

Amrutvahini College of Engineering, Sangamner
(An Autonomous Institute)
Department of Civil Engineering

**National Education Policy (NEP)-2020 Compliant
Curriculum**



MTech (Structural Engineering)
(2025 Pattern)

(With effect from Academic Year 2025-26)



**First Year M. Tech (Structural Engineering) (2025 Pattern)**

| Course Code | Course Type | Course Name | Teaching Scheme (Hrs./week) | | | Examination Scheme and Marks | | | | | Credits | | | |
|---------------------|-------------------------------------|--|-----------------------------|----------|-----------|------------------------------|------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| | | | Theory | Tutorial | Practical | CCE* | End-Sem | Term work | Practical | Oral | Theory | Tutorial | Practical | Total |
| Semester I | | | | | | | | | | | | | | |
| R25-MSE-NMSE-501 | Major Core Course | Numerical Methods in Structural Engineering | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-ADSS-502 | Major Core Course | Advanced Design of Steel Structures | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-SD-503 | Major Core Course | Structural Dynamics | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-TEP-504 | Major Core Course | Theory of Elasticity and Plasticity | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-SADE-505 | Major Core Course | Structural Analysis and Design Using ETAB | - | - | 4 | - | - | 50 | - | - | - | - | 2 | 2 |
| R25-MSE-MEC 506(A) | Major Elective Course (Elective –I) | Elective-I A) Design of Composite Construction | 3 | - | - | 50 | 50 | - | - | - | 3 | - | - | 3 |
| R25-MSE -MEC-506(B) | | B) Structural Design of Concrete Bridges | | | | | | | | | | | | |
| R25-MDE-MEC-506(C) | | C) Structural Design of Foundation | | | | | | | | | | | | |
| R25-MDE-MEC-506(D) | | D) Design of Earthquake Resistant Structures | | | | | | | | | | | | |
| R25-MSE-LP I-507 | Major Elective Course-I | Lab Practice - I | - | - | 2 | - | - | 50 | - | - | - | - | 1 | 1 |
| R25-MSE-CTS-508 | Civictch Skills Course | Human Right-I | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Total | | | 19 | - | 6 | 250 | 250 | 100 | -- | 50 | 19 | -- | 3 | 23 |

CCE*: Comprehensive Continuous Evaluation

Approved By:

**First Year M. Tech (Structural Engineering) (2025 Pattern)**

| Course Code | Course Type | Course Name | Teaching Scheme (Hrs./week) | | | Examination Scheme and Marks | | | | | Credits | | | |
|---------------------|---------------------------------------|--|-----------------------------|----------|-----------|------------------------------|------------|-----------|-----------|-----------|-----------|----------|-----------|-----------|
| | | | Theory | Tutorial | Practical | CCE* | End-Sem | Term work | Practical | Oral | Theory | Tutorial | Practical | Total |
| Semester II | | | | | | | | | | | | | | |
| R25-MSE-ADCS-509 | Major Core Course | Advanced Design of Concrete Structures | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-FEM-510 | Major Core Course | Finite Element Method | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-TPS-511 | Major Core Course | Theory of Plates and Shells | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-LP II-512 | Major Core Course | Lab Practice - II | - | - | 4 | - | - | - | - | 50 | - | - | 2 | 2 |
| R25-MSE -MEC-513(A) | Major Elective Course (Elective –II) | Elective-II A) Structural Audit and Retrofitting of Structures | 3 | - | - | 50 | 50 | - | - | - | 3 | - | - | 3 |
| R25-MSE -MEC-513(B) | | B) Design of High-Rise Structures | | | | | | | | | | | | |
| R25-MSE -MEC-513(C) | | C) Structural Forensics and Health Monitoring | | | | | | | | | | | | |
| R25-MSE -MEC-513(D) | | D) Design of Industrial Structures | | | | | | | | | | | | |
| R25-MSE-MEC-514 (A) | Major Elective Course (Elective –III) | Elective-III A) Design of Liquid Retaining Structures | 3 | - | - | 50 | 50 | - | - | - | 3 | - | - | 3 |
| R25-MSE-MEC-514 (B) | | B) Bio Mechanics and Bio Materials | | | | | | | | | | | | |
| R25-MSE-MEC-514 (C) | | C) Structural Reliability | | | | | | | | | | | | |
| R25-MSE-MEC-514 (D) | | D) Nonlinear Analysis of Structures | | | | | | | | | | | | |
| R25-MSE-SEM I-515 | Seminar | Seminar-I | - | - | 4 | - | - | 25 | - | 25 | - | - | 2 | 2 |
| R25-MSE-CTS-516 | Civitech Skills Course | Human Right-II | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Total | | | 18 | - | 8 | 250 | 250 | 25 | - | 75 | 18 | - | 4 | 23 |

CCE*: Comprehensive Continuous Evaluation

Approved By:

**Second Year M. Tech (Structural Engineering) (2025 Pattern)**

| Course Code | Course Type | Course Name | Teaching Scheme (Hrs./week) | | | Examination Scheme and Marks | | | | | Credits | | | |
|--------------------------|-----------------------------|---|-----------------------------|----------|-----------|------------------------------|------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| | | | Theory | Tutorial | Practical | CCE* | End-Sem | Term work | Practical | Oral | Theory | Tutorial | Practical | Total |
| Semester III | | | | | | | | | | | | | | |
| R25-MSE-RM-601 | RM | Research Methodology and IPR | 4 | - | - | 50 | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-OJT/II-602 | On job Training/ Internship | Industry Internship | - | - | 10 | -- | -- | 100 | - | - | -- | - | - | 5 |
| R25-MSE-MOOC/ SWAYAM-603 | Major Core Course | Program open elective courses based on MOOC / SWAYAM Prabha Platform. <ul style="list-style-type: none"> • Disaster Management • Artificial Intelligence in Structural Engg <ul style="list-style-type: none"> • Optimization Technique • Any others course | 4 | - | -- | -- | 50 | - | - | - | 4 | - | - | 4 |
| R25-MSE-RPS I-604 | Research Project | Research Project Stage -I | -- | - | 18 | -- | -- | - | - | 50 | -- | - | 9 | 9 |
| R25-MSE-CTS-605 | Civitech Skills Course | Introduction to Constitution of India | - | - | -- | - | - | -- | - | -- | - | - | - | 2 |
| Total | | | 08 | - | 28 | 50 | 100 | 100 | -- | 50 | 08 | -- | 14 | 24 |

CCE*: Comprehensive Continuous Evaluation

Approved By:

**Second Year M. Tech (Structural Engineering) (2025 Pattern)**

| Course Code | Course Type | Course Name | Teaching Scheme (Hrs./week) | | | Examination Scheme and Marks | | | | | Credits | | | |
|---------------------|------------------------|---------------------------|-----------------------------|----------|-----------|------------------------------|---------|------------|-----------|------------|---------|----------|-----------|-----------|
| | | | Theory | Tutorial | Practical | CCE* | End-Sem | Term work | Practical | Oral | Theory | Tutorial | Practical | Total |
| Semester IV | | | | | | | | | | | | | | |
| R25-MSE-SEM III-606 | Research Project | Seminar-II | - | - | 08 | -- | -- | 50 | - | 50 | - | - | 04 | 4 |
| R25-MSE-RPS II-607 | Research Project | Research Project Stage-II | - | - | 36 | - | - | 150 | - | 50 | - | - | 18 | 18 |
| R25-MSE-CTS-608 | Civitech Skills Course | Cyber Security | -- | - | | -- | -- | - | - | - | -- | - | -- | 4 |
| Total | | | -- | - | 44 | -- | -- | 200 | -- | 100 | -- | -- | 18 | 26 |

CCE*: Comprehensive Continuous Evaluation*Approved By:*



| | | | |
|------------------------------------|---|---------------------|-------------------------|
| Program: | F. Y. M. Tech | Semester: | I |
| Course: | Numerical Methods in Structural Analysis | Course Code: | R25-MSE-NMSE-501 |
| Teaching Scheme (Hrs./week) | | | Credits |
| Lecture | Practical | Tutorial | |
| 04 Hrs/Week | - | - | 04 |

Course Description and:

This course introduces fundamental numerical methods used to model and solve engineering problems, including error analysis, solution of equations, eigenvalue computation, differential equation techniques, finite difference formulations, and the stiffness matrix approach.

Course Relevance: This course equips structural engineering students with essential numerical techniques for solving complex engineering problems that cannot be handled analytically. It enhances their ability to model real-world systems, perform accurate structural analysis, and apply computational methods such as finite differences and stiffness matrices, which form the foundation of modern analysis tools like FEM software.

Prerequisite: Basic Concepts of differentiation and integration, differential equations, and calculus.

Bridge Content: - Students should have a basic understanding of mathematics, mechanics, structural analysis, numerical methods, and introductory programming before beginning this course.

Course Objectives:

1. To make students aware of different techniques of numerical methods this could be useful to find out the approximate solution of any structural engineering problem close to the exact solution.

Course Outcomes: After learning the course, students will be able to

| CO | Course Outcome | Bloom's Level |
|-----------|---|----------------------|
| CO1 | Understand basic concepts of various numerical methods for performing tasks, such as interpolation, differentiation, integration, solution of linear and nonlinear equations, solution of differential and integral equations. | 1, 2,3,4 |
| CO2 | Apply the knowledge of eigenvalues and eigenvectors for vibrational trivial solutions. | 2, 3, 4 |
| CO3 | Apply knowledge of numerical methods to obtain approximate solutions to indeterminate beams and frames using ordinary differential equations. | 2, 3, 4 |
| CO4 | Find the approximate solutions of beams and plates using finite difference method. | 3, 4 |
| CO5 | Understand the application of indirect method of stiffness matrix for beams, trusses, frames and grids. | 3, 5 |

Course Content

| Unit 1 | Fundamentals of Numerical Methods | 6 Hrs. | CO Mapped: CO 1 |
|--|--|---------------|------------------------|
| Fundamentals of numerical methods, Error analysis, Engineering Systems, Physical and Mathematical Modeling, Error Analysis Approximations, round off and Truncation errors, Roots of nonlinear equations, multiple roots, Solution of Linear Simultaneous Equations, Solution of Nonlinear Simultaneous Equations. | | | |
| Unit 2 | Eigen Values and Eigen Vectors | 6 Hrs. | CO Mapped: CO 2 |
| Power method, Relaxation Method, Diagonalization method. | | | |

Approved By:



| | | | |
|---|--|---------------|------------------------|
| Unit 3 | Ordinary Differential Equations | 6 Hrs. | CO Mapped: CO 3 |
| Method of Weighted Residuals, Initial Value and Boundary Value Problems, Euler's method, Improvement of Euler's method, Runge-Kutta Method, Multiple Steps Method. | | | |
| Unit 4 | Finite Difference Method | 6 Hrs. | CO Mapped: CO 4 |
| Forward, Backward, and Central Finite Difference approximations to the derivatives. Application to indeterminate beams and plates. | | | |
| Unit 5 | Stiffness Matrix Method | 6 Hrs. | CO Mapped: CO 5 |
| Stiffness matrices, numerical examples of stiffness method to beams and plane trusses, concept of transformation matrix, stiffness matrix for plane frame and grid. | | | |
| Textbooks: | | | |
| 1. Chapra S. C. and Canale R. P., Numerical Methods for Engineering. Tata Mcgraw-Hill Pub, 7 th Edition, 2016. | | | |
| 2. Madhujit Mukhopadhyay and Abdul Hamid sheikh Matrix and Finite element Analysis of structures, 5 th edition, New Age international Publications. | | | |
| Reference Books: | | | |
| 1. Scheid F., Theory, and problems of Numerical analysis. New York. McGraw Hill Book Co. (Shaum Series), 1988 | | | |
| 2. Sastry S. S., Introductory Methods of Numerical Analysis. Prentice-Hall of India, 1998. | | | |
| 3. E.Ward Cheney, David R. Kincaid, Numerical Methods and Applications, Brooks Cole / Cengage Learning India. | | | |
| 4. E. Balgurusamy, Numerical Methods, Tata Mcgraw-Hill Pub. | | | |
| MOOCs Links and additional reading material: | | | |
| 1. www.scilab.org/ | | | |
| 2. http://nptel.ac.in/ | | | |
| 3. http://ocw.mit.edu/ | | | |

CO-PO mapping table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | 2 | - | - | - |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | - | - | - |
| CO3 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - | 2 | - | - | - |
| CO4 | 2 | 3 | 2 | 3 | 3 | - | - | - | - | - | 2 | - | - | - |
| CO5 | 3 | 2 | 3 | 2 | 3 | - | - | - | - | - | 2 | - | - | - |
| Avg. | 2.8 | 2.6 | 2.0 | 2.0 | 2.6 | - | - | - | - | - | 1.8 | - | - | - |

Assessment Pattern

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
| | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Approved By:



| | | | | | | | |
|----|---|---|---|---|---|--|---|
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | 5 | | | | | 05 |
| Seminar | 5 | | | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | | |
|---|--|-----------------|------------|---------------------|---------------------------|------------------------|----------------------|--|
| Program: | F. Y. M. Tech | | | Semester: | I | | | |
| Course: | Advanced Design of Steel Structure | | | Course Code: | R25-MSE-ADSS-502 | | | |
| Teaching Scheme (Hrs./week) | | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | CCE | | ESE | TW | PR | |
| 04 Hrs./Week | - | - | 04 | 50 | 50 | - | - | |
| <p>Course Description and: This course introduces advanced concepts in the design of steel structures, covering design philosophies, codal loadings, and connection detailing. It emphasizes the analysis and design of industrial buildings, pre-engineered structures, steel bunkers, silos, portal frames, and steel chimneys as per relevant IS and IRC codes. The course equips students with practical design skills and an understanding of real-world steel structural systems used in industrial and infrastructural applications.</p> <p>Course Relevance: This course is highly relevant for careers in structural engineering, providing essential skills for designing industrial and special steel structures commonly used in infrastructure, manufacturing, and construction industries. It prepares students for professional work in consulting, steel fabrication, and modern PEB (Pre-Engineered Building) design.</p> <p>Prerequisite: Basic Concepts and design of steel structures.</p> <p>Bridge Content: - Students should have basic knowledge of structural analysis, material properties of steel, load calculations, and fundamentals of design codes before starting this course.</p> <p>Course Objectives: This course aims to equip students with the knowledge of steel design philosophies and codes, and the ability to design industrial buildings, PEBs, crane girders, bunkers, silos, portal and gable frames, lightweight systems, and steel chimneys including loading, stability, connections, and foundations.</p> <p>Course Outcomes: After learning the course, students will be able to</p> | | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level | |
| CO1 | Understand basic concepts of various steel structure design and will be able to give design solutions for on-site situations. | | | | | | 2,3 | |
| CO2 | Apply the knowledge of mathematical solutions for Industrial shed design. | | | | | | 3, 4 | |
| CO3 | Apply knowledge of IS codal provisions to design bankers and silos. | | | | | | 4,5 | |
| CO4 | Find the approximate solutions for Portal frame design | | | | | | 3, 4 | |
| CO5 | Understand the application of design philosophy in chimney design. | | | | | | 4, 5 | |
| Course Content | | | | | | | | |
| Unit 1 | Introduction to Design philosophy | | | | 6 Hrs. | CO Mapped: CO 1 | | |

Approved By:



| | | | |
|---|---------------------------------------|---------------|------------------------|
| Introduction to Allowable Stress Design, Plastic design, Limit state Design, Loadings as per IRC, IS (IS: 800-2007, IS: 875 part1-V, IS: 1893) applicable to various steel structures. Design of Welded and Bolted connections. | | | |
| Unit 2 | Design of Industrial Buildings | 6 Hrs. | CO Mapped: CO 2 |
| Design of Industrial Buildings including crane girders, Design of Pre-engineered Building. | | | |
| Unit 3 | Steel Bunkers and Silos | 6 Hrs. | CO Mapped: CO 3 |
| Design of square bunker – Jansen’s and Airy’s theories – IS Code provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams Design of cylindrical silo – Side plates – Ring girder – stiffeners. | | | |
| Unit 4 | Portal Frames | 6 Hrs. | CO Mapped: CO 4 |
| Design of portal frame with hinge base, design of portal frame with fixed base -Gable Structures – Lightweight Structures | | | |
| Unit 5 | Chimneys | 6 Hrs. | CO Mapped: CO 5 |
| Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation. | | | |
| Textbooks: | | | |
| 1. Limit State Design of Steel Structures, 3 rd edition S.K. Duggal – McGraw Hill | | | |
| 2. Design of Steel Structures, 2 nd edition, N. Subramanian – Oxford University Press | | | |
| Reference Books: | | | |
| 1. Design of Steel Structures - Vol. II, Ramchandra. Standard Book House, Delhi. | | | |
| 2. Design of Steel Structures - Arya A. S., Ajmani J. L., Nemchand and Bros., Roorkee. 3. The Steel Skeleton- Vol. II, Plastic Behaviour and Design - Baker J. F., Horne M. R., Heyman J., ELBS. | | | |
| 4. Plastic Methods of Structural Analysis, Neal B. G., Chapman and Hall London. | | | |
| 5. IS 800: 2007 – General Construction in Steel - Code of Practice, BIS, 2007. | | | |
| 6. SP – 6 - Handbook of Structural Steel Detailing, BIS, 1987 | | | |
| MOOCs Links and additional reading material: | | | |
| 1. https://nptel.ac.in/courses/105/106/105106113/ 8. | | | |
| 2. https://www.youtube.com/watch?v=CNE4hk_SGTo&list=PLry0oTiKPxdWSdla5MeAGae69h6KMK1a3 . | | | |

**CO-PO mapping table:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 3 | 2 | 3 | 2 | 2 | 1 | - | - | - | 2 | 1 | - | - | - |
| CO2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | 1 | 1 | - | - | - |
| CO3 | 3 | 2 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | - | - |
| CO4 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 1 | - | - | - | - |
| CO5 | 3 | 2 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | - | - |
| Avg. | 3.0 | 2.4 | 2.8 | 2.0 | 2.0 | 0.6 | - | - | - | 1.2 | 0.8 | - | - | - |

Assessment Pattern

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
| | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | 5 | | | | | 05 |
| Seminar | 5 | | | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | |
|------------------------------------|----------------------------|---------------------|----------------|---------------------------|------------|-----------|-----------|
| Program: | F. Y. M. Tech | Semester: | I | | | | |
| Course: | Structural Dynamics | Course Code: | R25-MSE-SD-503 | | | | |
| Teaching Scheme (Hrs./week) | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | CCE | ESE | TW | PR |
| 04 Hrs/Week | - | - | 04 | 50 | 50 | - | - |

Course Description and:

This course introduces the fundamental concepts of vibrations in structures and their application to earthquake-resistant design. Students will learn the principles of Single Degree of Freedom (SDOF) and Multiple Degree of Freedom (MDOF) systems, including free and forced vibrations, as well as damped and undamped responses.

Course Relevance: This course is highly relevant for civil and structural engineering students, as it bridges theoretical concepts of vibrations with practical applications in earthquake-resistant design. Understanding the dynamic behavior of SDOF and MDOF systems enables engineers to predict structural responses to dynamic loads such as earthquakes, wind, and machinery vibrations.

Prerequisite: Basic Concepts of Engineering Mechanics (Dynamics), Mathematics.

Bridge Content: - This course builds on foundational knowledge of mechanics, strength of materials, and structural analysis. Students are expected to be familiar with concepts of forces, moments, stiffness, and basic static and dynamic equilibrium.

Course Objectives: Introduce the fundamentals of vibrations of SDOF and MDOF systems for damped and undamped system under forced and free vibrations. Also expose the students to fundamentals of earthquake engineering, seismology of the world and country, so that this knowledge could be used for seismic design and construction of structures with the provisions of Indian standard codes.

Course Outcomes:

| CO | Course Outcome | Bloom's Level |
|-----------|---|----------------------|
| CO1 | Formulate and solve equations of motion for single-degree-of-freedom (SDOF) systems under free vibrations considering damping mechanisms. | 3,4 |
| CO2 | Evaluate the response of SDOF systems subjected to various dynamic loadings using Duhamel's integral and apply response spectra concepts for seismic design. | 3,5 |
| CO3 | Formulate equations of motion for multi-degree-of-freedom (MDOF) systems, compute natural frequencies and mode shapes, and apply modal superposition principles for vibration analysis. | 3,4 |
| CO4 | Assess and design vibration control strategies such as tuned mass dampers, base isolation, and supplemental damping devices for structural applications. | 4,5 |
| CO5 | Apply numerical integration methods for solving dynamic response problems of structures. | 3,4 |

Course Content

| Unit 1 | Single Degree of Freedom Systems | 6 Hrs. | CO Mapped: CO 1 |
|--|--|---------------|------------------------|
| Dynamic equilibrium, degrees of freedom, damping mechanisms and energy dissipation; mathematical modeling of SDOF systems; solution to free vibration problems (undamped and damped); forced vibration under harmonic excitation, resonance, dynamic amplification, transmissibility, and principles of vibration isolation. | | | |
| Unit 2 | Response to General Dynamic Loading | 6 Hrs. | CO Mapped: CO 2 |

Approved By:



SDOF response to step, ramp, and pulse loads; formulation and evaluation of Duhamel's integral; impulse response function; response to base motion under dynamic excitation; response spectra concepts and applications in seismic design.

| | | | |
|--|---|---------------|------------------------|
| Unit 3 | Multi Degree of Freedom Systems | 6 Hrs. | CO Mapped: CO 3 |
| Equations of motion for MDOF systems; determination of natural frequencies and mode shapes; orthogonality of modes and modal participation factors; modal superposition for free and forced response; applications to multi-storey frames and shear buildings. | | | |
| Unit 4 | Vibration Control in Structures | 6 Hrs. | CO Mapped: CO 4 |
| Principles of vibration control; passive, active, and semi-active strategies; tuned mass dampers; base isolation systems; supplemental damping devices; performance evaluation and practical applications in buildings, bridges, and infrastructure. | | | |
| Unit 5 | Numerical Methods in Structural Dynamics | 6 Hrs. | CO Mapped: CO 5 |
| Time-integration methods for dynamic analysis: explicit and implicit schemes, stability and convergence; Newmark- β and Wilson- θ methods; average acceleration method; direct integration vs modal superposition; introduction to finite element method for dynamic problems; practical aspects of computational modeling. | | | |

Textbooks:

1. Structural Dynamics: Theory and Computation, Mario Paz (Springer)
2. Dynamics of Structures: Theory and Applications to Earthquake Engineering, A.K. Chopra (Prentice Hall / Pearson)

Reference Books:

1. Dynamics of Structures, R. W. Clough, J. Penzin (McGraw Hill Publications)
2. Dynamics of Structures, J. L. Humar (CRC Press)

MOOCs Links and additional reading material:

1. E Resources: <http://52.7.61.3/civil/>, <https://ocw.tudelft.nl/course-lectures/2-1-structural-dynamics-part-1/>, <https://nptel.ac.in/courses/105/106/105106151/>
2. NPTEL Lectures on Structural analysis I - <https://nptel.ac.in/courses/105105166>

**CO-PO Mapping Table:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|--------|--------|--------|
| CO1 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | 3 | 2 | 1 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 3 | 3 | 1 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 3 | 3 | 2 |
| CO4 | 3 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 3 | - | 3 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 2 | 3 | 1 |
| Avg. | 3.0 | 1.8 | 2.0 | 3.0 | 2.8 | 1.2 | 1.4 | 1.2 | 1.00 | 1.4 | - | 2.8 | 2.8 | 1.4 |

Assessment Pattern

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|----------------|------------|----------------------|--------------------------|-----|
| | CT1 | CT2 | Open Book Test | Assignment | Seminar / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | | | 5 | | | 05 |
| Seminar | | | 5 | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | |
|------------------------------------|-------------------------------------|------------------|---------------------|---------------------------|------------|-----------|-----------|
| Program: | F. Y. M. Tech | Semester: | I | | | | |
| Course: | Theory of Elasticity and Plasticity | | Course Code: | R25-MSE-TEP-504 | | | |
| Teaching Scheme (Hrs./week) | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | CCE | ESE | TW | PR |
| 04 Hrs./Week | - | - | 04 | 50 | 50 | - | - |

Course Description and:

This course introduces students to the fundamentals of stress and strain in Cartesian and polar coordinate systems as governed by generalized Hooke's law. It covers the theoretical and practical aspects of elasticity, plasticity, and torsion of structural elements. Students will learn to analyze and solve problems involving complex stress states, deformation under generalized loading, and torsional behavior of shafts and structural components, preparing them for advanced study and applications in structural and mechanical engineering design.

Course Relevance: This course is highly relevant for students in civil, mechanical, and structural engineering, as it provides a strong foundation in understanding material behavior under various loading conditions. Knowledge of stress and strain analysis, plasticity, and torsion is essential for the design and evaluation of structural components, shafts, and mechanical elements. It equips students with the analytical skills needed to predict failure, ensure safety, and optimize performance in engineering structures and machinery, aligning with both industry requirements and advanced research in structural and mechanical design.

Prerequisite: Engineering Mathematics, Strength of Materials, Structural Mechanics.

Bridge Content: - This course builds on foundational knowledge of mechanics, strength of materials, and structural analysis. Students are expected to be familiar with concepts of forces, moments, stiffness, and basic static and dynamic equilibrium.

Course Objectives: Students get the knowledge of stress and strain in Cartesian and polar coordinate system as per generalized Hooke's law. This course enhances the knowledge of plasticity and generalized torsion problem.

Course Outcomes:

| CO | Course Outcome | Bloom's Level |
|-----------|---|----------------------|
| CO1 | Understand the principles of elasticity and plasticity useful for the analysis of structures. | 2 |
| CO2 | Understand the concept of plane stress, plane strain, Airy's stress function for Cartesian and polar coordinate system. | 2 |
| CO3 | Understand the concept of Axisymmetric problem and generalized torsion formulation for any cross section of member. | 2 |
| CO4 | Understand the concept of plasticity and different criteria's of yield condition as per theory of plasticity. | 2 |
| CO5 | Analyze torsion in bars and pressure in cylinders. | 4 |

Course Content

| | | | |
|--|--------------------------------------|---------------|------------------------|
| Unit 1 | Analysis of Stress and Strain | 6 Hrs. | CO Mapped: CO 1 |
| 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. | | | |

Approved By:



| Unit 2 | Stress-Strain Relations | 6 Hrs. | CO Mapped: CO 2 |
|---|------------------------------------|--------|-----------------|
| Generalized Hook's law, plane stress, plane strain Problems in 2D Cartesian coordinate system, Airy's stress function, 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 3 | Axisymmetric Problems and Torsion | 6 Hrs. | CO Mapped: CO 3 |
| Equilibrium equations, Strain displacement relations, Stress- strain relationship, Stress compatibility equations, Plane stress and Plane strain conditions. Cylinders subjected to internal and external pressure. Assumptions and Torsion equation for general prismatic solid bars, warping of non-circular sections and St. Venant's theory, Prandtl's stress function approach. Torsion of Circular, Elliptical and Triangular cross-section bar. | | | |
| Unit 4 | Introduction to Plasticity | 6 Hrs. | CO Mapped: CO 4 |
| Stress - strain diagram - Ideal plastic body - Illustration of plastic Analysis - Yield criteria - Rankine 's theory - St. Venant's theory - Tresca Criterion - Beltrami's theory - Von Mises criterion - Mohr 's theory of yielding - Yield surface - Flow rule (stress - strain relation for perfectly plastic flow)- Prandtl Reuss equality - plastic work - stress - strain relation based on Tresca – plastic potential - uniqueness of a stress distribution - strain hardening. | | | |
| Unit 5 | Plastic analysis of Thick Cylinder | 6 Hrs. | CO Mapped: CO 5 |
| Elasto-plastic problems of beams in bending – thick hollow spheres and cylinders subjected to internal pressure – General relations - plastic torsion –Nadai's and heap analogy. | | | |
| Textbooks: | | | |
| 1. Theory of Elasticity – Timoshenko, S.P. & Goodier, J.N., McGraw-Hill 2. Advanced Strength of Materials / Theory of Elasticity – Sadhu Singh, Khanna Publishers 3. Elasticity: Theory, Applications, and Numeric – Martin H. Sadd, Elsevier 4. Plasticity for Structural Engineers – C.R. Calladine, Springer 5. Introduction to the Mechanics of a Continuous Medium – Lawrence E. Malvern, Prentice Hall 6. Mechanics of Materials – Ferdinand P. Beer & E. Russell Johnston Jr., McGraw-Hill | | | |
| Reference Books: | | | |
| 1. Timoshenko, S. and Goodier, J. N., <i>Theory of Elasticity</i> , McGraw Hill, (1961). 2. Sadd, M. H., <i>Elasticity</i> , Elsevier, (2005). 3. Ragab, A. R. and Bayoumi, S. E., <i>Engineering Solid Mechanics</i> , CRC Press, (1999). 4. Ameen, M., <i>Computational Elasticity</i> , Narosa, (2005). 5. Kazimi, S. M. A., <i>Solid Mechanics</i> , Tata McGraw Hill, (1994). 6. Srinath, L. S., <i>Advanced Mechanics of Solids</i> , Tata McGraw Hill, (2000). 7. Sadhu Singh, <i>Theory of Plasticity</i> , Khanna Publisher, New Delhi, (1988). 8. Chakrabarty, J., <i>Theory of Plasticity</i> , Elsevier Butterworth- Heinemann UK. | | | |
| MOOCs Links and additional reading material: | | | |
| 3. Theory of Elasticity – NPTEL, IIT Kharagpur (Link) 4. Applied Elasticity – NPTEL, IIT Bhubaneswar (Link) 5. Introduction to Crystal Elasticity & Plasticity – NPTEL, IIT Guwahati (Link) 6. Mechanical Behavior of Materials – NPTEL, IIT Kanpur (Link) | | | |

Approved By:

**CO-PO Mapping Table:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | - |
| CO2 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - |
| CO3 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - |
| CO4 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - |
| CO5 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 3 | - |
| Avg. | 3.0 | 3.0 | 2.0 | - | - | - | - | - | - | 1.4 | - | - | 3.0 | - |

Assessment Pattern

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|----------------|------------|----------------------|--------------------------|-----|
| | CT1 | CT2 | Open Book Test | Assignment | Seminar / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | | | 5 | | | 05 |
| Seminar | | | 5 | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | | |
|--|--|-----------------|---|---------------------|---------------------------|--------------------------|----------------------|-----------|
| Program: | F.Y M Tech | | | Semester: | I | | | |
| Course: | Structural Analysis and Design Using Etab | | | Course Code: | R25-MSE-SADE-505 | | | |
| Teaching Scheme (Hrs./week) | | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | | CCE | ESE | TW | PR |
| -- | 02 Hrs./Week | - | - | - | - | 50 | - | |
| Course Prerequisites: Basic Concepts of structural analysis and design, knowledge of engineering materials and its properties. | | | | | | | | |
| Prerequisite: Basic computer literacy | | | | | | | | |
| Bridge Content: - Knowledge of Basic ETAB Software and Excel Spreadsheet | | | | | | | | |
| Course Objectives: Students will be able to analyze and design RCC, steel and composite structure using ETAB software. Students edify the knowledge using ETAB software. Students will understand the concepts of Excel spreadsheets and programming language. | | | | | | | | |
| Course Outcomes: After learning the course, students will be able to | | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level | |
| CO1 | Understand and apply theories, methods and procedures for analysis and design of various structural systems using modern computer tool ETAB. | | | | | | 2,3 | |
| CO2 | Perform advanced modeling and simulation of Steel/RCC buildings subjected to various loadings as per Indian standards. | | | | | | 4,5 | |
| CO3 | Understand the basics of spreadsheet and programming. | | | | | | 2 | |
| CO4 | Analyze and interpret the dynamic response of RCC multi storey building. | | | | | | 4,5 | |
| Course Content | | | | | | | | |
| List of Practical: | | | | | | | | |
| Experiment No.1 | | | | | | CO Mapped: CO 2,3 | | |
| Objective: Design of doubly reinforced continuous beams using Excel Spreadsheets or any programming language as per IS 456 code of practice. | | | | | | | | |
| Experiment No.2 | | | | | | CO Mapped: CO 2,3 | | |
| Objective: Design of one column and one beam element of RC plane frame using Excel Spreadsheets as per IS 456 and IS 13920. | | | | | | | | |
| Experiment No.3 | | | | | | CO Mapped: CO 2,3 | | |
| Objective: | | | | | | | | |

Approved By:



| | | |
|---|--|----------------------------|
| Design of plane truss elements using Excel Spreadsheets or any programming language as per IS 800 code of practices. | | |
| Experiment No.4 | | CO Mapped: CO 2,3 |
| Objective: Design of isolated and combine RC footing using Excel Spreadsheets. | | |
| Experiment No.5 | | CO Mapped: CO 1,2 |
| Objective: Analysis and design of simple determinate and indeterminate beams using ETAB Software. | | |
| Experiment No.6 | | CO Mapped: CO 1,2 |
| Objective: Analysis and design of plane and space trusses using ETAB software. | | |
| Experiment No.7 | | CO Mapped: CO 1,2 |
| Objective: Analysis and design of plane frames for lateral and vertical loading using ETAB software. | | |
| Experiment No.8 | | CO Mapped: CO 1,2,4 |
| Objective: Analysis of three-dimensional multi storied multi bay RC building using ETAB software subjected to earthquake and wind loading. | | |
| Experiment No.9 | | CO Mapped: CO 1,2,4 |
| Objective: Eigenvalue and Eigenvector analysis of G+2 multi storey building by manually and ETAB software. | | |
| Experiment No.10 | | CO Mapped: CO 1,2,4 |
| Objective: Dynamic analysis of multi storey three-dimensional building using ETAB software as per IS 1893. | | |

CO-PO Mapping Table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|------|------|------|-------|-------|--------|--------|--------|
| CO1 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| CO3 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| CO4 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | - |
| Avg. | 2.4 | 2.4 | 2.6 | 2 | 2.2 | - | - | - | - | - | - | - | - | - |

Approved By:



| | | | | | | | | |
|--|--|-----------------|------------|---------------------|---------------------------|------------------------|----------------------|--|
| Program: | F. Y. M. Tech | | | Semester: | I | | | |
| Course: | Elective I: Design of Composite Construction | | | Course Code: | R25-MSE-MEC 506(A) | | | |
| Teaching Scheme (Hrs./week) | | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | CCE | | ESE | TW | PR | |
| 03 Hrs/Week | - | - | 03 | 50 | 50 | - | - | |
| Course Description and: | | | | | | | | |
| This course provides an in-depth study of composite construction systems, emphasizing the combination of different materials to achieve enhanced structural performance. Students will explore steel–concrete, concrete–timber, FRP–concrete, and hybrid systems, learning how these systems are designed and used in real-world applications. | | | | | | | | |
| Course Relevance: This course is highly relevant to modern civil and structural engineering as it equips students with the knowledge to design and construct efficient, durable, and high-performance structures using composite systems. | | | | | | | | |
| Prerequisite: Basic structural analysis, RCC, steel design, and construction materials knowledge. | | | | | | | | |
| Bridge Content: - Composite construction is widely used in bridge engineering due to its ability to combine materials for high strength, reduced weight, and long spans. | | | | | | | | |
| Course Objectives: This course aims to provide students with comprehensive knowledge of the behavior, advantages, and design of composite construction systems, focusing on steel–concrete composites for buildings and bridges. | | | | | | | | |
| Course Outcomes: After learning the course, students will be able to | | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level | |
| CO1 | Understand composite types, advanced materials, shear interfaces, and the latest global trends. | | | | | | 2 | |
| CO2 | Describe the behavior of composite beams and slabs under different actions. | | | | | | 2,3 | |
| CO3 | Understand composite columns' behavior, slenderness, seismic, and tall structures. | | | | | | 3 | |
| CO4 | Discuss detailing, connection, and long-term durability aspects of composite structures. | | | | | | 4 | |
| CO5 | Evaluate the role of modern technologies like BIM, SHM, and modular systems in composite construction. | | | | | | 5 | |
| Course Content | | | | | | | | |
| Unit 1 | Introduction to Composite Construction & Materials | | | | 6 Hrs. | CO Mapped: CO 1 | | |
| Types of composite construction: steel-concrete, concrete-timber, FRP-concrete, hybrid systems. Advantages over conventional construction: weight savings, high strength-to-weight ratio, modularity. Materials used: structural steel, RCC, high-performance concrete, FRP composites—interface behavior: shear connectors, headed studs, bolts. Latest trends: high-strength steel, ultra-high-performance concrete (UHPC), corrosion-resistant FRP. | | | | | | | | |
| Unit 2 | Composite Beams and Slabs | | | | 6 Hrs. | CO Mapped: CO 2 | | |
| Behavior of composite beams under flexure, shear interaction, and slip. Types of shear connectors and their functional principles. Concept of partial vs. full interaction. | | | | | | | | |
| Composite slabs: profiled steel sheeting with concrete, load transfer, fire performance. Case discussions on modern composite floors and multi-story construction systems. | | | | | | | | |
| Unit 3 | Composite Columns and Frames | | | | 6 Hrs. | CO Mapped: CO 3 | | |

Approved By:



Types: concrete encased steel sections, concrete-filled steel tubes (CFST), FRP-wrapped columns. Axial and combined loading behavior, slenderness effects.

Typical load-deflection responses and interaction diagrams. Behavior under seismic and lateral loads: drift considerations, ductility. Use of composite frames in tall buildings and bridges.

| | | | |
|---------------|--|---------------|------------------------|
| Unit 4 | Connections, Detailing & Durability | 6 Hrs. | CO Mapped: CO 4 |
|---------------|--|---------------|------------------------|

Philosophy of connections in composite systems: bolted, welded, and mechanical couplers. Detailing of shear connectors, bearing plates, and stiffeners. Long-term performance: creep, shrinkage, differential movements.

Durability concerns: steel corrosion, concrete carbonation, chloride attack in composite environments.

Modern protective strategies: coatings, cathodic protection, corrosion-resistant alloys.

| | | | |
|---------------|---|---------------|------------------------|
| Unit 5 | Emerging Technologies & Case Studies | 6 Hrs. | CO Mapped: CO 5 |
|---------------|---|---------------|------------------------|

BIM applications in composite construction projects. Modular and precast composite systems: speed & quality advantages.

Green composites: recycled fibers, low-carbon binders.

Case studies of advanced composite bridges & high-rise buildings globally, highlighting innovations.

Textbooks:

1. Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings, Roger P. Johnson (Wiley)
2. Composite Steel and Concrete Structural Members: Fundamental Behavior, D. J. Oehlers, M. A. Bradford (Pergamon Press)

Reference Books:

1. Composites for Construction Structural Design with FRP Materials, Lawrence C. Bank (Wiley)
2. Elementary Behavior of Composite Steel and Concrete Structural Members, D. J. Oehlers, M. A. Bradford (Butterworth-Heinemann).

MOOCs Links and additional reading material:

1. https://www.steelconstruction.info/Composite_construction
(Excellent free tutorials, detailing, worked examples on composite beams, slabs, columns)
2. NPTEL Lectures on Composite Structures → <https://nptel.ac.in/courses/105/105/105105210/>
3. <https://www.steel-sci.com/> (Technical guides on modular composite systems & BIM integration)

CO-PO Mapping Table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | P01 | PO 2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|------|------|-----|------|-----|-----|------|------|------|------|------|--------|--------|--------|
| CO1 | 3 | 2 | - | 2 | - | - | - | - | - | - | - | - | - | - |
| CO2 | 2 | 3 | 3 | - | 2 | - | - | - | - | - | - | - | - | - |
| CO3 | 2 | 3 | 3 | - | - | - | 2 | - | - | - | - | - | - | - |
| CO4 | - | 2 | 2 | - | - | 2 | 2 | 2 | - | - | - | - | - | - |
| CO5 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - |
| Avg. | 2.25 | 2.4 | 2.5 | 2.00 | 2.5 | 2.5 | 2.00 | 2.00 | 3.00 | - | - | - | - | - |

Approved By:

**Assessment Pattern**

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|----------------|------------|----------------------|--------------------------|-----|
| | CT1 | CT2 | Open Book Test | Assignment | Seminar / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | | | 5 | | | 05 |
| Seminar | | | 5 | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | |
|--|--|------------------------|---------------|---------------------------|---------------------|-----------------------|----------------------|
| Program: | | F. Y. M. Tech | | | Semester: | | I |
| Course: | | Lab Practices-I | | | Course Code: | | R25-MSE-LP I-507 |
| Teaching Scheme | | | | Examination Scheme | | | |
| Lecture | Practical | Tutorial | Credit | CCE | ESE | TW | OR |
| - | 2 Hrs./Week | -- | 1 | -- | -- | 50 | -- |
| <p>Course Description: Lab Practice-I offers practical experience with advanced structural engineering instruments, methodologies, and experiments. Using contemporary software like ETABS, the course focuses on the analysis and design of RCC, steel, and composite structures. It is bolstered by laboratory-based studies on vibration characteristics, concrete performance, and structural behavior. In order to connect theoretical understanding with real-world applications in structural engineering, students also participate in non-destructive testing, mix design, and research evaluations.</p> <p>Course Relevance: Because it bridges the gap between analytical concepts and practical engineering practice, this course is extremely useful for postgraduate students studying structural engineering. Students acquire industry-oriented skills necessary for design offices, consulting firms, research organizations, and infrastructure development projects through software-based modeling, sophisticated material testing, experimental vibration investigations, and exposure to current research.</p> <p>Prerequisite: Basic Concepts of structural analysis and design, knowledge of engineering materials and its properties</p> <p>Bridge Content: This course bridges diverse M.Tech backgrounds by strengthening structural analysis, materials, design basics, software skills, vibration studies, NDT, and concrete mix design.</p> <p>Course Objectives: Students will be able to analyze and design RCC, steel, and composite structures using ETAB software. Students edify the knowledge using the ETAB software. Students will understand the concepts of Excel spreadsheets and programming languages.</p> <p>Course Outcomes: After learning the course, students will be able to</p> | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level |
| CO1 | Design advanced steel structures in accordance with relevant IS codes. | | | | | | 2 |
| CO2 | Evaluate vibrational characteristics of SDOF, MDOF, and continuous systems through experimental testing | | | | | | 3 |
| CO3 | Design and verify the structural properties and behavior of concrete structural members | | | | | | 3 |
| CO4 | Conduct technical reviews of research articles and analyze developments in seismology. | | | | | | 3 |
| CO5 | Apply NDT and laboratory investigation methods to assess material performance and structural behavior. | | | | | | 3 |
| List of Practical: | | | | | | | |
| Experiment No.1 | Design and detailed drawing of Industrial Building / Transmission Tower / Steel formwork by an individual student using the latest relevant IS codes. | | | | 2 Hrs. | COs Mapped:CO1 | |

Approved By:



Objective: To develop the ability to design and draft steel structural systems using relevant IS codes and modern design practices.

Associated Tasks:

1. Identify functional requirements of the selected steel structure.
2. Apply IS codes (IS 800, IS 875, IS 1893, IS 802).
3. Model and analyze using ETABS or equivalent software.
4. Perform member design and connection detailing.
5. Prepare final structural drawings and calculation sheets.

Exemplars and Utility:

1. Complete set of design calculations and CAD drawings.
2. Utility: Builds competence in steel structure design essential for consultancy and industrial projects.

| | | | |
|----------------------------|---|---------------|-----------------------|
| Experiment No.2 | Design of a steel chimney or Transmission tower using any suitable software. | 2 Hrs. | COs Mapped:CO1 |
|----------------------------|---|---------------|-----------------------|

Objective: To enable students to analyze and design tall steel structures subjected to wind and seismic loads using software tools.

Associated Tasks:

1. Study functional and loading requirements.
2. Apply IS 875 (Wind), IS 1893, IS 6533 (chimney).
3. Model chimney/tower in software.
4. Design braces, legs, base plates, and connections.
5. Generate analysis reports.

Exemplars and Utility:

1. *Exemplar:* Software analysis diagrams, design tables, and detailing sheets.
2. *Utility:* Prepares students for real-world tall structure design and advanced software usage.

| | | | |
|----------------------------|--|---------------|-----------------------|
| Experiment No.3 | Non-Destructive Testing (NDT) of Concrete Members | 2 Hrs. | COs Mapped:CO5 |
|----------------------------|--|---------------|-----------------------|

Objective: To assess in-situ concrete strength and quality using NDT equipment.

Associated Tasks:

1. Operate NDT devices (UPV, Rebound Hammer).
2. Select test locations and prepare surfaces.
3. Conduct tests and record measurements.
4. Interpret results using IS 13311.
5. Compare NDT results with expected structural performance.

Exemplars and Utility:

1. *Exemplar:* NDT report with test results, graphs, and interpretation.
2. *Utility:* Essential skill for structural audit, rehabilitation, and forensic investigations.

| | | | |
|----------------------------|---|---------------|----------------------------|
| Experiment No.4 | Free vibration of SDOF and MDOF systems over a horizontal shake table. | 4 Hrs. | COs Mapped: CO2 |
|----------------------------|---|---------------|----------------------------|

Objective:To experimentally determine natural frequency, damping, and mode shapes for SDOF and MDOF systems.

Associated Tasks:

1. Set up shake table or vibration rig.

Approved By:



2. Install sensors/accelerometers.
3. Conduct free vibration tests.
4. Record data using DAQ system.
5. Plot response curves and determine dynamic properties.

Exemplars and Utility:

1. Exemplar: Time history plots, frequency response curves, damping calculations.
2. Utility: Strengthens understanding of structural dynamics and earthquake engineering.

| | | | |
|----------------------------|---|---------------|------------------------|
| Experiment No.5 | Free vibration of a continuous system using sensors and a data acquisition system. | 2 Hrs. | COs Mapped: CO2 |
|----------------------------|---|---------------|------------------------|

Objective: To analyze vibration characteristics of beams or continuous systems using sensors and data acquisition tools.

Associated Tasks:

1. Prepare beam/continuous structural model.
2. Perform impact or free vibration tests.
3. Capture response using sensors.
4. Process data to obtain mode shapes and natural frequencies.
5. Compare theoretical and experimental results.

Exemplars and Utility:

1. *Exemplar:* Mode shape diagrams and frequency tables.
2. *Utility:* Builds practical understanding of dynamic response essential for advanced structural dynamics.

| | | | |
|----------------------------|---|---------------|-----------------------|
| Experiment No.6 | Mix design of high-performance concrete. | 2 Hrs. | COs Mapped:CO3 |
|----------------------------|---|---------------|-----------------------|

Objective: To design a high-performance concrete mix using IS code provisions and evaluate its workability and strength

Associated Tasks:

1. Select materials (cement, mineral admixtures, fibers, etc.).
2. Perform mix calculations using IS 10262.
3. Prepare trial batches.
4. Conduct slump/flow tests.
5. Cast and cure test specimens.
6. Test compressive strength.

Exemplars and Utility:

1. Exemplar: Mix design sheet and strength test results.
2. Utility: Essential for modern concrete technologies and high-strength applications.

| | | | |
|----------------------------|--|---------------|-----------------------|
| Experiment No.7 | Report based on one site visit of steel structures. | 2 Hrs. | COs Mapped:CO1 |
|----------------------------|--|---------------|-----------------------|

Objective: To observe and document real-time behavior, detailing, and construction practices in steel structures.

Associated Tasks:

1. Visit the selected steel structure site.

Approved By:



2. Document structural system, connections, bracing, and fabrication.
3. Interact with engineers/contractors.
4. Prepare a technical site report.

Exemplars and Utility:

1. *Exemplar:* Visit report with sketches, photos, and technical observations.
2. *Utility:* Bridges gap between theoretical design and field construction practices.

| | | | |
|----------------------------|---|---------------|-----------------------|
| Experiment No.8 | Experimental test of RCC beam for multiple point loads over the loading frame. | 2 Hrs. | COs Mapped:CO3 |
|----------------------------|---|---------------|-----------------------|

Objective: To study the load–deflection behavior and failure modes of RCC beams.

Associated Tasks:

1. Prepare reinforcement and cast beam specimens.
2. Set up loading frame and dial gauges/LVDTs.
3. Apply incremental point loads.
4. Record deflections and cracking behavior.
5. Compare results with theoretical predictions.

Exemplars and Utility:

- 1 Exemplar: Load–deflection curves, crack pattern documentation.
- 2 Utility: Strengthens understanding of structural behavior and failure mechanisms

| | | | |
|----------------------------|--|---------------|-----------------------|
| Experiment No.9 | Technical review and critique of a research article/paper on any topic from the referred journal related to structures. | 2 Hrs. | COs Mapped:CO4 |
|----------------------------|--|---------------|-----------------------|

Objective: To develop critical thinking and analytical skills by reviewing a published research article.

Associated Tasks:

1. Select a peer-reviewed article related to structural engineering.
2. Identify objectives, methodology, results, and limitations.
3. Compare with existing literature.
4. Write a structured critical review.

Exemplars and Utility:

1. *Exemplar:* Written review with summary, analysis, and critique.
2. *Utility:* Enhances research skills required for thesis work and publication

| | | | |
|-----------------------------|---|---------------|-----------------------|
| Experiment No.10 | One assignment on Indian and World seismology. | 2 Hrs. | COs Mapped:CO4 |
|-----------------------------|---|---------------|-----------------------|

Objective: To study global and Indian seismicity patterns and understand their influence on seismic design.

Associated Tasks:

1. Research global earthquake zones.
2. Study Indian seismic zones as per IS 1893.
3. Analyze major historic earthquakes.
4. Prepare a comparative seismicity report.

Exemplars and Utility:

- 1 Exemplar: Assignment on seismic zones, maps, and seismic parameters.
2. Utility: Builds understanding of seismology essential for earthquake-resistant design.

Approved By:

**Strength of CO-PO-PSO Mapping**

| CO | P01 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3 | 2 | 3 | 1 | 2 | -- | -- | -- | 1 | 1 | -- | 1 | 3 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 2 | -- | -- | -- | 1 | 1 | -- | 1 | 2 | 3 |
| CO3 | 3 | 2 | 3 | 1 | 2 | -- | -- | -- | 1 | 1 | -- | 1 | 3 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 3 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 3 | 1 | 2 | 2 | 3 |
| Avg. | 2.8 | 2.2 | 2.6 | 1 | 1.8 | 1 | 1 | 1 | 1.2 | 1.8 | 1 | 1.6 | 2.2 | 2.2 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

| BT Level | Journal Experiments | Course Project / Demonstration | Presentation |
|----------|---------------------|-----------------------------------|--------------|
| L1 | √ | | |
| L2 | √ | | |
| L3 | √ | √ | √ |
| L4 | | √ | √ |
| L5 | | √ | √ |
| L6 | | √ | √ |

Assessment Pattern

| EXAM | Particular | CO1 | CO2 | CO3 | CO4 | CO5 | Total | TW |
|-------------------------------------|-----------------------------------|----------------------|-------------------|-------------------|--------------------|-------------|-------|--|
| Knowledge and Attitude Profile (WK) | | | | | | | 150 | Convert the total marks obtained to 50 |
| TW | Journal Experiment | 45 Exp 1, 2, 7 | 30 Exp 4, 5 | 30 Exp 6, 8 | 30 Exp 9, 10 | 15 Exp 3 | | |
| | Course Project / Demonstration | | | | | | | |
| | Presentation | | | | | | | |
| Total | | 45 | 30 | 30 | 30 | 15 | | |

This course serves as a prerequisite for / maps with the following future courses:

This Lab Practice–I course builds essential analytical, experimental, and software-based skills required for several advanced structural engineering courses. It serves as a prerequisite or foundation for the following future courses:

1. Advanced Structural Analysis
2. Advanced Steel Design
3. Advanced RCC Design
4. Structural Dynamics & Earthquake-Resistant Design
5. Construction Materials and NDT Techniques
6. Research Methodology and Seminar / Dissertation

Job Mapping:

This lab enhances employability by developing practical skills in structural design, analysis, material testing, and software modeling. It prepares students for roles such as Structural Design Engineer through steel and

Approved By:



RCC design using IS codes and ETABS, and Structural Analyst or Earthquake Engineer through vibration and seismic studies. Hands-on work in high-performance concrete mix design, RCC testing, and NDT supports careers as Concrete Technologists, Material Engineers, or NDT Auditors. Site visits build competence for Site Engineers, while research review and seismology activities strengthen skills needed for research-oriented roles.

Approved By:



| | | | | | | | |
|------------------------------------|---|---------------------|------------------|---------------------------|------------|-----------|-----------|
| Program: | F. Y. M. Tech | Semester: | II | | | | |
| Course: | Advanced Design of Concrete Structures | Course Code: | R25-MSE-ADSS-509 | | | | |
| Teaching Scheme (Hrs./week) | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | CCE | ESE | TW | PR |
| 04 Hrs/Week | - | - | 04 | 50 | 50 | - | - |

Course Description and: This course provides advanced concepts in the analysis and design of reinforced concrete structural elements, including slabs, flat slabs, grid floors, elevated service reservoirs, and foundation systems. It focuses on modern limit state design methods, yield line theory, seismic/wind considerations for staging, and practical aspects such as pile caps and formwork design, enabling students to handle complex structural engineering problems.

Course Relevance: This course equips students with the advanced structural design skills required for modern construction projects, enabling them to design complex slabs, reservoirs, and foundation systems using current IS codes.

Prerequisite: Engineering Mathematics (linear algebra, differential equations, vector calculus)

Bridge Content: -

Course Objectives:

1. To introduce advanced analysis methods such as yield line theory, grid analysis, and flat slab behaviour for reinforced concrete floor systems.
2. To develop the ability to design slabs, grid floors, flat slabs, reservoirs, and foundations using relevant IS codes and limit state principles.
3. To enhance competence in practical structural design, including staging for ESRs, pile/raft foundations, and formwork for major RCC components.

Course Outcomes: After learning the course, students will be able to

| CO | Course Outcome | Bloom's Level |
|-----------|---|----------------------|
| CO1 | <i>Apply</i> yield line theory and virtual work/equilibrium methods to analyze collapse patterns and loads for reinforced concrete slabs of various geometries and edge conditions. | 3,4,5 |
| CO2 | <i>Analyze</i> grid and coffered slab systems using rigorous and approximate methods to determine moments and structural behaviour. | 4,5 |
| CO3 | <i>Design</i> flat slab systems using the direct design method, including moment distribution, shear checks, and detailing of column and middle strips. | 4,5 |
| CO4 | <i>Design and evaluate</i> elevated service reservoirs (rectangular and circular) and staging considering wind and earthquake forces. | 4,5 |
| CO5 | <i>Design</i> raft and pile foundations (single and group) with pile caps and <i>develop</i> appropriate formwork designs for slabs, girders, and columns. | 3,5 |

Course Content

Approved By:



| | | | |
|---|---|----------------|------------------------|
| Unit 1 | Yield Line Theory and Design of Slabs | 08 Hrs. | CO Mapped: CO 1 |
| Yield line theory for analysis of slabs, various patterns of yield lines, assumptions in yield line theory, characteristics of yield lines, equilibrium and virtual work method of analysis. Design of various slabs such as rectangular, triangular, circular with various edge conditions using yield line theory, Design for limit state of strength and serviceability of orthotropically reinforced slabs | | | |
| Unit 2 | Design of Grid and Coffered Slabs | 08 Hrs. | CO Mapped: CO 2 |
| Grid and coffered slabs, general features, rigorous and approximate method of analysis, design of grid floor by approximate method. | | | |
| Unit 3 | Analysis and Design of Flat Slabs | 08 Hrs. | CO Mapped: CO 3 |
| Flat slabs, types, design methods, column and middle strip, proportioning of flat slab element, total design moment, distribution of moments, effect of pattern loading, design for shear, design of intermediate and end panel by direct method only | | | |
| Unit 4 | Design of Elevated Service Reservoirs | 08 Hrs. | CO Mapped: CO 4 |
| Elevated service reservoir: Rectangular and circular type only flat bottom, Design of staging for wind and earthquake forces. | | | |
| Unit 5 | Design of Raft Foundations, Pile Foundations, and Formwork | 08 Hrs. | CO Mapped: CO 5 |
| Design of raft foundations, pile foundations, single pile, group of piles, Pile cap, design of form work for slabs, girders and, columns. | | | |
| Textbooks: | | | |
| <ol style="list-style-type: none"> 1. Advance R. C. C. Design, S. S. Bhavikatti, New Age International Publishers 2. B.C. Punmia, Ashok K. Jain, Arun K. Jain, Reinforced Concrete Structures Vol. II, Laxmi Publications, New Delhi | | | |
| Reference Books: | | | |
| <ol style="list-style-type: none"> 1. N. C. Sinha, S.K. Roy, Fundamentals of Reinforced Concrete, S. Chand & Co. Ltd, NewDelhi 2. P. C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall of India Pvt. Ltd., New Delhi 3. Dr .H.J.Shah, Reinforced Concrete design, Charotar publishing house 4. Design of R. C. C, S. Ramaamruthum, Dhanpat Rai publications 5. IS: 456-2000, Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi. 6. IS: 1893:-2017, Indian Standard Code of practice for criteria for Earthquake resistant design of Structures, Bureau of Indian Standards, New Delhi. 7. IS: 3370, Indian Standard code of practice for concrete structures for storage of liquids, Bureau of Indian Standards, New Delhi | | | |
| MOOCs Links and additional reading material: | | | |
| <ol style="list-style-type: none"> 1. Design and Detailing of RCC Elements (on Coursera) — Covers detailed design of reinforced-concrete elements: beams, flat slabs, continuous slabs, etc | | | |

Approved By:



https://www.coursera.org/learn/design-and-detailing-of-rcc-elements?utm_source=chatgpt.com

2. Design of Reinforced Concrete Structures (by NPTEL / IIT Kharagpur) https://onlinecourses.nptel.ac.in/noc21_ce42/preview?utm_source=chatgpt.com
3. Structural Design of Foundations (on LTU Edu) — Focuses on foundation design (shallow & deep) and is very relevant for your Unit 5. https://ltuedu.eu-west.catalog.canvaslms.com/browse/mooc/mooc-eng/courses/what-lies-beneath-structural-design-of-foundations?utm_source=chatgpt.com

CO-PO mapping table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | P01 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | 1 | - | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 1 | - | 3 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | 1 | - | 3 | 1 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | 1 | - | 3 | 2 | 2 |
| Avg. | 3 | 3 | 2.4 | 2.2 | 2.0 | - | - | - | - | 1.0 | - | 3 | 1.6 | 1.4 |

Assessment Pattern

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
| | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | | | 5 | | | 05 |
| Seminar | | | 5 | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | |
|--|---|-----------------|----------------|---------------------------|------------------------|-----------|----------------------|
| Program: | F. Y. B. Tech | | | Semester: | II | | |
| Course: | Finite Element Method | | | Course Code: | R25-MSE-FEM-510 | | |
| Teaching Scheme (Hrs./week) | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | CCE | ESE | TW | PR |
| 04 Hrs./Week | - | - | 04 | 50 | 50 | - | - |
| <p>Course Description and: The course provides fundamental understanding of the Finite Element Method (FEM) through variational principles, weighted residual methods, and element formulations. It covers 1D, 2D, and 3D elements, including shape functions, isoparametric concepts, and numerical integration. Students gain the ability to model and analyze structural, plate, shell, and axisymmetric problems using FEM.</p> <p>Course Relevance: This course is essential for developing the ability to model and analyze complex engineering structures using numerical methods. FEM forms the foundation of modern structural analysis software, making the course highly relevant for advanced design, research, and industry applications. It equips students with skills required for solving real-world engineering problems with accuracy and efficiency.</p> | | | | | | | |
| Prerequisite: Engineering Mathematics (linear algebra, differential equations, vector calculus) | | | | | | | |
| Bridge Content: - | | | | | | | |
| <p>Course Objectives: The course aims to impart theoretical understanding and practical formulation techniques of the finite element method (FEM) for structural engineering problems.</p> | | | | | | | |
| Course Outcomes: After learning the course, students will be able to | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level |
| CO1 | Understand and apply variational and weighted residual methods for FEM formulation. | | | | | | 2,3 |
| CO2 | Formulate stiffness matrices and load vectors for truss, beam, and plane stress/strain elements. | | | | | | 3, 4 |
| CO3 | Develop and interpret shape functions for 1D, 2D, and 3D elements using cartesian and natural coordinates. | | | | | | 3, 4 |
| CO4 | Apply isoperimetric formulations and numerical integration for complex geometries. | | | | | | 3, 4 |
| CO5 | Analyze thin and thick plates, shell, and curved structural elements using FEM. | | | | | | 4 |
| Course Content | | | | | | | |
| Unit 1 | Fundamentals of FEM and Variational Formulation | | | 08 Hrs. | CO Mapped: CO 1 | | |
| Overview of finite element method; comparison with other numerical methods; review of variational calculus; weighted residual methods – Galerkin, collocation, least squares; variational principles – Rayleigh–Ritz method, principle of minimum potential energy; concept of polynomial displacement functions (introduction only); stiffness formulation for 1D bar, truss, and beam elements using variational methods. | | | | | | | |
| Unit 2 | 2D FEM Formulation – Plane Stress and Plane Strain | | | 08 Hrs. | CO Mapped: CO 2 | | |

Approved By:



| | | | |
|--|--|----------------|------------------------|
| Basic 2D element types – CST, LST, rectangular; displacement functions using Pascal's triangle; geometric invariance and convergence criteria; stiffness matrix and load vector formulation using variational principles; treatment of boundary conditions; assembly of global matrices; aspect ratio effects and mesh refinement; static condensation and overall analysis procedure for 2D problems. | | | |
| Unit 3 | Shape Functions and Higher Order Elements | 08 Hrs. | CO Mapped: CO 3 |
| Shape functions in cartesian and natural coordinates; interpolation functions for 1D, 2D, and 3D elements; completeness and compatibility; derivation of shape functions for Lagrange and Serendipity elements; numerical integration (Gaussian quadrature); stiffness matrix formulation for higher-order elements. | | | |
| Unit 4 | Isoparametric Formulation | 08 Hrs. | CO Mapped: CO 4 |
| Isoparametric, sub-parametric, and super-parametric elements; coordinate mapping and Jacobian; 2D quadrilateral isoparametric elements in plane elasticity; introduction to 3D isoparametric solids. | | | |
| Unit 5 | FEM for Plates and Shells | 08 Hrs. | CO Mapped: CO 5 |
| Analysis of thin and thick plates using triangular and rectangular elements (ACM, BFS); Mindlin's theory for thick plates; introduction to shell elements – flat and curved; conforming and non-conforming elements; Axisymmetric elements in axisymmetric problems, cylindrical shells. | | | |
| Textbooks: | | | |
| 3. Introduction to Finite Elements in Engineering, T. R. Chandrupatla, A. D. Belegundu (Pearson Education) | | | |
| 4. An Introduction to the Finite Element Method, J. N. Reddy (Mc-Graw Hill) | | | |
| Reference Books: | | | |
| 8. Finite Element Procedures, K. J. Bathe (Prentice Hall) | | | |
| 9. Concepts and Applications of Finite Element Analysis, R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt (Wiley). | | | |
| MOOCs Links and additional reading material: | | | |
| 4. NPTEL: https://onlinecourses.nptel.ac.in/noc22_me43/preview?utm_source=chatgpt.com | | | |
| 5. ["Finite Element Method" – IIT Kharagpur] (Prof. Biswanath Banerjee & Prof. Amit Shaw) — Preview Page: https://onlinecourses.nptel.ac.in/noc22_me43/preview NPTEL Online Courses | | | |
| 6. ["Introduction to Finite Element Method" – IIT Madras] (Dr. R. Krishnakumar) — Course Page: https://nptel.ac.in/courses/112106135 NPTEL | | | |
| 7. ["Finite Element Method and Computational Structural Dynamics" – IIT Roorkee] (Prof. Manish Shrikhande) — Preview Page: https://onlinecourses.nptel.ac.in/noc22_ce95/preview NPTEL Online Courses . | | | |

**CO-PO mapping table:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | 1 | - | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | 3 | 3 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 1 | - | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | 1 | - | 3 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | 1 | - | 3 | 3 | 1 |
| Avg. | 3 | 3 | 2.4 | 2.2 | 2.0 | - | - | - | - | 1.0 | - | 3 | 2.4 | 1.0 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|-------------|----------------|-----------------------------|--------------------------|-----|
| | CT1 | CT2 | Assignments | Course Project | Field Activity / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | 5 | | | | | 05 |
| Seminar | 5 | | | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | | |
|------------------------------------|------------------------------------|-----------------|----|------------------|---------------------------|------------|-----------|-----------|
| Program: | F. Y. M. Tech | | | Semester: | II | | | |
| Course: | Theory of Plates and Shells | | | Course Code: | R25-MSE-TPS-511 | | | |
| Teaching Scheme (Hrs./week) | | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | | CCE | ESE | TW | PR |
| 04 Hrs./Week | - | - | 04 | 50 | 50 | - | - | |

Course Description and:

This course introduces the behavior, analysis, and design of thin plates and shell structures. Students will study classical and advanced plate theories, explore membrane and bending actions in shells, and learn approximate and numerical solution methods. Practical design applications are emphasized through the study of codal provisions and real-world structural examples.

Course Relevance: Understanding the behavior and design of thin plates and shell structures is essential for civil, mechanical, and aerospace engineers involved in the design of buildings, bridges, tanks, aircraft, and other complex structures. This course equips students with the analytical and practical skills needed to model, analyze, and design lightweight yet efficient structural elements, bridging theoretical concepts with real-world engineering applications.

Prerequisite: Fundamentals of solid mechanics and structural analysis.

Bridge Content: - Builds on mechanics of materials and structural analysis, preparing students for advanced structural design and finite element analysis in engineering applications.

Course Objectives: This course aims to provide students with a thorough understanding of the behavior, analysis, and design of thin plates and shell structures. Students will learn classical and advanced plate theories, membrane and bending actions of shells, approximate and numerical solution methods, and codal provisions for practical design.

Course Outcomes:

| CO | Course Outcome | Bloom's Level |
|-----------|---|----------------------|
| CO1 | Formulate and apply classical and advanced plate theories to derive governing equations, stress resultants, and boundary conditions for isotropic and anisotropic plates. | 3,4 |
| CO2 | Analyze rectangular plates under various loading and boundary conditions using analytical and approximate methods. | 4 |
| CO3 | Evaluate the behavior of circular and annular plates subjected to symmetric and asymmetric loads with different edge conditions. | 4,5 |
| CO4 | Assess the buckling and stability of thin plates under in-plane forces, and determine critical loads for structural applications. | 3,5 |
| CO5 | Apply membrane and bending theories of shells to analyze and evaluate design aspects of shell structures. | 3,5 |

Approved By:

**Course Content**

| Unit 1 | Fundamentals of Plate Theory | 8 Hrs. | CO Mapped: CO 1 |
|--|---|---------------|------------------------|
| Introduction to thin and thick plates; assumptions of classical plate theory; small and large deflection theories; moment–curvature relations; governing differential equations in Cartesian coordinates; stress resultants; boundary conditions; pure and simple bending; orthotropic and anisotropic plates. | | | |
| Unit 2 | Analytical and Approximate Methods | 8 Hrs. | CO Mapped: CO 2 |
| Navier and Levy solutions for simply supported and partially fixed rectangular plates under uniform, concentrated, and distributed loads; Rayleigh–Ritz method; first-order shear deformation theory (Reissner–Mindlin); moment–curvature relations for shear-deformable plates; approximate solutions for practical problems. | | | |
| Unit 3 | Analysis of Circular Plates and Annular Plates | 8 Hrs. | CO Mapped: CO 3 |
| Formulation and solutions for circular and annular plates under symmetric and asymmetric loads; boundary conditions (simply supported, clamped, free edges); plates with central openings. | | | |
| Unit 4 | Buckling and Stability of Plates | 8 Hrs. | CO Mapped: CO 4 |
| Stability of thin plates under in-plane forces; governing equations for uniaxial, biaxial, and shear loading; critical buckling loads for simply supported and stiffened plates; applications to panels, stiffened plates, and industrial components; introduction to numerical methods for stability analysis. | | | |
| Unit 5 | Membrane and Bending Theory of Shells | 8 Hrs. | CO Mapped: CO 5 |
| Classification and geometry of shells; thin shell assumptions; derivation of membrane theory for shells of revolution (cylindrical, conical, spherical); bending theory of cylindrical and doubly curved shells; beam and arch analogies; hyperbolic paraboloid and folded plate structures; application to tanks, silos, and roofs; codal provisions and practical design considerations. | | | |
| Textbooks: | | | |
| 1. Theory of Plates and Shells, S. Timoshenko, S. Krieger (McGraw Hill) 2. Stresses in Plates and Shells, A. C. Ugural (McGraw Hill) | | | |
| Reference Books: | | | |
| 1. Design and Construction of Concrete Shell Roofs, G. S. Ramaswamy (CBS Publishers) 2. Buckling of Bars, Plates, and Shells, Brush and Almroth (McGraw Hill) | | | |
| MOOCs Links and additional reading material: | | | |
| 1. https://onlinecourses.nptel.ac.in/noc21_ce59/preview?utm_source=chatgpt.com 2. https://onlinecourses.nptel.ac.in/noc25_me76/preview?utm_source=chatgpt.com | | | |

CO-PO Mapping Table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P010 | P011 | PSO 01 | PSO 02 | PSO 03 |
|-----------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|---------------|---------------|---------------|
| CO1 | 1 | 1 | 1 | 1 | - | 0 | - | - | - | - | - | 1 | 1 | - |
| CO2 | 1 | 1 | 1 | 1 | 1 | 0 | - | - | - | - | - | 1 | 1 | - |
| CO3 | 1 | 1 | 1 | 1 | 1 | 0 | - | - | - | - | - | 1 | 1 | - |
| CO4 | 1 | 1 | 1 | 1 | - | 1 | - | - | - | - | - | 1 | 1 | - |
| CO5 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | 1 | 1 | - |
| Avg. | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.0 | - | - | - | - | - | 1.0 | 1.0 | - |

Approved By:

**Assessment Pattern**

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|----------------|------------|----------------------|--------------------------|-----|
| | CT1 | CT2 | Open Book Test | Assignment | Seminar / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | | | 5 | | | 05 |
| Seminar | | | 5 | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | | |
|---|--|-------------------------|---------------|---------------------------|---------------------|------------------------|----------------------|--|
| Program: | | F. Y. M. Tech | | | Semester: | | II | |
| Course: | | Lab Practices-II | | | Course Code: | | R25-MSE-LP II-512 | |
| Teaching Scheme | | | | Examination Scheme | | | | |
| Lecture | Practical | Tutorial | Credit | CCE | ESE | TW | OR | |
| - | 4 | -- | 2 | -- | -- | -- | 50 | |
| Course Description: Hands-on training in advanced modelling, analysis, and design of RC structures using professional software tools for complex and realistic problems. | | | | | | | | |
| Course Relevance: Develops industry-ready skills in FEM modelling, tank design, retrofitting simulations, and analysis of plates, shells, and RC systems. | | | | | | | | |
| Prerequisite: Basic structural analysis, RC design skills, and familiarity with engineering software | | | | | | | | |
| Bridge Content: Introductory sessions on interface, modelling workflow, material properties, meshing, boundary conditions, and result interpretation for engineering software. | | | | | | | | |
| Course Objectives: Students will learn advanced modelling using structural analysis software, develop FEM skills for plates, shells, and continuum problems, perform software-based RC design with detailing, analyse tank structures, and simulate retrofitting using suitable engineering tools. | | | | | | | | |
| Course Outcomes: After learning the course, students will be able to | | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level | |
| CO1 | Apply software-based modelling and design techniques to advanced RC systems and retaining structures under different loading conditions. | | | | | | 3 | |
| CO2 | Develop and implement FEM programs for isoparametric elements, and accurately interpret stiffness and shape function behaviour. | | | | | | 3 | |
| CO3 | Analyse the bending behaviour of plates and shells using classical and computational tools and compare membrane and bending theory results. | | | | | | 4 | |
| CO4 | Perform structural auditing using NDT methods and visual inspection to assess condition and deterioration of existing buildings | | | | | | 4 | |
| CO5 | Evaluate material behaviour using stress–strain curve fitting and identify appropriate elastic, plastic, viscoelastic, or hyperelastic models. | | | | | | 5 | |
| List of Practical: | | | | | | | | |
| Experiment No.1 | Advanced Design of Concrete Structures | | | | 4 Hrs. | COs Mapped: CO1 | | |
| Objective: To develop students' ability to design elevated reservoirs and foundation systems using structural analysis, detailing skills, and professional-quality drawings with engineering accuracy. | | | | | | | | |
| Associated Tasks: | | | | | | | | |
| <ol style="list-style-type: none"> Design a rectangular or circular flat-bottom elevated service reservoir with staging analysis for wind and earthquake forces, prepare full design calculations, and submit detailed, dimensioned drawings on full-size sheets with required supporting data. Prepare detailed drawings and reinforcement details for a combined or pile-raft foundation system | | | | | | | | |

Approved By:



| | | | |
|--|------------------------------------|---------------|----------------------------|
| Exemplars and Utility: | | | |
| <ol style="list-style-type: none"> 1. Improves drafting skills needed for professional engineering practice. 2. Useful for consultancy, structural design offices, and competitive exams. | | | |
| Experiment No.2 | Finite Element Method | 4Hrs. | COs Mapped: CO2 |
| <p>Objective: To develop an understanding of isoparametric finite elements by writing a simple program that generates shape functions and stiffness matrices for basic structural elements.</p> <p>Associated Tasks:</p> <ol style="list-style-type: none"> 1. Write a simple program to generate shape functions and stiffness matrices for a 1D or 2D element using an isoperimetric formulation. 2. One assignment from each unit. <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> 1. Examples include coding shape functions for 1D two-node elements, computing Jacobians, evaluating derivatives, and assembling stiffness matrices for simple 2D quadrilateral elements. 2. Useful for understanding FEM implementation, validating commercial software results, improving modelling skills, and strengthening computational knowledge for advanced structural engineering applications. | | | |
| Experiment No.3 | Theory of Plates and Shells | 4 Hrs. | COs Mapped: CO3 |
| <p>Objective: To analyse plate bending using Navier or Levy methods and model shell behaviour comparing membrane and bending theories through computational tools.</p> <p>Associated Tasks:</p> <ol style="list-style-type: none"> 6. Use computational tools or software to analyse the bending behaviour of rectangular plates under various boundary conditions using Navier or Levy methods. 7. Model a shell structure (e.g., cylindrical or spherical dome) using membrane theory and compare results with bending theory. <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> 1. Examples include analysing plates and shells, comparing deflections and stresses, and validating results against solutions representing membrane and bending behaviour. 2. Useful for understanding plate and shell behaviour, validating numerical models, learning classical theory, and strengthening modelling skills for advanced curved structural systems | | | |
| Experiment No.4 | Major Elective Course 2 | 4 Hrs. | COs Mapped: CO4 |
| <p>Objective: Assess the structural condition of an existing building using NDT and inspection.</p> <p>Associated Tasks:</p> <p>A group of up to 4 students should select an existing building and conduct a structural audit using NDT Tests and Visual Inspections, and prepare a report.</p> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> 3. Examples include conducting rebound hammer and UPV tests, mapping visible cracks, evaluating deterioration, and preparing a detailed structural audit report. 4. Useful for real-world building assessment, identifying distress, planning maintenance, ensuring safety, and understanding practical application of structural auditing techniques. | | | |

Approved By:



| Experiment No.5 | Major Elective Course 3 | 4 Hrs. | COs Mapped: CO5 |
|---|-------------------------|--------|-----------------|
| <p>Objective: To analyse material behaviour by generating stress–strain curves from sample data and identifying suitable elastic, plastic, viscoelastic, or hyperelastic material models.</p> <p>Associated Tasks:</p> <p>Material Behaviour Study Using Curve Fitting Tools</p> <p>Use experimental or sample data to obtain stress–strain curves and identify the material model (elastic, plastic, viscoelastic, or hyperelastic).</p> <p>Exemplars and Utility:</p> <ol style="list-style-type: none"> 1. Examples include plotting stress–strain data, fitting linear and nonlinear models, comparing material responses, and validating predicted behaviour with experimental or published results. 2. Useful for understanding material properties, selecting accurate models for structural analysis, improving simulation accuracy, and strengthening practical skills in computational material characterisation. | | | |

Strength of CO-PO-PSO Mapping

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|-----|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 3 |
| CO5 | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 |
| Avg | 2.8 | 2.8 | 2.6 | 2.4 | 2.8 | 1.2 | 1.2 | 1.2 | 1.8 | 1.8 | 1.6 | 3 | 2.6 | 2.2 |

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

| BT Level | Journal Experiments | Course Project / Demonstration | Presentation |
|----------|---------------------|--------------------------------|--------------|
| L1 | | | |
| L2 | | | |
| L3 | ✓ | ✓ | |
| L4 | ✓ | ✓ | |
| L5 | ✓ | ✓ | |
| L6 | | | |

Assessment Pattern

| EXAM | Particular | CO1 | CO2 | CO3 | CO4 | CO5 | Total | TW |
|-------------------------------------|--------------------------------|-----|-----|-----|-----|-----|-------|--|
| Knowledge and Attitude Profile (WK) | | | | | | | 100 | Convert the total marks obtained to 50 |
| TW | Journal Experiment | 5 | 5 | 5 | 5 | 5 | | |
| | Course Project / Demonstration | 5 | 5 | 5 | 5 | 5 | | |
| | Presentation/viva | 10 | 10 | 10 | 10 | 10 | | |
| Total | | 100 | | | | | | |

Approved By:



| | | | | | | | | |
|---|--|-----------------|----|------------------|---------------------------|------------------------|----------------------|-----------|
| Program: | F. Y. M. Tech | | | Semester: | II | | | |
| Course: | Elective Course – II Structural Audit and Retrofitting of Structures | | | Course Code: | R25-MSE -MEC-513(A) | | | |
| Teaching Scheme (Hrs./week) | | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | | CCE | ESE | TW | PR |
| 03 Hrs./Week | - | - | 04 | 50 | 50 | - | - | |
| Course Description and: | | | | | | | | |
| This course teaches students to assess the health of existing structures and design effective retrofitting and rehabilitation strategies using structural auditing, condition assessment, and codal guidelines. | | | | | | | | |
| Course Relevance: Equips engineers to assess and strengthen existing structures for safety, durability, and sustainable infrastructure management. | | | | | | | | |
| Prerequisite: Knowledge of reinforced concrete and steel design, construction materials and practices. | | | | | | | | |
| Bridge Content: - Covers structural health evaluation, damage assessment, retrofitting techniques, rehabilitation strategies, and codal guidelines for bridges and related infrastructure. | | | | | | | | |
| Course Objectives: This course aims to develop advanced knowledge and skills in evaluating the health of existing structures and designing effective retrofitting and rehabilitation strategies. Students will learn the principles, practices, and codal guidelines for structural audit, condition assessment, and damage diagnosis of buildings, bridges, and other structures. | | | | | | | | |
| Course Outcomes: | | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level | |
| CO1 | Understand the principles, need, scope, and professional responsibilities in structural audit of civil infrastructure. | | | | | | 2 | |
| CO2 | Apply appropriate survey techniques and assessment methodologies to evaluate the condition of existing structures and document findings for engineering decision-making. | | | | | | 3,4 | |
| CO3 | Select and interpret suitable Non-Destructive and Semi-Destructive Tests for diagnosing material and structural performance. | | | | | | 3,4,5 | |
| CO4 | Evaluate and recommend repair materials and techniques ensuring durability, constructability, and compatibility with the parent structure. | | | | | | 5,6 | |
| CO5 | Design retrofitting and strengthening solutions for RC, steel, and composite structures by considering codal provisions, cost-effectiveness, and sustainability, supported by lessons from case studies. | | | | | | 5,6 | |
| Course Content | | | | | | | | |
| Unit 1 | Introduction to Structural Audit and Damage Mechanisms | | | | 6 Hrs. | CO Mapped: CO 1 | | |
| Need and scope of structural audit, objectives, stages of audit, legal and professional obligations. Common causes of deterioration: material degradation, design and construction deficiencies, environmental effects, overloading and accidental events. Symptoms of distress: cracks, deflections, corrosion, and other visible indicators. | | | | | | | | |
| Unit 2 | Condition Assessment and Survey Techniques | | | | 6 Hrs. | CO Mapped: CO 2 | | |
| Planning and methodology of structural surveys; visual inspection techniques; load testing; long term monitoring; use of condition assessment checklists. Interpretation and documentation of survey data for decision-making in | | | | | | | | |

Approved By:



| | | | |
|---|---|---------------|------------------------|
| civil engineering projects. | | | |
| Unit 3 | Non-Destructive (NDT) and Semi-Destructive Testing (SDT) | 6 Hrs. | CO Mapped: CO 3 |
| Overview and application of NDT and SDT: rebound hammer, ultrasonic pulse velocity (UPV), carbonation depth, core testing, half-cell potential, ground-penetrating radar, infrared thermography, and acoustic emission. Guidelines for selection, execution, and interpretation in real civil structures. | | | |
| Unit 4 | Repair Materials and Techniques | 6 Hrs. | CO Mapped: CO 4 |
| Repair materials: polymers, micro-concretes, mortars, fiber-reinforced composites, grouts, coatings, and corrosion inhibitors. Repair techniques: crack injection, jacketing, shotcreting, epoxy bonding, grouting, surface treatment, and cathodic protection. Practical considerations for durability, constructability, and structural compatibility. | | | |
| Unit 5 | Retrofitting, Strengthening and Case Studies | 6 Hrs. | CO Mapped: CO 5 |
| Retrofitting strategies for RC, steel, and composite structures; section enlargement, post tensioning, FRP strengthening, addition of members, bracing, shear walls, base isolation, and energy dissipation devices. Code provisions, cost, sustainability, and durability considerations. Case studies highlighting civil engineering applications, lessons learned, and best practices in retrofitting. | | | |
| Textbooks: | | | |
| 1. Maintenance, Repair and Rehabilitation of Concrete Structures, P. C. Varghese (PHI Learning) | | | |
| 2. Testing of Concrete in Structures, J. Bungey, J., S. Millard, M. Grantham, M. (CRC Press) | | | |
| Reference Books: | | | |
| 1. Concrete Structures Protection, Repair and Rehabilitation, R. Dodge Woodson (Butterworth Heinemann) | | | |
| 2. RILEM Technical Recommendations on Repair Materials and Testing Methods. | | | |
| MOOCs Links and additional reading material: | | | |
| 1. https://onlinecourses.nptel.ac.in/noc25_ce49/preview?utm_source=chatgpt.com | | | |
| 2. https://seismosoft.com/product/seismic-assessment-retrofitting-of-existing-rc-structures-using-seisbuild-and-seismostruct/?utm_source=chatgpt.com | | | |

CO-PO Mapping Table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | P01 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|------|------|------|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| CO2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| CO3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| CO4 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| CO5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Avg. | 1.0 | 1.0 | 1.00 | 1.00 | 1.00 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.00 |

Approved By:

**Assessment Pattern**

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|----------------|------------|----------------------|--------------------------|-----|
| | CT1 | CT2 | Open Book Test | Assignment | Seminar / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| L4 | | | | | | | |
| L5 | | | | | | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | | | 5 | | | 05 |
| Seminar | | | 5 | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | | |
|--|---|-----------------|----|---------------------|----------------------------|------------------------|----------------------|--|
| Program: | F. Y. M. Tech | | | Semester: | II | | | |
| Course: | Elective-III A) Design of Liquid Retaining Structures | | | Course Code: | R25-MSE-MEC-514 (A) | | | |
| Teaching Scheme (Hrs./week) | | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | CCE | ESE | TW | PR | |
| 03 Hrs/Week | - | - | 03 | 50 | 50 | - | - | |
| Course Description: This course focuses on the analysis, design, and detailing of reinforced concrete liquid retaining structures such as water tanks, reservoirs, sumps, sewage tanks, staging systems, and special hydraulic structures. The emphasis is on crack control, serviceability, stability, and safety requirements to ensure water-tightness. Design is carried out as per IS 3370 (Part 1–4), IS 456, and relevant codes. | | | | | | | | |
| Course Relevance: This course is essential for civil and structural engineers as liquid storage structures are vital in water supply, sewerage, and industry. It builds skills in crack control, water-tightness, and durability for professional design practice. | | | | | | | | |
| Prerequisite: Strength of Materials, Reinforced Concrete Design (RCC), Structural Analysis, and Basics of IS 456:2000 provisions | | | | | | | | |
| Bridge Content: -The bridge content strengthens foundational concepts such as material behavior, load combinations, serviceability, structural behavior of slabs and domes, hydrostatic forces, and fundamental limit state and working stress methods for better preparedness. | | | | | | | | |
| Course Objectives: The course objectives are to help students understand the behavior, failure modes, and crack-control requirements of liquid retaining structures; apply IS 3370 and related codes for structural design; analyze and design underground and overhead tanks of various shapes; design staging systems and assess safety against uplift, sliding, and overturning; and evaluate special considerations such as temperature stresses, joints, and durability to ensure water-tight and long-lasting structures. | | | | | | | | |
| Course Outcomes: | | | | | | | | |
| CO | Course Outcome | | | | | | Bloom's Level | |
| CO1 | Explain and apply codal provisions for liquid retaining structures as per IS 3370 and IS 456. | | | | | | 2 | |
| CO2 | Design circular and rectangular underground and overhead tanks using WSM and LSM. | | | | | | 3 | |
| CO3 | Analyze and design staging systems, raft foundations, and check tank stability. | | | | | | 4 | |
| CO4 | Evaluate detailing requirements, crack-width control, joints, and durability provisions. | | | | | | 5 | |
| Course Content | | | | | | | | |
| Unit 1 | Introduction & Codal Provisions | | | | 6 Hrs. | CO Mapped: CO 1 | | |
| Types of liquid retaining structures, Structural behaviour under liquid load, General design requirements for water-tightness, Crack-width control: direct tension, bending, temperature stresses, IS 3370 (Parts 1, 2, 4) overview, Working Stress Method (WSM) vs Limit State Method (LSM) for tanks, Permissible stresses, allowable crack widths | | | | | | | | |
| Unit 2 | Design of Circular Tanks | | | | 6 Hrs. | CO Mapped: CO 2 | | |
| Types: Ground-supported circular tanks, underground circular tanks, overhead circular tanks, Hoop tension & bending in walls, Design of domes, and circular floors, stiffening ring beam design, Design examples using IS 3370 (LSM & WSM). | | | | | | | | |
| Unit 3 | Design of Rectangular Tanks | | | | 6 Hrs. | CO Mapped: CO 2 | | |
| Ground-supported and underground rectangular tanks, Structural behaviour under distribution of liquid pressure, Bending moments & shear forces in walls and slabs, Design using WSM and LSM, Cantilever walls, slab design, corner conditions, Design of rectangular tanks (long wall & short wall analysis). | | | | | | | | |

Approved By:



| | | | |
|---|---|---------------|------------------------|
| Unit 4 | Overhead Tanks and Staging Systems | 6 Hrs. | CO Mapped: CO 3 |
| Types of overhead tanks: circular, rectangular, Intze tank, Design of container, top dome, bottom dome, ring beams, Analysis and design of staging: RC shafts, Braced frame staging, Wind, and seismic considerations (IS 1893 & IS 875), Stability checks: sliding, overturning, uplift, Foundation design considerations for tanks. | | | |
| Unit 5 | Special Considerations, Durability & Detailing | 6 Hrs. | CO Mapped: CO 4 |
| Joint types: construction joints, expansion joints, contraction joints. Water-stops and sealants, Temperature and shrinkage stresses, Crack prevention techniques, Durability provisions: cover, exposure conditions, impermeability, Design of sewage tanks, fire tanks, sumps, Floating roof tanks and special RC hydraulic structures (overview), Detailing practices as per IS 3370 & IS 456. | | | |
| Textbooks: | | | |
| 1 N. Krishna Raju – “Reinforced Concrete Structures” <i>CBS Publishers & Distributors, Latest Edition (commonly 2016 or later)</i> | | | |
| 2 R. S. Varma – “Design of Liquid Retaining Structures” <i>Oxford & IBH Publishing Co., Latest Reprint Edition</i> | | | |
| 3 N. Krishna Raju – “Advanced Reinforced Concrete Design” <i>CBS Publishers & Distributors, Latest Edition (popular 2014/2016 edition)</i> | | | |
| Reference Books: | | | |
| 1. Jain & Jaikrishna – “Plain and Reinforced Concrete (Vol. 1 & 2)” <i>Nem Chand & Bros., Latest Edition</i> | | | |
| 2. Jagadish & Jayaram – “Design of Liquid Retaining Structures” <i>I.K. International Publishing House, Latest Edition</i> | | | |
| 3. Park & Paulay – “Reinforced Concrete Structures” <i>John Wiley & Sons, 1975 (Classic standard reference)</i> | | | |
| 4. IS Codes: | | | |
| • IS 3370 (Parts 1–4): 2009 / 2021 – Code of Practice for Concrete Structures for Retaining Aqueous Liquids | | | |
| • IS 456: 2000 – Plain and Reinforced Concrete – Code of Practice | | | |
| • IS 875 (Parts 1–5): 1987 / 2015 – Design Loads for Buildings and Structures | | | |
| • IS 1893 (Part 1): 2016 – Criteria for Earthquake Resistant Design of Structure | | | |
| MOOCs Links and additional reading material: | | | |
| NPTEL – "Design of Reinforced Concrete Structures" | | | |
| NPTEL – "Advanced Structural Analysis" | | | |
| IIT lectures on water tank design (YouTube – NPTEL archive) | | | |
| MOOC – Public Health Engineering (Sections on storage tanks) | | | |

CO-PO Mapping Table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | P01 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|--------|--------|--------|
| CO1 | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | – | 3 | 2 | 1 |
| CO2 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | – | 3 | 3 | 1 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | – | 3 | 3 | 2 |
| CO4 | 3 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 3 | – | 3 | 3 | 2 |
| Avg. | 3 | 1.8 | 2 | 3 | 2.8 | 1.2 | 1.4 | 1.2 | 1 | 1.4 | -- | 3 | 2.8 | 1.4 |

Approved By:

**Assessment Pattern**

| BT Level | CCE | | | | | | ESE |
|----------|-----|-----|----------------|------------|----------------------|--------------------------|-----|
| | CT1 | CT2 | Open Book Test | Assignment | Seminar / Case Study | Quiz / presentation etc. | |
| L1 | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| L2 | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| L3 | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| L4 | | | ✓ | | | | |
| L5 | | | | | ✓ | | |
| L6 | | | | | | | |

Unit wise Weightage:

| Exam | Unit1 | Unit2 | Unit3 | Unit4 | Unit5 | Total |
|----------------|-------|-------|-------|-------|-------|-------|
| CT1 | 8 | 7 | | | | 15 |
| CT2 | | | 8 | 7 | | 15 |
| Open Book Test | | | | | 10 | 10 |
| Assignments | 5 | | | | | 05 |
| Seminar | 5 | | | | | 05 |
| ESE | 10 | 10 | 10 | 10 | 10 | 50 |
| | | | | | | 100 |

Approved By:



| | | | | | | | |
|------------------------------------|----------------------|------------------|-------------------|---------------------------|------------|-----------|-----------|
| Program: | F. Y. M. Tech | Semester: | II | | | | |
| Course: | Seminar-I | Course Code: | R25-MSE-SEM I-515 | | | | |
| Teaching Scheme (Hrs./week) | | | Credits | Examination Scheme | | | |
| Lecture | Practical | Tutorial | | CCE | ESE | TW | OR |
| - | 04 Hrs./Week | - | 02 | - | - | 25 | 25 |

Course Objectives: To develop students' ability to critically analyse advanced or emerging topics from Elective I and communicate their findings through a well-organized report and formal presentation.

Course Outcomes:

| CO | Course Outcome | Bloom's Level |
|-----|--|---------------|
| CO1 | Identify and critically analyse a topic from any subject in the Elective I list, incorporating a literature review to highlight research gaps or practical implications. | 4 |
| CO2 | Develop a concise seminar report and deliver a professional oral presentation demonstrating subject understanding, clarity, and effective audience engagement. | 6 |

Course Content

The seminar shall be centered on an advanced or emerging topic selected from any subject within the Elective I list. The topic will be chosen by the student in consultation with the faculty supervisor and may be based on recent research trends, innovative materials, advanced analysis or design techniques, significant project case studies, or industry-relevant issues within the chosen elective area. The seminar content should demonstrate a clear understanding of the subject, incorporate a critical review of relevant literature, identify research gaps or practical significance, and outline possible future directions or applications. It should reflect the student's ability to synthesis technical information, organize it logically, and effectively engage the audience in meaningful discussion.

As part of the seminar, students are required to prepare a well-structured report that includes the literature review, identified research gaps, justification of the study, objectives, and methodology or key findings related to the selected topic. Additionally, students must deliver a professional oral presentation, utilize appropriate visual aids, and respond effectively to questions and feedback

CO-PO Mapping Table:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| CO | P01 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 01 | PSO 02 | PSO 03 |
|------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|--------|--------|--------|
| CO1 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 3 | 0 |
| CO2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 2 | 0 | 0 | 3 | 0 | 2 |
| Avg. | 3.0 | 3.0 | 0.0 | 3.0 | 0.0 | 2.0 | 0.0 | 3.00 | 2.00 | 0.0 | 0.0 | 3.00 | 3.00 | 2.00 |

Approved By: