indian Standards, New Delhi, 2000.
   c. IS 800, General construction in steel - Code of practice, Bureau of Indian Standards, New Delhi, 2007.
   d. IS 875 (Part 1), Code of practice for design loads (other than earthquake) for buildings and structures: Dead loads, Bureau of Indian Standards, New Delhi, 1987, Reaffirmed 2003.
   e. IS 875 (Part 2), Code of practice for design loads (other than earthquake) for buildings and structures: Imposed loads, Bureau of Indian Standards, New Delhi, 1987, Reaffirmed 2003.
   f. IS 875 (Part 3), Code of practice for design loads (other than earthquake) for buildings and structures: Wind loads, Bureau of Indian Standards, New Delhi, 1987, Reaffirmed 2003.
   g. IS 883, (1994), Reaffirmed 2005, Design of Structural Timber in Building- Code of Practice, Bureau of Indian Standards, New Delhi, 1994, Reaffirmed 2005.
   h. IS 1161, Steel tubes for structural purposes - Specification, Bureau of Indian Standards, New Delhi, 1998, Reaffirmed 2003.
   i. IS 4990, Plywood for concrete shuttering work - Specification, Bureau of Indian Standards, New Delhi, 1993, Reaffirmed 2003.
   j. IS 14687, Falsework for concrete structures - Guidelines, Bureau of Indian Standards, New Delhi, 1999, Reaffirmed 2005.

Reference Books:

1. Robinson, J.R. (Library Accn No. 29797). Piers, Abutments, and Formwork for Bridges.
2. Austin, C.K. (1960). Formwork to Concrete. London: Cleaver - Hume Press.
3. Moore, C.E. (1977). Concrete Form Construction. Delmar Cengage Learning

Weblink for MOOC / NPTEL Links:

1. https://digitalskills.iitmpravartak.org.in/course_details.php?courseID=250

List of Assignments:

1. Analysis and design considerations for loads on formwork systems as per is codes.
2. Design and analysis of formwork components for foundations and walls, including proprietary systems.

3. Design and analysis of column formwork systems
4. Design and analysis of beam formwork systems
5. Design and analysis of slab formwork systems
6. Formwork support strategies and load behavior in multi-story construction.
7. Exploration and analysis of special formwork systems in advanced construction.
8. Formwork failures: analysis, design deficiencies, prevention, and safety practices.

Course Code: 210106	Course Name: Skill Development Laboratory – I (Software Skills)	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**TW : 25 Marks**

Prerequisite Courses:

- Engineering Mechanics, Mechanics of Structures, Design of RCC Structures, Design of steel Structures.

Course Objectives:

- To acquire basic design software skills and competency skill.
- To design G+7 structures having minimum area at each floor not less than 350 Sq.m.
- To prepare schedule of structural element and checking at site.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: To handle the any one design software at proficiency level.

CO2: To create the model and apply various loads on structures with reference to Standard codes.

CO3: Design the building.

CO4: Prepare the various reports required for execution and inspection.

Course Contents

ASSIGNMENT-I: 08 Hours

Learn any one software used for design of RC /or steel structures like ETABS/STAAD with BIM integration.

ASSIGNMENT-II 08 Hours

Prepare the model for any structure in software having area more than 350 m^2 at each floor and G + 7 floor.

ASSIGNMENT-III 06 Hours

Apply the various load and analyze the prepared model and apply all necessary checks as per standards.

ASSIGNMENT-IV 06 Hours

Prepare the various report required for execution of work (Structural drawings and schedule with

reinforcement details).

Learning Resources:

Text Books:

1. Design of Reinforced Concrete Structures – N. Subramanian
2. Limit State Design of Steel Structures – S. K. Duggal
3. Reinforced Concrete Design – P. C. Varghese.
4. Design of Steel Structures – N. Subramanian.

Reference Books:

2. Structural Analysis and Design Using STAAD.Pro V8i – G. Sai Krishna Step-by-step guide to modeling and designing using STAAD.
3. ETABS 2016 Black Book – Gaurav Verma Focused on software workflow for modeling, analysis, and design.
4. SAP2000 Integrated Software for Structural Analysis and Design – Prof. K.S. Ramesh Best suited for understanding modeling techniques and result interpretation.
5. Advanced Reinforced Concrete Design – P. C. Varghese Use for deeper understanding of design output validation from software.
6. IS Codes:
   a. IS 456:2000 (RC design)
   b. IS 800:2007 (Steel design)
   c. IS 875 (Loads)
   d. IS 1893:2016 (Earthquake)
   e. IS 13920:2016 (Ductile detailing)

Semester - II

Course Code:210201	Course Name: Finite Element Methods	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week	**4**	**CCE :** 50 Marks **ESE :** 50 Marks

Prerequisite Courses:

- Strength of Materials, Engineering Mathematics Structural Analysis.

Course Objectives:

- To introduce the fundamentals and mathematical formulation of the Finite Element Method, FEM.
- To develop skills in modeling, analyzing, and interpreting the results of structural problems using FEM.
- To apply FEM techniques to solve real-world structural engineering problems involving various elements and boundary conditions.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the foundational concepts and mathematical background of FEM and apply them to basic structural models.

CO2: Apply FEM to 1-D structural elements such as bars and trusses, and interpret results with boundary and loading conditions.

CO3: Model and analyze beam and frame structures using appropriate shape functions and FEM formulation.

CO4: Formulate and analyze 2-D elements for structural problems and implement isoperimetric and numerical integration techniques.

CO5: Analyze axisymmetric and basic plate problems, understand FEM software applications, and interpret real-life structural case studies.

Course Content:

UNIT-I: Introduction to FEM and Basic Concepts **11 Hours**

Historical development and importance of FEM, General steps in FEM analysis, Basic concepts: nodes, elements, degrees of freedom, shape functions, Classification of elements: 1-D, 2-D, 3-D, Principles of virtual work and minimum potential energy, Introduction to weighted residual

methods.

UNIT-II: 1-D Finite Element Analysis 11 Hours

Formulation of stiffness matrix for bar and truss elements, Assembly of global stiffness matrix, Application of boundary conditions, Solution of systems of equations, Problems on axial deformation and temperature effects, Analysis of stepped bars and pin-jointed frames.

UNIT-III: Analysis of Beams and Frames 10 Hours

Beam element formulation using Hermite shape functions, Stiffness matrix for beam and frame elements, Analysis of continuous beams and rigid-jointed frames, Fixed-end moments and distributed loads, Comparison with classical methods, convergence, mesh sensitivity, and error estimation.

UNIT-IV: Two-Dimensional Elements and Isoparametric Formulation 10 Hours

Introduction to plane stress and plane strain problems, CST and LST elements: shape functions and stiffness matrix derivation, concept of isoparametric formulation, Jacobian matrix, numerical integration (Gaussian quadrature), Serendipity and Lagrangian elements.

UNIT-V: Advanced Topics and Applications 10 Hours

Axisymmetric problems and elements, dynamic analysis using FEM, plate bending using FEM, software implementation: pre-processing, meshing, post-processing, Overview of commercial FEM software, Case studies in structural FEM applications.

Learning Resources:

Text Books:

1. J.N. Reddy – An Introduction to the Finite Element Method, McGraw-Hill Education.
2. C.S. Krishnamoorthy – Finite Element Analysis, Tata McGraw-Hill.
3. S.S. Bhavikatti – Finite Element Analysis, New Age International Publishers.
4. Finite Element Method by C S Desai.

Reference Books:

1. T.R. Chandrupatla and A.D. Belegundu – Introduction to Finite Elements in Engineering, Pearson.
2. K.J. Bathe – Finite Element Procedures, Prentice Hall.
3. R.D. Cook, D.S. Malkus, M.E. Plesha – Concepts and Applications of Finite Element Analysis, Wiley.
4. O.C. Zienkiewicz and R.L. Taylor – The Finite Element Method, ElsevierEnergy Conservation Act 2001, Electricity Act 2003.

5. Asghar Bhatti, M., Fundamental Finite Element Analysis and Applications: With Mathematica and Matlab Computations, Wiley, 2005.
6. Cook, R. D., Malkus, D. S., Plesha, M. E., and Witt, R.J., Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley-India, 2007.

Web link for MOOC / NPTEL Links:

1. http://www.digimat.in/nptel/courses/video/105106051/L01.html

List of Assignments:

1. Solve any one problem of FEM by using ANSYS/ ABAQUS.

Course Code: 210202	Course Name: Design Prefab and Pre-engineering Building	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE :** 50 Marks **ESE :** 50 Marks **TW :** 25 Marks **OR :** 25 Marks

Prerequisite Courses:

- Concrete Technology, Design of steel Structures, Analysis of structures.

Course Objectives:

- Analyze the behaviour and design considerations of prefabricated load-carrying members under various loading and handling conditions.
- Identify and evaluate different production technologies used in prefabrication, including stationary and mobile setups, manufacturing processes, and quality control practices.
- Design and detail structural joints in precast construction to ensure structural integrity, waterproofing, and durability under service and erection conditions.
- Apply engineering principles to design and detail complete precast structural systems, including beams, slabs, columns, and frames for industrial and commercial applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze the behavior of prefabricated structural elements under transportation, lifting, and in-service loading conditions.

CO2: Evaluate various prefabrication technologies, including stationary and mobile production systems.

CO3: Design and detail structural joints in precast systems with considerations for load transfer, erection tolerances, waterproofing, and long-term durability.

CO4: Apply design methodologies to develop complete precast systems comprising beams, slabs, columns, and frames for industrial buildings.

CO5: Integrate construction planning and erection techniques with structural design to ensure safe, efficient, and code-compliant implementation of precast structures.

Course Contents

UNIT-I: Introduction to Prefabrication **08 Hours**

Need for prefabrication, general principles of prefabrication, comparison with monolithic construction, types of prefabrication: site vs plant prefabrication, economy of prefabrication standardization and modular coordination definitions and design principles, materials used in prefabrication: steel, concrete, composites, systems and technologies used in prefabricated buildings.

UNIT-II: Prefabricated Load-Carrying Members 08 Hours

Planning for components of prefabricated structures, disuniting of structures, design of simple rectangular beams and I-beams, handling and erection stresses, elimination of erection stresses, beams, columns, symmetric frames.

UNIT-III: Structural Components and Joints 08 Hours

Overview of large panel construction systems, including the design and construction of precast roof and floor slabs, wall panels, columns, and shear walls. Detailed study of joints used for various structural connections, emphasizing structural integrity, durability, and ease of assembly. Includes effective techniques for joint sealing to ensure waterproofing, provisions for non-structural attachments, and design considerations for expansion joints in precast structures.

UNIT-IV: Production Technology 08 Hours

Choice of production setup, manufacturing methods, stationary and mobile production, planning of production setup, storage of precast elements, dimensional tolerances, acceleration of concrete hardening. Hoisting technology - equipment for hoisting and erection, techniques for erection of different types of members like beams, slabs, wall panels and columns, vacuum lifting pads.

UNIT-V: Erection, Applications and Progressive Collapse 08 Hours

Overview of hoisting technologies and erection methods for precast elements such as beams, wall panels, slabs, and columns. Design and detailing of precast units for industrial and factory structures including purlins, principal rafters, roof trusses, lattice girders, gable frames, and single-span, single-storey structural frames. Emphasis on design of structural components such as slabs, beams, and columns in precast buildings. Incorporates relevant code provisions for equivalent design loads, accounting for abnormal conditions such as earthquakes and cyclones. Highlights the critical importance of preventing progressive collapse in precast construction.

Learning Resources:

Text Books:

1. Vijaya kandeeban, Introduction of Precast Factory, 2021.
2. Phillip Meuser, Prefabricted Housing: Construction and Design Manual, DOM Publishers, 2020.

3. CBRI, Building materials and components, India, 1990
4. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge based process planning for construction and manufacturing, Academic Press Inc., 1994.
5. T., Bauverlag, Manual of precast concrete construction, Vols. I, II and III, Koncz GMBH, 1971.
6. Netherl and Betor Verlag, Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, 1978.
7. Mokk. L, Prefabricated Concrete for Industrial and Public Structures, Publishing House of the Hungarian Academy of Sciences, Budapest, 1964.

Reference Books:

1. Kim S. Elliott. - Precast Concrete Structures
2. M. M. Sabuwala. - Design of Pre-Engineered Buildings
3. Central Public Works Department (India) - Handbook on Precast Building Systems (CPWD Publication).
4. IS 15916:2010 for precast concrete buildings.

Weblink for MOOC / NPTEL Links:

1. https://www.youtube.com/watch?v=b9WQhnYq81s

List of Assignments:

1. Comparative analysis of prefabrication and monolithic construction.
2. Modular coordination and standardization in prefabrication.
3. Design and detailing of prefabricated beams and columns.
4. Behavior of wall panels, floor slabs, and shear walls in large panel construction.
5. Design joints for water tightness, structural stability, and ease of erection. Include detailing of expansion and non-structural joints.
6. Prepare prefabrication production and hoisting plan.
7. Design for progressive collapse resistance.
8. Case study of precast structure with BIM-based erection planning.
9. Site visit.

Course Code: 210203	Course Name: Structural Audit and Retrofitting	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week	**4**	**CCE : 50 Marks** **ESE : 50 Marks**

Prerequisite Courses:

- Concrete Technology, Design of steel Structures, Analysis of structures.

Course Objectives:

- To understand the principles, procedures, and importance of structural audit and visual inspection in assessing the condition and safety of structures.
- To evaluate the health and durability of structures
- To explain the assessment criteria, planning process, and execution methods of retrofitting and demolition to ensure structural safety and sustainability.
- To identify deterioration causes in steel and masonry structures and apply suitable preventive and repair measures.
- To gain knowledge of modern repair materials and techniques.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Assess the structural health of buildings using visual inspections, structural audit methods, and non-destructive testing.

CO2: Evaluate, plan, and implement retrofitting and restoration techniques while ensuring construction and demolition safety, incorporating sustainable practices such as material reuse and fire protection.

CO3: Identify causes of structural degradation, assess the extent of deterioration, and apply appropriate repair methods for reinforced concrete structures.

CO4: Select and apply suitable materials and techniques for effective structural repair.

CO5: Implement structural health monitoring and controlled demolition practices for concrete structures.

Course Content:

UNIT-I: Fundamentals and Visual Assessment **11 Hours**

Introduction to structural audit, objectives and importance of structural audit, bye-laws related to structural audit, various stages involved in structural audit, structural health monitoring: need and

scope, visual inspection of structures: techniques and parameters, introduction to Non-Destructive Testing (NDT): types and applications.

UNIT-II: Structural Health and Durability Assessment 11 Hours

Structural health: Definition and influencing factors, effects of leakage, age, creep, corrosion, and fatigue on structures, quality control and assurance of materials in construction, durability of concrete: factors affecting durability, corrosion in structures: causes, testing, and prevention, assessment of health of structure through structural drawings and observations, investigation of distress and collapse: tools, techniques, limitations.

UNIT-III: Retrofitting Strategies and Demolition Planning 10 Hours

Introduction to retrofitting of structures, parameters for assessment and strategy selection for restoration, construction chemicals: types and selection for restoration, specification for key restoration works, structural detailing and retrofitting techniques, FRP wrapping, steel jacketing, and base isolation retrofitting, safe demolition of structures: planning and methodology, evaluation of demolition techniques: partial and controlled demolition, temporary support systems and safety measures during demolition, recycling and reuse of demolished materials.

UNIT-IV: Deterioration in Steel and Masonry Structures 10 Hours

Steel structures: types and causes of deterioration, preventive measures and repair procedures, corrosion protection: inhibitors, coatings, Cathodic protection, distress during fabrication and erection, masonry structures: discoloration, weakening, preservation techniques, distress in brick masonry and remedial measures.

UNIT-V: Repair Materials, Techniques, and Maintenance Strategies 10 Hours

Repair materials-premixed mortar and concrete, sulphur infiltrated, fiber reinforced, expansive cement, polymer concrete, polymer modified concrete, epoxy concrete and mortar, surface coatings: types and applications, maintenance and repair strategies.

Learning Resources:

Text Books:

1. Fundamentals of Material Management by Gopalkrishnan, Tata McGraw Hills.
2. Financial Management by M. Y. Khan and Jain, Tata McGraw Hills.
3. Properties of Concrete by A. M. Neville, Longman.
4. Formwork Construction and Practice by Richardson. J. G.
5. Formwork For Concrete Structures by Peurifoy, Tata McGraw-Hill
6. Design & Construction of Formwork for Concrete Structures, by Wynn.A. E.

7. Demolition and Reuse of Concrete, by Y Kasai, Chapman and Hall
8. Concrete Repair and Maintenance, P. H. Emmons and G. M. Sabnis, Galgotia Publication.

Reference Books:

1. Construction project scheduling and control, Mubarak, Wiley India.
2. Construction Management & PWD Accounts, D Lal, S. K. Kataria & Sons, 2012
3. Construction Management and Accounts -- Singh H. Tata McGraw Hill, New Delhi, 1988
4. Construction Management: Planning and finance, Cormican D. Construction press.

Web link for MOOC / NPTEL Links:

1. https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-oe05/

Course Code: 210204A		Course Name: Advanced Design of RCC Structures
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical :** 2 Hours/Week	**4** **1**	**CCE :** 50 Marks **ESE :** 50 Marks **TW :** 25 Marks

Prerequisite Courses:

- Concrete Technology, Design of RCC Structures, Analysis of Structures.

Course Objectives:

- The objective of this course is to make students to learn principles of structural design.
- To design different types of structures and to detail the structures.
- To evaluate performance of the structures.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Design safe and efficient combined footings, using the Limit State Method for columns transferring loads through slabs and beams to the soil.

CO2: Design flat slabs using appropriate methods and understand their structural behavior, advantages, and reinforcement requirements.

CO3: Analyze slab behavior using yield line theory and apply yield criteria and assumptions to predict failure patterns and ultimate load capacity.

CO4: Design silos and bunkers, using lateral pressure theories and shape-specific design considerations.

CO5: Design elevated water tanks and their staging, considering wind, earthquake loads, and structural continuity.

Course Contents

UNIT-I: Design of Combined footing 11 Hours

Introduction of limit state method, column transforming load to the soil directly through footing slab, column transforming load to the soil directly through longitudinal beam and footing slab, design of combined footing.

UNIT-II: Design of Flat slab 11 Hours

Introduction of flat slab, advantage and disadvantage of flat slab, requirement of flat slab, bending

pattern in flat slab, methods of analysis design, design of flat slabs: proportioning of flat slabs, determination of bending moment and shear force, direct design method, equivalent frame method, slab reinforcement.

UNIT-III: Yield Line Theory 10 Hours

Introduction, behaviors of slab up to failure, assumptions, guide lines for predicting yield line pattern, yield criterion, method of analysis and basic principles behind yield theory.

UNIT-IV: Design of Silos and Bunkers 10 Hours

Design of silos and bunkers: Lateral pressure as per Janssen's and Airy's theories, design consideration for square, rectangular and circular shapes, design of hoppers and supporting structures.

UNIT-V: Design Water Tank 10 Hours

Elevated water tank: rectangular, circular and Intze type. Design of staging for wind and earthquake forces, container with flat base and domed bottom. Membrane analysis, effect of joint reactions due to continuity.

Learning Resources:

Text Books:

1. B.C. Punmia, Ashok K. Jain, Arun K. Jain – Reinforced Concrete Structures Vol. II, Laxmi Publications, New Delhi.
2. N.C. Sinha, S.K. Roy – Fundamentals of Reinforced Concrete, S. Chand & Co. Ltd, New Delhi.
3. P.C. Varghese – Advanced Reinforced Concrete Design, Prentice Hall of India Pvt. Ltd., New Delhi.
4. N. Krishana Raju, Advanced reinforced concrete design, CBS Publishers and distributors, Delhi.
5. IS: 456: Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.
6. Park R and Paulay T. Reinforced Concrete Structures, John Wiley and sons, 1975.
7. Purushothaman P. Reinforced concrete Structural element, Tata McGraw hill.1984.
8. Nilson A. H. Design of concrete structures McGraw hill,1997.
9. Pilai S.U. and Menon D. Advanced reinforced concrete design, Prentice -hall of India, 2005.

Reference Books:

1. Arthur H. Nilson, David Darwin, and Charles W. Dolan.- Design of Concrete Structures
2. N. Subramanian - Design of Reinforced Concrete Structures

Web link for MOOC / NPTEL / YouTube Links:

1. https://nptel.ac.in/courses/105106224

List of Assignments:

1. Combined Footing Design-Design a combined rectangular footing for two columns (with different loads and spacing), considering soil bearing capacity and limit state design.
2. Flat Slab Design using Direct Design Method - Analyze and design a flat slab for a multi-bay panel using the direct design method (IS 456).
3. Yield Line Analysis of One-Way and Two-Way Slabs- Predict yield line patterns and calculate ultimate collapse loads for a rectangular slab with given boundary conditions.
4. Design of Circular Silo with Hopper Bottom - Design a circular RCC silo (given dimensions and material properties) based on Airy's theory.
5. Design of Intze-type Water Tank with Staging - Design an elevated Intze tank with a capacity of 300 kL, including staging under seismic and wind loads (zone to be specified).

Course Code: 2105204B	Course Name: Design of Bridges and Flyover	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical:** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Concrete Technology, Design of RCC Structures, Analysis of structures.

Course Objectives:

- To ensure structural stability under various loads including traffic, wind, and seismic forces.
- To design aesthetically pleasing structures that blend with the environment
- To comply with relevant design codes, safety standards, and legal requirements.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the basics of bridge engineering, types and aesthetics, design codes, loading standards (IRC/IRS), and force distribution in bridges.

CO2: Analyze and design RC bridge decks including slab culverts, slab-and-beam, skew decks, and box girders, with an understanding of load distribution behavior.

CO3: Analysis and design of PSC bridge decks, including load distribution, prestressing, stress checks, and deflection control.

CO4: Understand the types, functions, and design principles of various bridge bearings.

CO5: Understand the types, materials, and forces acting on piers and abutments, and perform their design and stability analysis.

Course Content:

UNIT-I: Introduction of Bridge 11 Hours

Introduction to bridge engineering. Historical background of bridges and types. Bridge aesthetics and proportioning. Design process. Review of applicable design codes. Loads on bridges and force distribution. Bridge geometry. Loading standards for highway and railway bridges (IRC, IRS), balance cantilever method of construction, segmental construction of bridge.

UNIT-II: Design of RC Slab Bridge Decks 11 Hours

Analysis and design of RC bridge decks: Slab culvert bridges, slab-and-beam bridges, load distribution in slabs and beams, behaviour of skew bridge decks, box girder bridges.

UNIT-III: Design of Prestress Bridge 10 Hours

Analysis and design of PSC bridge decks: Flexural and torsional parameters, Courbon's theory, Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces–Eccentricity – Live load and dead load shear forces– Cable Zone in girder – check for stresses at various sections – check for diagonal tension– Diaphragms – End block – short term and long-term deflections.

UNIT-IV: Design and Analysis of Bridge Bearing 10 Hours

General features, types of bearing, design principal of steel rocker and roller bearing, design of steel rocker bearing, design of steel rocker and roller bearing, design of reinforced concrete rocker bearing, rocker bearing, design of elastomeric pad bearing, elastomeric pot bearings.

UNIT-V: Design Piers and Abutments 10 Hours

Introduction, bed block, materials for piers and abutment, types of piers, force acting on piers, design of piers, stability analysis of piers, general features of abutments, design of abutments, stability analysis of abutments.

Learning Resources:

Text Books:

1. Krishna K. Raju, N. (2017). Design of Bridges. New Delhi: Oxford IBH Publication House.
2. Jagadeesh, T.R., & Jayaram, M.A. (2016). Design of Bridge Structures. New Delhi: PHI Learning Pvt Ltd.
3. Krishna Raju, N. (2006). Prestressed Concrete. New Delhi: Tata McGraw Hill.
4. Dayaratnam, P. (2005). Prestressed Concrete Structures. New Delhi: Oxford & IBH Publication.
5. Ponnuswarmy, S. (2018). Bridge Engineering. New Delhi: Tata McGraw Hill.
6. Raina, V.K. (2018). Concrete Bridge Practice: Analysis, Design and Economics. New Delhi: Tata McGraw-Hill.
7. Subramanian, N. (2008). Design of Steel Structures. New Delhi: Oxford Publications.
8. V. K. Raina-Concrete Bridges Practice –Analysis-Design and Economics-Shroff Publications
9. V. N. Vazirani-M. M. Ratwani-M. G. Aswani-Design of Concrete Bridges-Khanna Publishers

Reference Books:

1. Ponnuswamy S (2008), Bridge engineering, Tata McGraw-Hill Education, ISBN.
2. Raina V.K(1994), Concrete Bridge Practice, Tata McGraw Hill, ISBN 0074623621, 756

pages

3. Tomlinson M.J (2001), Foundation Design and Construction, Prentice Hall.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc25_ce112/preview
2. Online books Link: https://www.google.co.in/books/edition/Design_of_Bridges/HUZH0T_1qM0C?hl=en&gbpv=1&pg=PA1&printsec=frontcover

List of Assignments:

1. Study and classification of bridge types
2. Design of rcc slab culvert for a highway
3. Design of a prestressed concrete i-girder bridge
4. Comparison and design of bridge bearings
5. Design and stability check of bridge abutment.
6. Site visit.

Course Code: 210204C	Course Name: Soil Structure Interaction	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical:** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Geotechnical Engineering, Foundation Engineering, Structural Dynamics, Finite Element Analysis.

Course Objectives:

- To understand the fundamentals of soil-structure interaction under various loading conditions.
- To analyze and model the effects of soil flexibility and foundation behavior on structural response.
- To familiarize with advanced methods and tools used for the assessment of soil-structure interaction (SSI) effects in real-world problems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Describe the fundamental principles of soil-structure interaction.

CO2: Analyze beams, plates, and frames on elastic/inelastic foundations.

CO3: Model and interpret dynamic behavior of soil-foundation systems.

CO4: Evaluate the effects of soil-structure interaction in earthquake and machine foundation scenarios.

CO5: Apply numerical techniques and software for SSI problems.

Course Content:

UNIT-I: Introduction to Soil-Structure Interaction 11 Hours

Concept and necessity of Soil-Structure Interaction, difference between conventional and Soil-Structure Interaction-based analysis, parameters influencing Soil-Structure Interaction, overview of soil modeling and constitutive relationships, significance of relative stiffness and embedment depth.

UNIT-II: Beams and Plates on Elastic Foundations 11 Hours

Winkler model and its limitations, Elastic continuum models, analysis of beams and plates resting

on deformable foundations using Winkler's, Pasternak's, and Vlasov's models. Beams and plates on elastic/inelastic foundations, Analytical and numerical analysis techniques. Parametric studies on soil-structure response. The limitations of the Winkler model and the advantages of more realistic elastic continuum models. Applications involve load distribution on structural elements supported by elastic and inelastic soils.

UNIT-III: Dynamic Soil-Structure Interaction 10 Hours

Dynamic Soil-Structure Interaction involves analyzing the behavior of shallow foundations under transient or cyclic loads, such as during earthquakes or machine vibrations. Modeling techniques include impedance functions represented by springs and dashpots. Differences between lumped and distributed parameter systems. Importance of radiation and material damping.

UNIT-IV: Soil-Structure Interaction Problems 10 Hours

Seismic response of structures considering SSI, focusing on foundation rocking, uplift, and base isolation. Design of machine foundations under dynamic loads, emphasizing vibration control, damping, and system resonance. Real-life failures due to ignored SSI highlight the importance of its inclusion in structural safety assessments.

UNIT-V: Numerical Modeling and Applications 10 Hours

Importance of numerical approaches in modern SSI analysis. Need for coupled soil-structure simulations, Overview of numerical methods: Finite Element Method (FEM), Finite Difference Method (FDM), Boundary Element Method (BEM), Selection criteria for method based on problem type and complexity, validation and calibration with experimental/field data.

Learning Resources:

Text Books:

1. Prakash, S., & Puri, V. K., Foundations for Machines: Analysis and Design, Wiley Eastern.
2. Wolf, J. P., Dynamic Soil-Structure Interaction, Prentice Hall.
3. Chopra, A. K., Dynamics of Structures, Pearson.

Reference Books:

1. Purchasing and Inventory Control- by K. S. Menon, Wheeler Publication.
2. Gazetas, G., Formulas and Charts for SSI Analysis, Journal of Geotechnical Engineering.
3. Das, B. M., Principles of Foundation Engineering, Cengage Learning.
4. Kameshwar Rao, N. S. V., Dynamics of Soil-Structure Interaction, Wiley India.

Web link for MOOC / NPTEL Links:

1. https://archive.nptel.ac.in/courses/105/105/105105200/
2. https://onlinecourses.nptel.ac.in/noc20_ce22/preview

List of Practicals (Any Six):

1. Evaluation of Soil-Structure Interaction for Shallow Foundations.
2. Comparison of Settlement: Isolated vs. Combined Footing.
3. Effect of Soil Stiffness on Structural Response.
4. Seismic Soil-Structure Interaction – Conceptual Study.
5. Analysis of Pile Foundations under Lateral Loads.
6. Beam on Elastic Foundation – Problem Solving.
7. Use of FEM Software for SSI Modeling.

Course Code: 210204D	Course Name: Advanced Concrete Technology	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical:** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Project Management and Finance.

Course Objectives:

- To provide in-depth knowledge of the microstructure and properties of concrete constituents and their influence on concrete performance.
- To explore the latest advancements in concrete technology, including special concretes and sustainability aspects.
- To understand the behaviour of concrete under various loading and environmental conditions.
- To develop practical knowledge in the design of concrete mixes for diverse applications.
- To enhance skills in evaluating the performance, durability, and quality control of concrete.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze and evaluate the properties of fresh and hardened concrete with various admixtures and supplementary materials.

CO2: Design concrete mixes for normal and special concrete applications using various methods and IS codes.

CO3: Evaluate the durability characteristics and identify deterioration mechanisms influencing the performance of concrete structures.

CO4: Apply modern testing methods and NDT techniques for concrete quality assurance.

CO5: Propose sustainable and cost-effective concrete solutions suitable for diverse structural applications.

Course Content:

UNIT-I: Concrete Materials and Microstructure 11 Hours

Cement types and hydration process, aggregates: grading, properties, and influence, admixtures and pozzolanic materials, Interfacial Transition Zone (ITZ), microstructure and micro-cracking. Types of mineral admixtures. Role of the supplementary cementitious materials on properties of

cement composites. Processing and testing the reactivity of mineral admixtures. Industrial wastes used in concrete.

UNIT-II: Properties of Fresh and Hardened Concrete 11 Hours

Chemical admixtures – classification and types of chemical admixtures, types of plasticizers and super-plasticizers, mode of action, dosages and effect on short term and long term properties. Other types of construction chemicals, their use and effect on short and long term properties. Workability and its measurement, mechanical properties: strength, elasticity, shrinkage, creep factors affecting properties, rheology of concrete.

UNIT-III: Concrete Mix Design 10 Hours

Design methods: IS 10262, ACI, DOE, Mix design for high strength and self-compacting concrete role of admixtures and supplementary cementitious materials, case studies.

UNIT-IV: Durability of Concrete 10 Hours

Permeability, sulphate attack, chloride ingress, carbonation, Alkali-Aggregate Reaction (AAR) corrosion of reinforcement, durability design and specifications, RCPT, sorptivity, and chloride migration index.

UNIT-V: Special Concretes and Testing 10 Hours

High Performance Concrete (HPC), Self-Compacting Concrete (SCC), Fibre Reinforced Concrete (FRC), Geopolymer and recycled aggregate concrete, sustainability and life-cycle assessment of concrete Non-destructive testing (NDT) methods, rebound hammer, ultrasonic pulse velocity, core testing, Statistical quality control of concrete, ready mix concrete and site quality practices.

Learning Resources:

Text Books:

1. Neville, A.M. – Properties of Concrete, Pearson Education.
2. Mehta, P.K., and Monteiro, P.J.M. – Concrete: Microstructure, Properties and Materials, McGraw-Hill.
3. Shetty, M.S. – Concrete Technology, S. Chand.

Reference Books:

1. Gambhir, M.L. – Concrete Technology, Tata McGraw-Hill.
2. Rixom, R. and Mailvaganam, N. – Chemical Admixtures for Concrete, E&FN Spon.
3. ACI and IS Codes – IS 456, IS 10262, IS 516, IS 1199, IS 9103, ACI 211.1, ACI 318.
4. Neville, A.M. and Brooks, J.J. – Concrete Technology, Pearson.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/105106176,
2. https://onlinecourses.nptel.ac.in/noc24_ce104/preview
3. https://archive.nptel.ac.in/courses/105/106/105106176/

List of Practicals:

Activity based practicals

1. **Mix Design and Casting:**
   a. Activity: Design and preparation of concrete mix for M25, M40, and SCC using IS 10262.
   b. Outcome: Hands-on understanding of batching, mixing, and casting with variable parameters.
2. **Durability Testing:**
   a. Activity: Perform permeability, sulphate attack, and chloride penetration tests on concrete cubes.
   b. Outcome: Analyze the durability characteristics under different environments.
3. **Non-Destructive Testing (NDT):**
   a. Activity: Evaluate compressive strength using rebound hammer and UPV on cast specimens.
   b. Outcome: Interpretation of NDT results for concrete integrity assessment.
4. **Rheology and Workability:**
   a. Activity: Conduct slump flow, V-funnel, and L-box tests for SCC.
   b. Outcome: Understanding the flow and passing ability of special concretes.
5. **Fiber Reinforced Concrete:**
   a. Activity: Casting and testing of FRC specimens under flexural load.
   b. Outcome: Understand the role of fibers in improving mechanical behavior.

Course Code: 210204E	Course Name: Theory of Plates and Shells	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 4 Hours/Week **Practical:** 2 Hours/Week	**4** **1**	**CCE : 50 Marks** **ESE : 50 Marks** **TW : 25 Marks**

Prerequisite Courses:

- Engineering Mechanics, Mechanics of Structures

Course Objectives:

- To apply membrane and bending theories to cylindrical shells,
- To build the ability to model and solve real-world structural engineering problems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze the bending behavior of rectangular thin plates under various loading and support conditions using classical small deflection theory.

CO2: Apply analytical and approximate methods like Levy's method and Rayleigh-Ritz approach to solve plate problems including shear deformation.

CO3: Solve axisymmetric bending problems in circular plates using classical theory with appropriate boundary conditions.

CO4: Interpret the governing equations and membrane theory for shells of revolution under symmetric loading conditions.

CO5: Analyze cylindrical shell structures using membrane and bending theory for practical applications like pipes and pressure vessels.

Course Content:

UNIT-I: Introduction to Thick and Thin Plates 11 Hours

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. Analysis of rectangular plates: Navier solution for plates with all edges simply supported, distributed loads, point loads and rectangular patch load.

UNIT-II: Analytical Methods 11 Hours

Levy's Method: Distributed load and line load, plates under distributed edge moments. Raleigh-Ritz approach for simple cases in rectangular plates. Introduction to shear deformation theories,

Riesener - Mindlin theory, moment curvature relationship for First order shear deformation theory.

UNIT-III: Circular Plates 10 Hours

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.

UNIT-IV: Introduction to Shell 10 Hours

Classification of shells on geometry, thin shell theory, equations to shell surfaces, stress resultants, stress- displacement relations, compatibility and equilibrium equations. Shells of revolution: Membrane theory, equilibrium equations, strain displacement relations, boundary conditions, cylindrical, conical and spherical shells.

UNIT-V: Circular cylindrical shells 10 Hours

Membrane theory: equilibrium equations, strain displacement relations, boundary conditions. Bending Theory: Equilibrium equation, strain displacement relations, governing differential equation, solution for a simply supported cylindrical shell, various boundary conditions and application to pipes and pressure vessels.

Learning Resources:

Text Books:

1. G. S Ramaswamy, Design and Construction of Concrete Shell Roofs, CBS Publications
2. Chandrashekhara K., Analysis of Concrete Shells, New Age International Edition
3. Chandrashekhara K., Analysis of Plates, New Age International Edition.

Reference Books:

1. S. Timoshenko and W. Krienger, “Theory of Plates and Shells”, McGraw-Hill, New York, 1959.
2. R.H. Wood, “Theory of Plates and Shells”, McGraw-Hill, New York, 2004.
3. O.C. Zienkiwicz, “Theory of Plates and Shells”, McGraw-Hill, New York, 1959.
4. G.S. Ramaswamy, “Design and Construction of Concrete Shell Roofs”, CBS Publications, New Delhi, 1986.
5. J. Ramchandran, “Thin Shells Theory and Problems”, Universities Press, Hyderabad,1993.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/105105180
2. https://nptel.ac.in/courses/105105177

List of Practicals / Assignments:

1. Assignment on theory and analysis of plates.
2. Assignment on buckling of plates.
3. Assignment on special and approximate methods for plate analysis.
4. Assignment on analysis of cylindrical shells 1.
5. Assignment on general shell structures and design using membrane theory.
6. Solve any one problem solving FEM.

Course Code: 210205		Course Name: Skill Development Laboratory – II
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 2 Hours/Week	**1**	**TW : 25 Marks**

Prerequisite Courses:

- Knowledge of Structural Analysis, RCC & Steel Design, FEM, Concrete Technology, and Soil Mechanics., Familiarity with design standards (IS codes), and basic software tools (AutoCAD, ETABS, etc.).

Course Objectives:

- To develop practical competency in structural analysis, design, assessment, and modeling tools.
- To bridge the gap between theoretical knowledge and industry practices.
- To expose students to modern tools, techniques, and practices in structural engineering.
- To encourage multidisciplinary problem-solving and professional presentation skills.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply software tools for structural analysis, design, and detailing.

CO2: Demonstrate skills in structural health monitoring and retrofitting techniques.

CO3: Prepare technical reports for bridge design, prefabricated structures, and auditing.

CO4: Conduct case studies integrating advanced material and construction techniques.

CO5: Collaborate and communicate effectively through presentations and documentation.

Guidelines:

1. Total activities to be conducted are four out of five.
2. Total: five activities in 15-20 hours.

Course Contents

UNIT I: Group Discussion and Debate **06 Hours**

Group Discussion: Make students aware of proper and globally accepted ethical ways to handle work, colleagues and clients. Develop group communication skills. Learn to speak-up one's opinion in a forum. Cultivate the habit of presenting solution-driven analytical arguments making them contributors in any team. **Debate on current affairs/ Social relevance topics:** Cultivate the habit of presenting forceful arguments while respecting the opponent's perspective and enhancing

verbal skills.

UNIT-II: Public Speaking **06 Hours**

Any one of the following activities may be conducted: **Prepared speech:** Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver. **Extempore speech**: Students deliver speeches spontaneously for 5 minutes each on a given topic.

UNIT-III: Writing an Article and Email Etiquettes **06 Hours**

Build writing skills, improve language and gain knowledge about how to write an article/ report. Provide students with an in-depth understanding of writing formal emails.

UNIT-IV: Reading and Listening Skills **06 Hours**

The batch can be divided into pairs. Each pair will be given an article by the facilitator. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students would be asked questions and needful corrections in the article. The facilitator can evaluate the students for reading and listening skills.

UNIT-V: Telephonic Etiquettes and Mock Interviews **06 Hours**

1. **Modeling and analysis of a steel structure using FEM software** (e.g., SAP2000/ETABS/Staad Pro).
2. **Design and detailing of a prestressed concrete bridge or flyover** using relevant software tools.
3. **Hands-on training on NDT** methods – Rebound hammer, Ultrasonic Pulse Velocity, Core Cutting (demo/video-supported).
4. **Preparation of a structural audit report** for an existing institutional/commercial building.
5. **Workshop on advanced concrete materials** – use of admixtures, high-performance mixes, fiber-reinforced concrete.
6. **Design of a pre-engineered building using PEB software** or manual + software-based approach.
7. **Study of soil-structure interaction** through numerical modeling (e.g., using PLAXIS or ANSYS).
8. **Hands-on project on detailing and drafting** using AutoCAD/Revit/BIM for prefab/retrofit components.
9. **Case study-based presentation** on real-life failures and their retrofitting solutions.
10. **Mini Capstone Exercise** – Design, analyze, and report a small-scale steel or concrete structure with sustainability considerations.

Course Code: 210206	Course Name: Seminar	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW** : 50 Marks **OR** : 50 Marks

Course Objectives:

- To understand, develop research ability and present the knowledge gained from curriculum.
- To study the recent trends, technological innovations in civil engineering construction management field.
- To learn how to prepare, seminar research project topic report and enhance presentation skills.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply theoretical knowledge gained in the Research Internship/ Field Visit Case Study / Experiential Learning activities to practical research projects and real-world engineering challenges.

CO2: Develop advanced problem-solving skills, critical thinking abilities, and a deep understanding of engineering principles.

Guidelines:

Seminar shall be on any related topic of specialization approved by a guide/authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the department/institute.

1. Individual student need to study recent topics in the field of construction management under the guidance of allocated guide.
2. Students can choose topic related to construction management, considering recent trends and its societal importance.
3. The extensive literature survey, mathematical modeling of particular method, experimentation and valuable conclusion is expected from seminar study.
4. Seminar report should be submitted as a compliance of term work.
5. Technical paper publication is expected as outcome of seminar.
6. Total duration: 24 contact hours and additional 24 hours should be spend by students on completion of related activities and requirements.

Course Contents

Week	Activities
1 and 2	Guide allotment and finalization of topic (Review 1)
2 and 3	Literature review, objectives and planning of the work.
4 and 5	Literature review, methodology finalization.
5 and 6	Detail topic data collection, mathematical model, case study analysis, experimentation methodology and findings. (Review 2)
6 to 8	Result and discussion, solutions to the identified problem or research gaps.
9 to 12	Seminar report writing, preparation of presentation and publication or copyright planning, final Review conduction.