**KONGU ENGINEERING COLLEGE**
**PERUNDURAI ERODE – 638 060**
**(Autonomous)**

## VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

## MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

## QUALITY POLICY

We are committed to

- Provide value based quality education for developing the student as a competent and responsible citizen
- Contribute to the nation and beyond through the state-of-the-art technology
- Continuously improve our services

## DEPARTMENT OF CIVIL ENGINEERING

### VISION

To develop the department as a center of excellence to take care of the local and regional needs related to Civil Engineering and to meet acute needs of trained specialists in the diverse field of Civil Engineering.

### MISSION

Department of Civil Engineering is committed to:

MS1: Encourage students and faculty to undertake research programmes and projects of multi-disciplinary nature.

MS2: Conduct summer and winter schools for faculty members and short-term course for technicians.

MS3: Produce Engineers who can participate in technical advancement and social upliftment of the country and to meet the growing global challenges.

MS4: Prosper in academic activities by continual improvement in teaching methods, laboratory facilities and research activities.

MS5: Develop consultancy for various industries

## 2018 REGULATIONS

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Post Graduates of Structural Engineering will

PEO1: Apply in-depth technical knowledge, effective design skills and sustainability principles to address evolving engineering challenges.

PEO2: Have commitment for continuing professional development in this field or in related inter disciplinary fields with a background in Civil Engineering to fulfill the industrial and societal needs with professional ethics.

PEO3: Engage in continual learning by pursuing advanced research activities.

## MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

| MS\PEO | PEO1 | PEO2 | PEO3 |
|---|---|---|---|
| **MS1** | 1 | 2 | 1 |
| **MS2** | 1 | 1 | 1 |
| **MS3** | 2 | 2 | 3 |
| **MS4** | 3 | 3 | 3 |
| **MS5** | 1 | 2 | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial

| PROGRAM OUTCOMES (POs) | |
|---|---|
| **Structural Engineering Post Graduates will be able to:** | |
| **PO1** | Independently carry out research / investigation and development work to solve practical problems |
| **PO2** | Write and present a substantial technical report/document |
| **PO3** | Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program |
| **PO4** | Analyze the structures with the aid of software packages. |
| **PO5** | Design a concrete, steel, pre-stressed concrete, prefabricated elements and steel-concrete composite structural elements. |

## MAPPING OF PEOs WITH POs

| PEO\PO | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| PEO1 | 2 | 2 | 3 | 3 | 3 |
| PEO2 | 3 | 2 | 3 | 3 | 3 |
| PEO3 | 3 | 3 | 3 | 3 | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial

## CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATION 2018

| Curriculum Breakdown Structure(CBS) | Curriculum Content (% of total number of credits of the program) | Total number of contact hours | Total number of credits |
|---|---|---|---|
| Program Core(PC) | 45.84 | 525 | 33 |
| Program Electives(PE) | 25 | 270 | 18 |
| Project(s)/Internships(PR)/Others | 29.16 | 600 | 21 |
| **Total** | | | **72** |

# KEC R2018: SCHEDULING OF COURSES – ME: (Structural Engineering)

| Sem. | Theory/ Theory cum Practical / Practical | | | | | | Internship & Projects | Special Courses | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| I | 18SET11 Theory of Elasticity & Plasticity (PC-3-1-0-4) | 18SET12 Computer Analysis of Structures (PC-3-1-0-4) | 18SET13 Structural Dynamics (PC-3-1-0-4) | 18SEC11 Design of Steel Structures (PC-3-0-2*-3.5) | 18SEC12 Design of Concrete Structures (PC-3-0-2*-3.5) | 18GET01 Introduction to Research (PC-3-0-0-3) | | | 22 |
| II | 18SET21 Theory of Structural Stability (PC-3-0-0-3) | 18SEC21 Experimental Methods and Model Analysis (PC-3-0-2-4) | 18SET22 Design of Pre-stressed and Pre-fabricated Concrete Structures (PC-3-1-0-4) | Professional Elective - I (PE-3-0-0-3) | Professional Elective - II (PE-3-0-0-3) | Professional Elective –III (PE-3-0-0-3) | 18SEP21 Mini Project (PR-0-0-4-2) | | 22 |
| III | Professional Elective - IV (PE-3-0-0-3) | Professional Elective - V (PE-3-0-0-3) | Professional Elective - VI (PE-3-0-0-3) | | | | 18SEP31 Project Phase – I (PR-0-0-12-6) | 18SEI31 Industrial Training (PR-0-0-0-1) | 16 |
| IV | | | | | | | 18SEP41 Project Phase – II (PR-0-0-24-12) | | 12 |

**Total Credits: 72**

**KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 060**
**(Autonomous)**

**M.E. DEGREE IN STRUCTURAL ENGINEERING**

**CURRICULUM**

(For the candidates admitted from academic year 2018-19 onwards)

**SEMESTER – I**

| Course Code | Course Title | Hours / Week | | | Credit | Maximum Marks | | | CBS |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | CA | ESE | Total | |
| | **Theory/Theory with Practical** | | | | | | | | |
| 18SET11 | Theory of Elasticity and Plasticity | 3 | 1 | 0 | 4 | 50 | 50 | 100 | PC |
| 18SET12 | Computer Analysis of Structures | 3 | 1 | 0 | 4 | 50 | 50 | 100 | PC |
| 18SET13 | Structural Dynamics | 3 | 1 | 0 | 4 | 50 | 50 | 100 | PC |
| 18SEC11 | Design of Steel Structures | 3 | 0 | 2* | 3.5 | 50 | 50 | 100 | PC |
| 18SEC12 | Design of Concrete Structures | 3 | 0 | 2* | 3.5 | 50 | 50 | 100 | PC |
| 18GET01 | Introduction to Research | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PC |
| | **Total** | | | | **22** | | | | |

***** Alternate weeks

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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**M.E. DEGREE IN STRUCTURAL ENGINEERING**

**CURRICULUM**

(For the candidates admitted from academic year 2018-19 onwards)

**SEMESTER – II**

| Course Code | Course Title | Hours / Week | | | Credit | Maximum Marks | | | CBS |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | CA | ESE | Total | |
| | **Theory/Theory with Practical** | | | | | | | | |
| 18SET21 | Theory of Structural Stability | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PC |
| 18SEC21 | Experimental Methods and Model Analysis | 3 | 0 | 2 | 4 | 50 | 50 | 100 | PC |
| 18SET22 | Design of Prestressed and Prefabricated Concrete Structures | 3 | 1 | 0 | 4 | 50 | 50 | 100 | PC |
| | Elective - I | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PE |
| | Elective - II | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PE |
| | Elective - III | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PE |
| | **Practical** | | | | | | | | |
| 18SEP21 | Mini Project | 0 | 0 | 4 | 2 | 100 | 0 | 100 | PR |
| | **Total** | | | | **22** | | | | |

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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**M.E. DEGREE IN STRUCTURAL ENGINEERING**

**CURRICULUM**

(For the candidates admitted from academic year 2018-19 onwards)

**SEMESTER – III**

| Course Code | Course Title | Hours / Week | | | Credit | Maximum Marks | | | CBS |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | CA | ESE | Total | |
| | **Theory/Theory with Practical** | | | | | | | | |
| | Elective - IV | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PE |
| | Elective - V | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PE |
| | Elective - VI | 3 | 0 | 0 | 3 | 50 | 50 | 100 | PE |
| | **Practical** | | | | | | | | |
| 18SEI31 | Industrial Training | 0 | 0 | 0 | 1 | 100 | 0 | 100 | PR |
| 18SEP31 | Project Work Phase I | 0 | 0 | 12 | 6 | 50 | 50 | 100 | PR |
| | **Total** | | | | **16** | | | | |

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

**KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 060**
**(Autonomous)**

## M.E. DEGREE IN STRUCTURAL ENGINEERING

## CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

**SEMESTER – IV**

| Course Code | Course Title | Hours / Week | | | Credit | Maximum Marks | | | CBS |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | CA | ESE | Total | |
| | **Practical** | | | | | | | | |
| 18SEP41 | Project Work Phase II | 0 | 0 | 24 | 12 | 50 | 50 | 100 | PR |
| | **Total** | | | | **12** | | | | |

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

**Total Credits: 72**

| LIST OF PROFESSIONAL ELECTIVES | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **Hours/Week** | | | **Credit** | **CBS** |
| | | **L** | **T** | **P** | | |
| **SEMESTER II** | | | | | | |
| 18SEE01 | Soil-Structure Interaction | 3 | 0 | 0 | 3 | PE |
| 18SEE02 | Earthquake Analysis and Design of Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE03 | Optimization of Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE04 | Fracture Mechanics of Concrete Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE05 | Design of Plates and Shells | 3 | 0 | 0 | 3 | PE |
| 18SEE06 | Design of Industrial Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE07 | Finite Element Analysis | 3 | 0 | 0 | 3 | PE |
| 18SEE08 | Design of Steel Concrete Composite Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE09 | Structural Health Monitoring | 3 | 0 | 0 | 3 | PE |
| **SEMESTER III** | | | | | | |
| 18CME18 | Maintenance and Rehabilitation of Structures | 3 | 0 | 0 | 3 | PE |
| 18CME19 | Green Building Management | 3 | 0 | 0 | 3 | PE |
| 18SEE10 | Design of Bridges | 3 | 0 | 0 | 3 | PE |
| 18SEE11 | Design of Tall Buildings | 3 | 0 | 0 | 3 | PE |
| 18SEE12 | Design of Structures for Dynamic Loads | 3 | 0 | 0 | 3 | PE |
| 18SEE13 | Design of Off Shore Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE14 | Mechanics of Composite Materials and Structures | 3 | 0 | 0 | 3 | PE |
| 18SEE15 | Design of Substructures | 3 | 0 | 0 | 3 | PE |
| 18SEE16 | Metro Transportation System and Engineering | 3 | 0 | 0 | 3 | PE |

## 18SET11 THEORY OF ELASTICITY AND PLASTICITY

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

| | |
|---|---|
| Preamble | To create an awareness about the research, model development in the elastic and plastic regime |
| Prerequisites | Strength of Materials |

**UNIT – I** **9**

**Introduction to Elasticity:** Basic concepts of deformation of deformable bodies - Displacement - Stress and Strain Fields - Stress Transformation laws - Differential equations of equilibrium in two and three dimensions in Cartesian coordinates - Generalized Hooke's law - Lame's Constant

**UNIT – II** **9**

**Two Dimensional Problems in Cartesian Coordinates:** Plane Stress and Plane Strain Problems - Airy's Stress Function - Polynomials - Direct method of determining Airy's Stress Function - Two Dimensional Problems in Cartesian Coordinates - Bending of a Cantilever Loaded at Free End - Bending of a Beam under Uniform Loading

**UNIT – III** **9**

**Two Dimensional Problems in Polar Coordinates:** Equations of Equilibrium in Polar Coordinates - Two Dimensional Problems in Polar Coordinates - Bending of Curved Beam - Thick Cylinder under Uniform Pressure - Flat Plate subjected to in plane traction and Shear with Circular Hole

**UNIT – IV** **9**

**Torsion and Energy Theory:** Torsion of Prismatic bars - Membrane Analogy of Torsion - Torsion of Rectangular Section - Torsion of Thin Tubes. Energy Methods - Principle of Virtual Work - Energy Theorems

**UNIT – V** **9**

**Plastic Deformation:** Strain Hardening, Idealized Stress - Strain Curve, Yield Criteria - Von Misses Yield Criterion - Tresca Yield Criterion, Plastic Stress - Strain Relations (Flow Rule), Plastic Problems of beams in Bending and Torsion

**Lecture:45, Tutorial:15, Total: 60**

**REFERENCES:**


| | |
|---|---|
| 1. | Chandramouli P.N., "Theory of Elasticity", 1st Edition, Yesdee Publishing Pvt. Ltd., Chennai, 2017. |
| 2. | Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi, 1988. |
| 3. | Jane Helena H., "Theory of Elasticity and Plasticity", Prentice Hall Publication, NewDelhi, 2017. |

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to | | BT Mapped<br>(Highest Level) |
|---|---|---|
| CO1: | calculate the stress and strain parameters | Applying (K3) |
| CO2: | analyze the induced stress in the two dimensional problems in cartesian coordinates | Analyzing (K4) |
| CO3: | interpret the induced stress in the two dimensional problems in polar coordinates | Applying (K3) |
| CO4: | apply the energy theorem and torsion to elastic problems | Analyzing (K4) |
| CO5: | determine the physical behavior of yield criteria of materials | Understanding (K2) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | | | 2 |
| CO2 | 3 | | | | 3 |
| CO3 | 2 | | | | 3 |
| CO4 | 3 | | | | 3 |
| CO5 | 1 | | | | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

| 18SET12 COMPUTER ANALYSIS OF STRUCTURES | | | | | |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | **Credit** |
| | | **3** | **1** | **0** | **4** |
| Preamble | To analyze the structure using flexibility and stiffness method | | | | |
| Prerequisites | Engineering Mechanics, Strength of Materials and Structural Analysis | | | | |

**UNIT – I** **9**

**Fundamental Concepts:** Introduction - Forces and Displacement measurements - Principle of superposition - Methods of structural analysis - Betti's law - Stiffness and flexibility matrices of the elements - A review.

**UNIT – II** **9**

**Transformation of Information:** Relationship between element and a system - Transformation of system force to element forces - Element flexibility to system flexibility - System displacement to element displacement - Transformation of forces and displacement in general, constrained, normal and orthogonal transformation.

**UNIT – III** **9**

**Flexibility Method:** Choice of redundant - ill and well conditioned equations - Automatic choice of redundant - Rank technique - Transformation of one set of redundant to another set - Thermal expansion - Lack of fit - Application to pin-jointed plane truss - Continuous beams - Frames and grids - Static condensation Technique - Substructure technique

**UNIT – IV** **9**

**Stiffness Method:** Development of stiffness method - Analogy between flexibility and stiffness - Analysis due to thermal expansion, lack of fit - Application to pin-jointed plane truss - Continuous beams - Frames and grids - Static condensation Technique - Substructure technique

**UNIT – V** **9**

**Matrix Displacement Methods and Special Topics:** Transfer Matrix Method - Symmetry and Anti symmetry of structures - Reanalysis technique. **Direct Stiffness Method:** Discrete system - Direct stiffness approach - Application to two dimensional pin-jointed trusses - Plane frames - Grids.

**Lecture:45, Tutorial:15, Total: 60**

**REFERENCES:**


1. Mcguire and Gallagher R.H., "Matrix Structural Analysis", 2nd Edition, John Wiley, 2015.
2. Rajasekaran S. and Sankarasubramanian G., "Computational Structural Mechanics", Prentice Hall of India, New Delhi, 2001.
3. Robert E. Sennett, "Matrix Analysis of Structures", 3rd Edition, John Wiley, 2000.
4. Natarajan C. and Revathi P., "Matrix Method of Structural Analysis", Eastern Economy Edition, PHI, 2014.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | apply the fundamentals in the analysis of structural members | Applying (K3) |
| CO2: | analyze the structural elements by transferring the information from system to element and vice-versa | Analyzing (K4) |
| CO3: | analyze the structural elements using flexibility method | Analyzing (K4) |
| CO4: | analyze the structural elements using stiffness method | Analyzing (K4) |
| CO5: | analyze and apply solutions for structural elements using matrix displacement method and direct stiffness method | Analyzing (K4) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | 3 | | |
| CO2 | 2 | | 3 | | |
| CO3 | 2 | | 3 | | |
| CO4 | 2 | | 3 | | |
| CO5 | 2 | | 3 | | |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

## 18SET13 STRUCTURAL DYNAMICS

(IS 1893:2002, IS 13935:2009, IS 13920 :2016 & IS 4326:1993 codes are permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

| | |
|---|---|
| Preamble | To expose the students about the principles and methods of dynamic analysis of structures and to prepare them for designing the structures for blast or earthquake and other dynamic loads |
| Prerequisites | Basics of Earthquake Engineering |

**UNIT – I** **9**

**Principles of Vibration Analysis:** Mathematical models of single degree of freedom systems - Free and forced vibration of SDOF systems - Response of SDOF system to special forms of excitation - Effect of damping - Transmissibility - Applications - Examples related to structural engineering.

**UNIT – II** **9**

**Two Degree of Freedom Systems:** Mathematical models of two degree of freedom systems - Free and forced vibrations of two degree of freedom systems - Normal modes of vibration – Applications

**UNIT – III** **9**

**Multi-degree of Freedom Systems:** Mathematical models of Multi-degree of freedom systems - Orthogonality of normal modes - Free and forced vibrations of multi degree of freedom systems - Mode superposition technique - Response spectrum method – Applications

**UNIT – IV** **9**

**Continuous Systems:** Mathematical models of continuous systems - Free and forced vibration of continuous systems - Rayleigh-Ritz method - Formulation using Virtual Work – Applications

**UNIT – V** **9**

**Response to General Dynamic Loading:** Fourier series expression for loading (blast or earthquake) - Duhamel's integral - Vibration analysis by Rayleigh's method - Improved Rayleigh's method - Earthquake response analysis of MDOF systems subjected to earthquake ground motion - Idealization of multi-storied frames

**Lecture:45, Tutorial:15, Total: 60**

**REFERENCES:**


1. Anil K. Chopra, "Dynamics of Structures", 3rd Edition, Pearson Education, 2007.
2. Mario Paz, "Structural Dynamics: Theory and Computation", 5th Edition, Kluwer Academic Publication, 2004.
3. Leonard Meirovitch, "Elements of Vibration Analysis", 2nd Edition, McGraw Hill, IOS Press, 1986.
4. Roy R. Craig, Jr Andrew J. Kurdila, "Fundamentals of Structural Dynamics", 2nd Edition, John Wiley & Sons, 2011.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | explain the effects of vibration and damping on structures | Analyzing (K4) |
| CO2: | determine the response of two degree of freedom systems | Applying (K3) |
| CO3: | interpret the response of Multi Degree of Freedom systems | Applying (K3) |
| CO4: | analyze the continuous systems using approximate methods | Analyzing (K4) |
| CO5: | apply the approximate method to solve complex problems subjected to different loading condition | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 1 |
| CO2 | 3 | | 2 | | 1 |
| CO3 | 3 | | 2 | | 1 |
| CO4 | 3 | | 2 | 2 | 1 |
| CO5 | 3 | | 2 | 2 | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEC11 DESIGN OF STEEL STRUCTURES

(IS 800 : 2007, IS 801, IS 811, IS 875 Part 3 & SP-06 are to be permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | $2^*$ | 3.5 |

| | |
|---|---|
| Preamble | This course deals with the plastic analysis and design of steel structures. The design and detailing of members subjected to axial force and bending moment, water tanks and chimneys with their connections were dealt in detail. In addition design of cold formed steel sections and pre-engineered buildings are also discussed. |
| Prerequisites | Engineering Mechanics and Structural Analysis |

**UNIT – I** **9**

**Industrial Building:** Roof trusses - Roof and side coverings - Design of truss elements - Design of purlins - Design of end bearings - Gable column, gable rafter, side rails, gable wind girder and end bracings of industrial buildings - Introduction to the design of steel structures for fire loads.

**UNIT – II** **9**

**Plastic Analysis of Structures:** Introduction - Shape factors - Moment redistribution - Static, kinematic and uniqueness theorem - Combined mechanisms - Analysis and design of continuous beams and portal frame - Effect of axial force and shear force on plastic moment.

**UNIT – III** **9**

**Design of Connections:** Bolted and welded connections - Types of connections for eccentric loading - Framed connections - Bracket connections - Seat connections - Moment resisting connections.

**UNIT – IV** **9**

**Water Tanks and Chimneys:** Water tanks - Water pressure on tank walls- Design of pressed steel water tank - Types of chimneys - Components of chimney - Design of self-supporting chimney (Lined).

**UNIT – V** **9**

**Light Gauge Steel Structures and Pre Engineered Buildings:** Types of cross sections - Local buckling - Design of compression and tension members - Design of beams - General concept of pre-engineered buildings - Simple portal frame design

**List of Exercises / Experiments :**

1. Analysis and design of plane and space truss using STAAD Pro
2. Plastic analysis of continuous beams and portal frames by developing the spread sheet
3. Design of various types of connections using spread sheet
4. Analysis and design of steel water tanks using STAAD Pro
5. Analysis and design of steel chimneys using STAAD Pro
6. Design of light gauge sections using spread sheet

**Lecture:45, Practical:15, Total: 60**

* Alternate weeks

**REFERENCES:**

1. Subramanian N., "Design of Steel Structures", Oxford University Press, New Delhi, 2011.
2. Dayaratnam P., "Design of Steel Structures", 3rd Edition, S. Chand & Company, New Delhi, 2013.
3. Wen Yu, "Cold-Formed Steel Design", 4th Edition, John Wiley & Sons, New York, 2010.
4. Gaylord E.H., Gaylord C.N., and Stallmeyer J.E., "Design of Steel Structures", 3rd Edition, McGraw-Hill Publications, London, 2010.

| **COURSE OUTCOMES:** On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | design the components of roof trusses and purlin | Analyzing (K4) |
| CO2: | analyze the steel structures using of plastic design | Analyzing (K4) |
| CO3: | illustrate the connections of various members using welded and bolted connections | Analyzing (K4) |
| CO4: | design the steel water tank and steel chimney | Analyzing (K4) |
| CO5: | inspect the behavior of light gauge steel members and pre-engineered structures | Analyzing (K4) |
| CO6: | analyze and design the steel trusses using STAAD Pro | Analyzing (K4), Manipulation (S2) |
| CO7: | perform the plastic analysis of structures using spread sheet | Analyzing (K4), Manipulation (S2) |
| CO8: | design water tanks, chimney and light gauge sections using modern tools | Analyzing (K4), Manipulation (S2) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |
| CO6 | 3 | | 2 | 3 | 3 |
| CO7 | 3 | | 2 | 3 | 3 |
| CO8 | 3 | | 2 | 3 | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEC12 DESIGN OF CONCRETE STRUCTURES

(IS 456:2000, IS 13920:2016, SP 16 and SP 34 codes are permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 2* | 3.5 |

| | |
|---|---|
| Preamble | This course give the detailed concept to check the serviceability of reinforced concrete members, analysis and design of the flat slab, grid floors, walls subjected to lateral load, deep beams, corbels, slender columns and inelastic behavior of reinforced concrete structures. |
| Prerequisites | Design of RC Elements |

**UNIT – I** **9**

**Design Concepts:** Stress-strain relationship for concrete and steel - Design Philosophies - Working stress method, ultimate load method - Limit state method - Review of basic design of RC members under flexure, shear, combined shear and torsion, axial compression - Bond and anchorage requirements. **Limit State of Serviceability:** Deflection - Calculation of short term deflection and long term deflection - Limits on deflection. Cracking - Causes of cracking - Factors influencing crack width - Mechanism of flexural cracking - Cracking control of flexural cracking in design - Calculation of crack width.

**UNIT – II** **9**

**Design of slabs:** Design of flat slab (IS methods) - Design of grid floors - Yield line theory and Hillerborgs strip method of design of slabs for various Boundary Conditions.

**UNIT – III** **9**

**Design of RC walls and deep Beams:** Design of RC walls - ordinary and shear walls. Design of deep beams.

**UNIT – IV** **9**

**Special RC Elements:** Design of Slender Column. Strut and tie method of analysis and design for corbels. Design of spandrel beams.

**UNIT – V** **9**

**Inelastic behaviour of Concrete Structures:** Moment - Rotation curves - Moment redistribution - Baker's method of plastic design - Detailing for ductility - Concrete cover - Fire resistance of structural members.

**List of Experiments:**

1. Introduction to software tools available to analysis the structural systems
2. Analysis of building frames for gravity loads using STAAD Pro/ETABS
3. Analysis of building frames for lateral loads using STAAD Pro/ETABS
4. Design and detailing of beams by developing the design spread sheet
5. Design and detailing of slabs by developing the design spread sheet
6. Design and detailing of columns by developing the design spread sheet
7. Design and detailing of columns by developing the design spread sheet
8. Analysis and design of water retaining structures

**Lecture:45, Practical:15, Total: 60**

* Alternate weeks

| **REFERENCES:** | |
|---|---|
| 1. | Unnikrishna Pillai and Devdas Menon, "Reinforced concrete Design", 3rd Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006. |
| 2. | Subramanian N., "Design of Reinforced Concrete Structures", 1st Edition, Oxford University Press, 2014. |
| 3. | Varghese P.C., "Advanced Reinforced Concrete Design", 2nd Edition, Prentice Hall of India, 2007. |
| 4. | Gambhir M.L., "Design of Reinforced Concrete Structures", 6th Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 2013. |

| **COURSE OUTCOMES:**<br>On completion of the course the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | calculate the deflection and crack width in the flexural members | Analyzing (K4) |
| CO2: | analysis and design the flat slabs and grid floors | Analyzing (K4) |
| CO3: | design the R.C walls, deep beams and yield analysis of slab | Analyzing (K4) |
| CO4: | formulate the procedure to design the slender column, corbels and spandrel beams | Analyzing (K4) |
| CO5: | evaluate the inelastic behavior of concrete structures | Analyzing (K4) |
| CO6: | analyze the building frames for various loads | Analyzing (K4), Manipulation (S2) |
| CO7: | develop a design spread sheet to design various structural elements | Applying (K3), Manipulation (S2) |
| CO8: | analyze and design the water retaining structures | Analyzing (K4), Manipulation (S2) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |
| CO6 | 3 | | 2 | 3 | 3 |
| CO7 | 3 | | 3 | 3 | 3 |
| CO8 | 3 | | 2 | 3 | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18GET01 INTRODUCTION TO RESEARCH

(Common to Engineering and Technology Branches)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting.<br>To disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools. |
| Prerequisites | Nil |

**UNIT – I** **9**

**Concept of Research:** Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.

**UNIT – II** **9**

**Research Methods and Journals:** Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.

**UNIT – III** **9**

**Paper Writing and Research Tools:** Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.

**UNIT – IV** **9**

**Effective Technical Thesis Writing/Presentation:** How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.

**UNIT – V** **9**

**Nature of Intellectual Property:** Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - innovation - patenting - development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents.

**Total: 45**

**REFERENCES:**


1. DePoy, Elizabeth, and Laura N. Gitlin, “Introduction to Research-E-Book: Understanding and Applying Multiple Strategies”, Elsevier Health Sciences, 2015.
2. Walliman, Nicholas, “Research Methods: The basics”, Routledge, 2017.
3. Bettig Ronald V., “Copyrighting culture: The political economy of intellectual property”, Routledge, 2018.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | list various stages in research/patenting and categorize the quality of journals | Analyzing (K4) |
| CO2: | formulate a research problem from published literature/journal papers | Evaluating (K5) |
| CO3: | write, present a journal paper/ project report using latest tools in proper format | Creating (K6) |
| CO4: | select suitable journal and submit a research paper | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 |
|---|---|---|---|
| CO1 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 1 |
| CO4 | 3 | 2 | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

| 18SET21 THEORY OF STRUCTURAL STABILITY | | | | | |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | **Credit** |
| | | **3** | **0** | **0** | **3** |
| Preamble: | To understand the basic concepts & terminology on structural stability and describe conceptual procedures for testing stability | | | | |
| Prerequisites: | Nil | | | | |

**UNIT – I** **9**

**Fundamental Concepts of Stability:** Criterion for design of structures: strength, stability and stiffness – Concepts of stability, instability and bifurcation – Stability criteria – Concepts of Equilibrium and Energy approaches – South well Plot.

**UNIT – II** **9**

**Buckling of Columns:** Governing differential equations – Higher order differential equations – Analysis for various boundary conditions – Behaviour of imperfect column – eccentrically loaded column – Rayleigh Ritz, Galerkin Methods – Effect of shear on buckling

**UNIT – III** **9**

**Buckling of Beam – Column and Frames:** Buckling of Beam – columns: Buckling of Beam – columns with concentrated lateral loads – Distributed loads – Effect of axial loads on bending stiffness. Buckling of frames: Mode of buckling – Single storey frames with and without sway.

**UNIT – IV** **9**

**Lateral and Torsional Buckling:** Differential equations for lateral buckling – Lateral buckling of beams in pure bending – Lateral buckling of simply supported I beams. Buckling of Thin Walled Open Sections: Introduction – Torsional buckling – Torsional flexural buckling.

**UNIT – V** **9**

**Stability of Plates and Inelastic Buckling:** Buckling of rectangular plates for various edge conditions – Finite difference method. Introduction to inelastic buckling – Double modulus theory (reduced modulus) - Tangent modulus theory - Shanley's theory.

**Total: 45**

**REFERENCES:**


1. Chajes A., "Principles of Structural Stability Theory", 4th Edition, Prentice Hall, 2008.
2. Iyengar N.G.R., "Structural Stability of Columns and Plates", Affiliated East West Press Pvt. Ltd., New Delhi, 2000.
3. Brush D.O. and Almorth B.O., "Buckling of Bars, Plates and Shells", 2nd Edition, McGraw Hill, 2006.
4. Timoshnko S.O. and Gere J.M., "Theory of Elastic Stability", 2nd Edition, McGraw Hill, 2009.

| **COURSE OUTCOMES:**<br>On completion of the course the students will be able to | | **BT Mapped<br>(Highest Level)** |
|---|---|---|
| CO1: | manipulate the stability and instability concepts | Applying (K3) |
| CO2: | analyze the buckling of columns with various boundary conditions | Analyzing (K4) |
| CO3: | compare the buckling of frames and plates | Analyzing (K4) |
| CO4: | apply the concept of lateral and torsional buckling | Applying (K3) |
| CO5: | identify the torsional, lateral and inelastic buckling of plates | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 1 | | 3 | | 2 |
| CO2 | 1 | | 3 | | 3 |
| CO3 | 1 | | 3 | | 3 |
| CO4 | 1 | | 3 | | 3 |
| CO5 | 1 | | 3 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEC21 EXPERIMENTAL METHODS AND MODEL ANALYSIS

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 2 | 4 |

| | |
|---|---|
| Preamble | This course discuss mainly on the various instruments that are used in civil engineering and to demonstrate about the significance of measurements and applications. |
| Prerequisites | Nil |

**UNIT – I** **9**

**General:** Basic concept in measurements - Measurement in displacement, strain pressure, force, torque etc. - Type of strain gauges (Mechanical, Electrical resistance, Acoustical etc.) - Load calibration of testing machines - I.S. Code provisions

**UNIT – II** **9**

**Measurement System:** Mechanical, Optical and Acoustical extensometers - Strain measurement - Electrical resistance strain gauges - Principle, Types, Performance, Uses - Strain Rosettes - Wheatstone Bridge - Electronic load cells - Proving rings - X Y Plotter - Wind Tunnels

**UNIT – III** **9**

**Testing and Analysis Method:** Indication and Recording - Static and Dynamic data recording - Data (Digital and Analogue) acquisition and processing systems - Strain analysis methods - Rosette analysis - Static and Dynamic testing techniques - Equipment for loading - Moire’s techniques

**UNIT – IV** **9**

**Testing Techniques:** Non destructive testing techniques - Photo elasticity - Optics of photo elasticity - Polariscope - Isoclinics and Isochromatics - Methods of stress separation - Holographic techniques

**UNIT – V** **9**

**Model Laws and Analysis:** Laws of similitude - Model materials - Model testing - Necessity for Model analysis – Advantages – Applications - Types of similitude - Scale effect in Models - Indirect model study - Direct model study - Limitations of model investigations - Structural problems that may demand model studies - Usage of influence lines in model studies

**List of Exercises / Experiments:**

1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behavior.
2. Testing of simply supported steel beam for strength and deflection behavior.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading
4. Dynamic testing of cantilever steel beam
   (i) To determine the damping coefficients for free vibrations.
   (ii) To evaluate the mode shapes
5. Static cyclic testing of single bay two storied steel frames to evaluate
   (i) Drift of the frame.
   (ii) Stiffness of the frame.
   (iii) Energy dissipation capacity of the frame.
6. Determination of in-situ strength and quality of concrete using
   (i) Rebound hammer
   (ii) Ultrasonic Pulse Velocity Test
7. Rapid Chloride Penetration Test
8. Acceleration Corrosion Test

**Lecture:45, Practical:30, Total: 75**

| REFERENCES: | |
|---|---|
| 1. | Rangan C.S., "Instrumentation – Devices and Systems", 2nd Edition, Tata McGrawHill Publishing Co. Ltd., New Delhi, 21st Reprint 2008. |
| 2. | Sadhu Singh, "Experimental Stress Analysis", 2nd Edition, Khanna Publishers, New Delhi, 1990. |
| 3. | Dally J.W. and Riley W.F., "Experimental Analysis", 1st Edition, McGraw Hill Inc., New York, 1991. |

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | Compare and classify the different types of strain gauges | Understanding (K2) |
| CO2: | apply the instrument techniques for the measurement of structural related problem in civil engineering | Applying (K3) |
| CO3: | apply dynamic instruments for measuring the vibration motion in structures | Applying (K3) |
| CO4: | quantify the structural characteristics by using the various measuring instruments | Applying (K3) |
| CO5: | explain the principle of model laws in vibrational systems | Applying (K3) |
| CO6: | perform the testing on beams | Evaluating (K5), Manipulation (S2) |
| CO7: | evaluate the behavior of the frames | Evaluating (K5), Manipulation (S2) |
| CO8: | assess the quality of reinforced concrete by non-destructive test | Evaluating (K5), Manipulation (S2) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 1 | | 2 | 2 | |
| CO2 | 2 | | 3 | 2 | 1 |
| CO3 | 3 | | 3 | 2 | 1 |
| CO4 | 2 | | 3 | 1 | |
| CO5 | 2 | | 1 | | |
| CO6 | 2 | | 2 | 3 | 1 |
| CO7 | 2 | | 2 | 3 | 1 |
| CO8 | 2 | | 2 | 3 | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

## 18SET22 DESIGN OF PRESTRESSED AND PREFABRICATED CONCRETE STRUCTURES
**(IS 1343-2012, IS 3370 Part III & IV-1967, IS 784-2001, IS 456-2000 and SP-16 are permitted)**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

| | |
|---|---|
| Preamble | To enable the students to design the prestressed and prefabricated Concrete Structural elements |
| Prerequisites | Design of Reinforced Concrete Elements |

**UNIT – I** **9**

**Design Concepts:** Basic Concepts - Advantages - Materials - Methods of prestressing - Pretensioning and post tensioning - Review on analysis of sections for stresses by various concepts - Types of Losses and deflection in prestress. **Design of Prestressed Flexural Member:** Flexural strength - Shear resistance - Web shear crack – Flexure - shear cracks - Design principles for members with flexure and shear - Design of slabs - Design of sleepers - Design of Anchorage zone - IS method - Introduction to Launching and erection of prestressed girders

**UNIT – II** **9**

**Tension and Compression Members:** Design of tension members - Design of compression members with and without flexure - Application in the design of prestressed pipes and prestressed concrete cylindrical water tanks.

**UNIT – III** **9**

**Design of Composite Structures**: Analysis for stresses - Estimate for deflections - Flexural and shear strength of composite members. **Continuous Members:** Advantages - Methods of achieving continuity - Concept of linear - Transformations - Primary moment - Secondary moment - Resultant moment - Pressure or thrust line - Line of prestress - Concordant cable profile - Analysis of continuous beams.

**UNIT – IV** **9**

**Prefabricated Elements:** Principles - Types of prefabrication - Modular Co-ordinate - Standardization - Systems - Manufacturing methods - Equipments for hoisting and erection - Techniques for erection of different types of members - Prefabricated components - Large panel construction - Disuniting of structures.

**UNIT – V** **9**

**Design of Prefabricated Elements:** Design of flexural member - Design of flat slab and hollow core slab- Design of Inverted -T beam and L-beam - Design principles of column - Joints for structural members.

**Lecture:45, Tutorial:15, Total: 60**

**REFERENCES:**


1. Krishnaraju N., “Prestressed Concrete”, 5th Edition, Tata McGraw Hill Publishing Co. Ltd, 2012.
2. Shinha N.C. and Roy S.K., “Fundamentals of Prestressed Concrete”, 2nd Edition, S.Chand and Company Ltd., 1985.
3. “PCI Design Hand Book”, 6th Edition, Precast/Prestressed Concrete Institute, ACI, 2004.

| **COURSE OUTCOMES:**<br>On completion of the course the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | analyze and design the flexural members | Analyzing (K4) |
| CO2 : | design the tension and flexural member | Analyzing (K4) |
| CO3: | analyze the composites structure and continuous member | Analyzing (K4) |
| CO4: | enumerate the principles, manufacture and erection of prefabricated components | Analyzing (K4) |
| CO5: | formulate the design procedure to design the prefabricated slabs and beams | Analyzing (K4) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 2 |
| CO2 | 3 | | 2 | | 2 |
| CO3 | 3 | | 2 | | 2 |
| CO4 | 3 | | 2 | | 2 |
| CO5 | 3 | | 2 | | 2 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

## 18SEE01 SOIL-STRUCTURE INTERACTION

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To provide an understanding of the relevance and significance of soil-structure interaction in the different cases of shallow foundation and pile foundation. It also focuses on idealization of soil response to various models and interaction analysis for machine foundation and retaining structures. |
| Prerequisites | Soil Mechanics and Foundation Engineering |

**UNIT – I** **9**

**Introduction to SSI:** Introduction to SSI - Importance of SSI - Applications and Examples of SSI - Effect of structure roughness / smoothness on soil behavior.

**UNIT – II** **9**

**SSI in Shallow Foundation:** General soil-structure interaction problems - Shallow foundation, Sheet piles, Mat/Raft foundation - Contact pressure and soil-structure interaction for shallow foundation - Fixed/ Flexible base - Differential foundation settlement for high rise buildings – Pressure - settlement prediction from constitutive laws

**UNIT – III** **9**

**SSI Models:** Elastic continuum - Winkler’s model - Multi parameter models - Hybrid models - Codal provisions - Machine foundation - Soil interaction - Analysis of finite plates - Rectangular and circular plates - Numerical analysis of finite plates - Simple solutions

**UNIT – IV** **9**

**Elastic Analysis of Pile:** Elastic analysis of single pile - Theoretical solutions for settlement and load distribution - Analysis of pile group - Interaction analysis - Load distribution in groups with rigid cap

**UNIT – V** **9**

**SSI in Retaining Structures:** Curved failure surfaces, their utility and analytical / graphical predictions from Mohr – Coulomb envelope and circle of stress - Earth pressure computations by friction circle method - Earth pressure on wall with limited / restrained deformations - Earth pressure on sheet piles, braced excavations - Design of supporting system for excavations

**Total: 45**

**REFERENCES:**


1. Michael J Tomlinson, John C Woodward., “Pile Design and Construction Practice”, 6th Edition, CRC Press, 2014.
2. Saran S., “Analysis and Design of Substructures”, 2nd Edition, Taylor & Francis Publishers, 2006.
3. Kurien N.P., “Design of Foundation Systems: Principles and Practices”, 3rd Edition, Narosa Publishing House, New Delhi, 1999.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | illustrate the overview of soil structure interactions | Understanding (K2) |
| CO2: | analyze soil structure interaction problems in shallow foundation | Analyzing (K4) |
| CO3: | demonstrate different types of soil structure models | Applying (K3) |
| CO4: | investigate soil structure interaction parameters involved in the pile foundation | Analyzing (K4) |
| CO5: | analyze the soil structure interaction involved in retaining structures | Analyzing (K4) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 1 | | | | 2 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 2 | | 1 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE02 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

(IS 1893:2002, IS13935:2009, IS 13920:2016 & IS 4326:1993 codes are permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To study the effect of earthquakes, analysis and design of earthquake resistant structures. |
| Prerequisites | Basics of Earthquake Engineering |

**UNIT – I** **9**

**Earthquakes and Strong Ground Motion:** Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake phenomenon), - Plate tectonics - Quantification of earthquakes - Strong ground motion instrumentation - Lessons learnt in past Earthquakes.

**UNIT – II** **9**

**Characteristics of Earthquake:** Estimation of earthquake parameters, Response spectra - Average response spectra - Design response spectra - Evaluation of Earthquake forces as per codal provisions - Seismic hazard analysis - Determination of probabilistic approaches.

**UNIT – III** **9**

**Earthquake Resistant Design of Masonry Structures:** Behaviour of reinforced and unreinforced masonry buildings - Lessons learnt from past earthquakes. Structural systems - Types of buildings, Causes of damage, Planning considerations, Philosophy and principle of earthquake Resistant design, Guidelines for earthquake resistant design of masonry buildings - Design consideration - Seismic strengthening of masonry buildings

**UNIT – IV** **9**

**Earthquake Resistant Design of RC Structures:** Mathematical modeling of multistoried RC buildings - Capacity based design - Earthquake resistant design of R.C.C buildings - Material properties - Lateral load analysis - Design and detailing - Rigid frames - Shear wall - Coupled shear wall.

**UNIT – V** **9**

**Vibration Control:** Tuned mass dampers - Principles and application - Basic concept of Seismic Base isolation - Various systems - Case studies - Computer Analysis and design of Building systems subjected to Earthquake Loads.

**Total: 45**

**REFERENCES:**


1. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, 3rd Edition, Prentice Hall of India, 2006.
2. Duggal S.K., “Earthquake Resistant Design of Structures”, 2nd Edition, Oxford University Press, 2013.
3. Roberto Villaverde, “Fundamentals of Concepts of Earthquake Engineering”, 1st Edition, CRC Press, 2009.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | explain the elements of seismology | Understanding (K2) |
| CO2: | assess the earthquake parameters using different methods | Applying (K3) |
| CO3: | illustrate the behavior of masonry buildings subjected to earthquake loading | Analyzing (K4) |
| CO4: | analyze the RC buildings subjected to earthquake loading | Analyzing (K4) |
| CO5: | apply various vibration control techniques on structures | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 1 |
| CO2 | 3 | | 2 | | 1 |
| CO3 | 3 | | 2 | | 1 |
| CO4 | 3 | | 2 | 1 | 1 |
| CO5 | 3 | | 2 | 1 | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE03 OPTIMIZATION OF STRUCTURES

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | This course provides to present modern concepts of optimal design of structures. Basic ideas from optimization theory are developed with simple design examples. |
| Prerequisites | Nil |

**UNIT – I** **9**

**Basic Principles and Classical Optimization Techniques:** Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behavior and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria)

**UNIT – II** **9**

**Linear Programming:** Formulation of problems - Graphical solution – Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - Simplex method - Two phase method - Penalty method - Duality theory -Primal - Dual algorithm

**UNIT – III** **9**

**Non Linear Programming:** One Dimensional minimization methods: One-dimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search – Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques

**UNIT – IV** **9**

**Geometric and Dynamic Programming:** Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty- Bellman's principle of optimality - Representation of a multistage decision problem - Concept of sub-optimization problems using classical and tabular methods

**UNIT – V** **9**

**Structural Applications:** Methods for optimal design of structural elements - Continuous beams and single storied Frames using plastic theory - Minimum weight design for truss members - Fully stressed Design - Optimization principles to design of R.C. structures such as multistory buildings,Water tanks and bridges

**Total: 45**

**REFERENCES:**


1. Rao S.S., "Engineering Optimization: Theory and Practice", 1st Edition, New Age International Pvt. Ltd., New Delhi, 2013.
2. Taha H.A., "Operations Research: An Introduction", 5th Edition, Macmillan, New York, 2013.
3. Hadley G., "Linear Programming", Narosa Publishing House, New Delhi, 2002.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | apply basic principles and classical optimization techniques | Applying (K3) |
| CO2: | analyze linear programming for variables | Analyzing (K4) |
| CO3: | design non linear programming by various methods | Applying (K3) |
| CO4: | develop geometric and dynamic programming | Applying (K3) |
| CO5: | apply optimization technique in structural problems | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | | | |
| CO2 | 2 | | | 2 | |
| CO3 | 1 | | 2 | 3 | 1 |
| CO4 | 2 | 1 | 2 | 3 | 1 |
| CO5 | 3 | 1 | 2 | 3 | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

## 18SEE04 FRACTURE MECHANICS OF CONCRETE STRUCTURES

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | The aim of study is to predict the propagation of crack growth and unbalanced condition under elastic and elasto-plastic conditions and to assess the stress intensity factors and strain energy liberation rate. |
| Prerequisites | Basic Mathematics, Strength of Materials |

**UNIT – I** **9**

**Introduction:** Review of Engineering Failure Analysis - Modes of fracture failure - The Griffith energy Balance Approach - Crack tip Plasticity - Fracture toughness

**UNIT – II** **9**

**Linear Elastic Fracture Mechanics:** Elastic crack tip theory - Stress and displacement fields in isotropic elastic materials - Westergaard's approach (opening mode) - Feddersen approach - Determination of R curve, Energy released rate for DCB specimen - $K_{1c}$ Test techniques - Critical energy release rate .

**UNIT – III** **9**

**Elastic-Plastic Fracture Mechanics:** Limitation of K approach - Approximate shape and size of the plastic zone - Effective crack length – Elastic-plastic fracture concept - Crack tip opening displacement - Dugdale approach - Path independence - Critical J integral - Evaluation of CTOD - Relationship between CTOD - $K_1$ and $G_1$ for small scale yielding.

**UNIT – IV** **9**

**Fatigue Crack Growth:** Fatigue crack growth to sharpen the tip - Methods to determine $J_{1c}$ Mechanism of Fatigue - Fatigue crack propagation - Paris law - Crack closure mechanism - Residual stresses at crack tip - Retardation effect fatigue crack growth test - Stress intensity factor - Factors affecting stress intensity factor - Variable amplitude service loading - Interaction effects.

**UNIT – V** **9**

**Crack Arrest and Numerical Methods:** Principles of crack arrest - Crack arrest in practice - K-R Curves - Crack resistance curve - Numerical Methods and Approaches in Fracture Mechanics - Methods to determine fracture parameters.

**Total: 45**

**REFERENCES:**


1. David Broek, "Elementary Engineering Fracture Mechanics", 3rd Edition, Martinus Nijhoff Publishers, The Hague, 2012.
2. Gdoutos E.E., "Fracture Mechanics – An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht, 2003.
3. Suresh S., "Fatigue of Materials", 2nd Edition, Cambridge University Press, Cambridge 2015.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | describe the fracture failure modes | Understanding (K2) |
| CO2: | evaluate the linear elastic fracture in concrete structures | Evaluating (K5) |
| CO3: | explain the behavior of elasto plastic fracture mechanics | Analyzing (K4) |
| CO4: | compute the residual life of fatigue crack growth in structure | Applying (K3) |
| CO5: | select suitable crack arrest parameters using various techniques | Analyzing (K4) |
| CO6: | evaluate the fracture parameters using direct and indirect methods | Evaluating (K5) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | | 1 | |
| CO2 | 3 | | 2 | 2 | 2 |
| CO3 | 1 | | 1 | 1 | 3 |
| CO4 | 3 | | 1 | 1 | 2 |
| CO5 | 3 | | 1 | 2 | 2 |
| CO6 | 3 | | 1 | 2 | 2 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE05 DESIGN OF PLATES AND SHELLS

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | The objective of this course is to offer a comprehensive and methodical presentation of the fundamentals of thin plate theories based on a strong foundation of mathematics and mechanics with emphasis on engineering aspects and also to apply the theories and methods to the analysis and design of thin plate structures in engineering |
| Prerequisites | Nil |

**UNIT – I** **9**

**Thin Plate Theory:** Assumptions - Bending of long rectangular plates to a cylindrical surface - Differential equation - Plates with simply supported Edges - Plates with built-in edges - Pure bending of plates - Slope and curvature of slightly bent plates - Relation between bending moment and curvature.

**UNIT – II** **9**

**Classical Approach and Methods:** Small deflections of laterally loaded plates - Differential equation of the deflection surface - Simply supported rectangular plates under sinusoidal loading - Navier's solution for simply supported rectangular plates under uniform loading, under hydrostatic pressure, under concentrated load and under a load uniformly distributed over the area of a rectangle - Levy's method - Advantages over Navier's solution - Simply supported rectangular plates under uniform loading and under hydrostatic pressure - Finite difference approach - Bending of laterally loaded thin plates - Differential equation - Simply supported and fixed square and rectangular plates under uniform loading, partial loading, triangular loading and trapezoidal loading - Energy methods - Principle of virtual work - Principle of minimum potential energy

**UNIT – III** **9**

**Circular Plates and Anisotropic Plates:** Symmetrical bending of laterally loaded circular plates – Differential equation – Uniformly loaded circular plates – Circular plate with triangular loading – Circular plate with circular hole – Circular plate concentrically loaded – Circular plate loaded at the centre – Circular plates with moments. Bending of Anisotropic plates – Differential equation of the bent plate – Bending of rectangular plates – Bending of circular and elliptic plates

**UNIT – IV** **9**

**Structural Behaviour of Shell:** Classification of shell surfaces – Surfaces of revolution - Δ-forms of surfaces – Folded plates – Characteristics of shell surfaces – Surfaces and its related aspects – Curvatures of a surface – Curves and related aspects - Structural behaviour and various relations – Equilibrium equations – Stress-strain relationships –Equilibrium equations for thin shell elements in membrane state – Curvilinear coordinate system –Shells of revolution – Strain-displacement relations for cylindrical shells

**UNIT – V** **9**

**Design of Shells:** Based on membrane theory – Shells having semicircular directrix – Shells with circular directrix – Design of shells based on beam theory - Design aspects of paraboloid, hyperboloid and hyperbolic paraboloid shells – Folded plates – Analysis and structural behaviour – Various types – Design of folded plates by ACI-ASCE Task Committee method

**Total: 45**

**REFERENCES:**


1. Timoshenko S., "Theory of Plates and Shells," 2nd Edition, McGraw Hill Education Pvt. Ltd., 2015.
2. Ansel C. Ugural, "Stresses in Beams, Plates and Shells," 3rd Edition, CRC Press, 2010.
3. Reddy J.N., "Theory and Analysis of Elastic Plates and Shells", 2nd Edition, CRC Press, Taylor and Francis Group, 2007.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | analyze bending of long rectangular plates using thin plate theory | Analyzing (K4) |
| CO2: | evaluate circular and anisotropic plates with various loading conditions | Evaluating (K5) |
| CO3: | analyze rectangular plates using classical approach and methods | Analyzing (K4) |
| CO4: | characterize the structural behavior of shell under different loading conditions | Analyzing (K4) |
| CO5: | design the components of shell structures | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 3 | | 3 |
| CO2 | 3 | | 3 | | 3 |
| CO3 | 3 | | 3 | | 3 |
| CO4 | 3 | | 3 | | 3 |
| CO5 | 3 | | 3 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

## 18SEE06 DESIGN OF INDUSTRIAL STRUCTURES
### [IS 800: 2007, IS 801, IS 811 & SP-06 are permitted]

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | This course offers the design of steel structures as per limit state method. This course follows the recommendation of IS: 800 – 2007. It aims at determination of safe as well as economical steel section for various industrial and framed structures. |
| Prerequisites | Engineering Mechanics, Basic RCC Design and Design of Steel Structures. |

**UNIT – I** **9**

**Planning and Functional Requirements:** Classification of Industries and Industrial structures - planning for Layout - Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration - Guidelines of Factories Act

**UNIT – II** **9**

**Industrial Buildings – Steel:** Roofs for Industrial Buildings - Gantry Girders - steel bunkers and silos

**UNIT – III** **9**

**Industrial Buildings – Concrete:** Design of Corbels and Nibs – Machine foundations

**UNIT – IV** **9**

**Power Plant Structures:** Concrete bunker and silos - concrete chimney

**UNIT – V** **9**

**Power Transmission Structures:** Transmission Line Towers - Substation Structures - Tower Foundations - Testing towers. (Only principles)

**Total: 45**

**REFERENCES:**


1. Manohar S.N., "Tall Chimneys - Design and Construction", 1st Edition, Tata McGraw Hill, 1985.
2. Santhakumar A.R. and Murthy S.S., "Transmission Line Structures", 1st Edition, Tata McGraw Hill, 1992.
3. Srinivasulu P. and Vaidyanathan C., "Handbook of Machine Foundations", 1st Edition, Tata McGraw Hill, 1976.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped<br>(Highest Level)** |
|---|---|---|
| CO1: | plan the industrial structures | Applying (K3) |
| CO2: | analyze and design the gantry girders, bunkers and silos | Analyzing (K4) |
| CO3: | categorize the design procedure in corbels and nibs | Analyzing (K4) |
| CO4: | simplify the design concepts in the power plant structures | Analyzing (K4) |
| CO5: | design the tower foundations | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | 1 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE07 FINITE ELEMENT ANALYSIS

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | This course provides an introduction to the finite element analysis. |
| Prerequisites | Engineering Mechanics and Structural Analysis |

**UNIT – I** **9**

**Introduction:** Basic Concept of FEM - Engineering problems and governing differential equations - Finite element modeling - Introduction to Elasticity - Discretisation - Node, Element - Different types of element - Approximate Solutions - Principal of minimum potential energy, Rayleigh-Ritz method and Galerkins methods.

**UNIT – II** **9**

**One Dimensional Problems:** One dimensional problems - Coordinate systems - Global, local and natural coordinate systems, shape functions - Bar, beam and truss element - Generation of Stiffness Matrix and Load Vector

**UNIT – III** **9**

**Two and Three Dimensional Problems:** Two Dimensional problems - Plane Stress, Plane Strain Problems - Triangular and Quadrilateral Elements - Isoparametric Formulation - Natural Coordinates, Shape function, stiffness matrix - Axisymmetric Problems - Higher Order Elements - Numerical Integration - Three dimensional elasticity - Governing differential equations - Higher order Isoparametric solid elements

**UNIT – IV** **9**

**Analysis of Framed Structures:** Stiffness of Truss Member - Analysis of Truss - Stiffness of Beam Member - Finite Element Analysis of Continuous Beam - Plane Frame Analysis - Numerical Evaluation of Element Stiffness - Formulation for 3 Dimensional Elements - Solution for simple frames.

**UNIT – V** **9**

**Applications:** Finite Elements for Elastic Stability - Dynamic Analysis - Nonlinear, Vibration and Thermal Problems - Meshing and Solution Problems - Modeling and analysis using recent softwares.

**Total: 45**

**REFERENCES:**


1. Bhavikatti S.S., “Finite Element Analysis”, New Age International Publishers, 2015.
2. Chandrupatla R.T. and Belegundu A.D., “Introduction to Finite Elements in Engineering”, Prentice Hall of India, 2012.
3. Krishnamoorthy C.S., “Finite Element Analysis”, 2nd Edition, McGraw Hill, 2017.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | apply the concept of finite element analysis and approximate solutions techniques | Applying (K3) |
| CO2: | analyze one dimensional problems | Analyzing (K4) |
| CO3: | apply the finite element analysis concept in two and three dimensional element problems | Applying (K3) |
| CO4: | evaluate the framed structures | Evaluating (K5) |
| CO5: | solve the nonlinear, vibration and thermal problems | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | | | |
| CO2 | 3 | | 2 | | |
| CO3 | 3 | | 2 | | 2 |
| CO4 | 3 | | 2 | | 2 |
| CO5 | 3 | | 2 | | 2 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

## 18SEE08 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES
## (IS: 800-2007 & EURO code-4 are permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | This course deals with limit state design of steel concrete composite structures. The discussion on the concept of limit state design based on IS: 800-2007 and EURO code-4 has been included. The design and detailing of composite beam, column, slab, truss etc. were dealt in detail. |
| Prerequisites | Structural analysis and Basic structural steel design |

**UNIT – I** **9**

**Theory of Composite Structures:** Introduction - Modular ratio - Transformed section - Sectional properties - Composite action - No interaction and Full interaction - Slip calculation - Stress block - Ultimate moment capacity - Codal provisions for steel concrete composites design - Local buckling and section classification - Partial safety factors - Design provisions for tension, compression, bending members and connections.

**UNIT – II** **9**

**Composite Beams:** Introduction to composite beams - Ultimate moment behaviour - Types and load transferring mechanism of shear connectors - Types, merits and behaviour of profiled decking - Design consideration for simply supported and continuous composite beam (with or without profile deck) - Introduction to skewed beams - Design philosophy.

**UNIT – III** **9**

**Composite Floors:** Introduction to composite floors - Shear transferring mechanism in profile deck system - Bending resistance of composite slab - Design consideration of composite floor - Design of Composite floor- Introduction to skewed slabs- Design philosophy.

**UNIT – IV** **9**

**Composite Columns:** Introduction to composite columns and its applications - Resistance of encased composite column cross section and infilled composite column cross section under compression - Design consideration of both encased and infilled composite column under axial compression, uniaxial bending and biaxial bending.

**UNIT – V** **9**

**Composite Trusses:** Behaviour and application of composite truss - Design consideration - Stud specifications - Load calculation - Design of composite truss - Composite connections - Complexities of composite connections and its design philosophies - Force flow in the joint.

**Total: 45**

**REFERENCES:**


1. Johnson R.P., “Composite Structures of Steel and Concrete”, Volume I, Blackwell Publishing, U.K. 2008.
2. Narayanan R., “Composite steel structures – Advances, design and construction”, Elsevier, Applied Science, UK, 1987.
3. “Teaching Resources for Structural Steel Design”, Volume 2 of 3, Institute for Steel Development and Growth (INSDAG), 2002.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | interpret the mechanism of composite action between steel and concrete and thereby determining it's the ultimate carrying capacity | Applying (K3) |
| CO2: | analyze and design composite beams with and without profile decking sheet | Analyzing (K4) |
| CO3: | design composite slabs with the provision of profile decking sheet | Analyzing (K4) |
| CO4: | design the encased and in-filled composite columns | Analyzing (K4) |
| CO5: | illustrate the design of composite trusses | Analyzing (K4) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE09 STRUCTURAL HEALTH MONITORING

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | The main objective is to monitor the health of the structures and to identify the proper solution for the structural problems. |
| Prerequisites | Nil |

**UNIT – I** **9**

**Introduction to Structural Health Monitoring (SHM):** An Overview of Structural Health Monitoring - Structural Health Monitoring and Smart Materials - Structural Health Monitoring versus Non Destructive Evaluation - Emerging SHM Technologies - Sensors - Piezoelectric Material - Magnetostrictive Material - Optical Fiber - LDV - Overview of Application Potential of SHM

**UNIT – II** **9**

**Application of SHM in Civil Engineering:** An overview of notable Applications of SHM - Civil Engineering field applications - Case studies bridges, pretension and pre fabricated structures, external post tension cables, historical buildings - Capacitive methods - Application on cover concrete.

**UNIT – III** **9**

**Non Destructive Testing of Concrete Structures:** Introduction to NDT - Situations and contexts, where NDT is needed, classification of NDT procedures, visual Inspection, half-Cell electrical potential methods, Schmidt Rebound Hammer Test, resistivity measurement, electromagnetic methods, radiographic Testing, ultrasonic testing, Infra Red thermography, ground penetrating radar, radio isotope gauges, other methods.

**UNIT – IV** **9**

**Vibration Control for SHM:** Introduction to FE formulation - Constitutive Relationship - Element stiffness matrix and Element Mass Matrix for High Precision Finite Element - Developing Actuator and Sensor Influence Matrix - Estimating Sensor Voltage - Damping - A Case study of Performance Estimation for Different Patches - SHM of Ribbon Reinforced Composite Laminate

**UNIT – V** **9**

**Rehabilitation and Retrofitting of Concrete Structure:** Repair rehabilitation & retrofitting of structures, damage assessment of concrete structures, Materials and methods for repairs and rehabilitation, modeling of repaired composite structure, structural analysis and design -Importance of re-analysis, execution of rehabilitation strategy, Case studies.

**Total: 45**

**REFERENCES:**


1. Daniel Balageas, Claus - Peter Fritzen, Alfredo Guemes, “Structural Health Monitoring”, 1st Edition, ISTE Publishing Ltd., U.K. 2006.
2. Guide Book on Non-destructive Testing of Concrete Structures, Training course series No. 17, International Atomic Energy Agency, Vienna, 2002.
3. Hand book on “Repair and Rehabilitation of RCC Buildings“, Director General, CPWD, Govt. of India, 2002.
4. “Hand Book on Seismic Retrofitting of Buildings”, CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | adapt a proper health monitoring technique | Applying (K3) |
| CO2: | analyze the various health monitoring system and apply to the real problems | Analyzing (K4) |
| CO3: | examine the accurate Non destructive technique for existing structure | Analyzing (K4) |
| CO4: | detect the proper vibration control systems in the construction | Evaluating (K5) |
| CO5: | carryout solution for the problems identified in the structures | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | 1 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 3 | | 3 |
| CO5 | 2 | | 1 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18CME18 MAINTENANCE AND REHABILITATION OF STRUCTURES

(Common to Construction Engineering and Management & Structural Engineering branches)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To identify the causes of deterioration and consequent modern rehabilitation strategy at optimum cost |
| Prerequisites | Construction Materials and Concrete Technology |

**UNIT – I** **9**

**General Aspects:** Performance of construction materials and components in actual structure for strength, permeability, thermal properties and cracking effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, Effects of cover thickness.

**UNIT – II** **9**

**Maintenance and Diagnosis of Failure:** Maintenance, Repair and rehabilitation, Facets of Maintenance, Importance of Maintenance, Various aspects of inspection - Assessment procedure for evaluating a damaged structure. Diagnosis of construction failures.

**UNIT – III** **9**

**Materials and Techniques for Repair:** Special concretes and mortar, concrete chemicals, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete. Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning.

**UNIT – IV** **9**

**Modern Techniques of Retrofitting:** Structural first aid after a disaster, guniting, jacketing, use of chemicals in repair, application of polymers, ferrocement and fiber concretes as rehabilitation materials, rust eliminators and polymer coating for rebars, foamed concrete, mortar repair for cracks, shoring and underpinning, strengthening by prestressing.

**UNIT – V** **9**

**Post repair Maintenance of Structures:** Protection and Maintenance schedule against environmental distress to all those structures - Special cares in rehabilitation of heritage structures - high rise buildings - bridges and other special structures.

**Total: 45**

**REFERENCES:**


1. Dayaratnam P. and Rao R., "Maintenance and Durability of Concrete Structures", 1st Edition, University Press, India, 1997.
2. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", 1st Edition, Longman Scientific and Technical, UK, 1991.
3. Dodge Woodson R., "Concrete Structures – protection, repair and rehabilitation", 1st Edition, Elsevier Butterworth – Heinmann, UK, 2009.

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to | | BT Mapped<br>(Highest Level) |
|---|---|---|
| CO1: | examine the performance of construction materials influenced by various factors | Applying (K3) |
| CO2: | choose repair and maintenance strategies for structures | Applying (K3) |
| CO3: | apply suitable post repair techniques for special structures | Applying (K3) |
| CO4: | adopt appropriate pre-stressing technique for special structures | Applying (K3) |
| CO5: | select the maintenance strategies for special structures | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | 3 | | 1 |
| CO2 | 2 | | 3 | | 1 |
| CO3 | 2 | | 3 | | 1 |
| CO4 | 2 | | 3 | | 1 |
| CO5 | 2 | | 3 | | 1 |

1 – Slight, 2 – Moderate, 3 – Substantial , BT - Bloom's Taxonomy

## 18CME19 GREEN BUILDING MANAGEMENT

(Common to Construction Engineering Management & Structural Engineering branches)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To categorize conventional and eco friendly building concept and building certification systems as per Indian and International Standards |
| Prerequisites | Nil |

**UNIT – I** **9**

**Introduction to IGBC and Green Building Concept:** Green building concept- Introduction to IGBC- Green Building rating tools - Green project management and certification - Documentation and certification - Methods and management practices

**UNIT – II** **9**

**Introduction to Green Rating Systems:** History of green rating systems - LEED, GRIHA, BREEAM, IGBC - Need and use of green rating systems - Structure of the rating systems - Market response to various rating systems - Selection of the appropriate rating system.

**UNIT – III** **9**

**Alternative Construction Materials and Construction Methods:** Building and material reuse - Salvaged materials - Material content - Manufactured materials - Recycled content – Eco block - Volatile organic compounds (VOC's) Natural non-petroleum based materials - Alternative construction methods - Alternative systems - Waste management and recycling - Design for deconstruction

**UNIT – IV** **9**

**Performance Testing:** Cost and performance comparisons and benchmarking - Building modeling and energy analysis - Cost benefit analysis - Testing and verification - Energy, shell and systems installation testing - Blower door - Duct tightness - Thermal imagery - Air quality - Moisture testing - Commissioning, metering, monitoring -Weatherization - Air sealing – HVAC - Moisture control - Energy retrofits and green remodels.

**UNIT – V** **9**

**Future of Building Rating Systems:** Role of green building consultant - Determining the various green points - Green accreditation examinations - Energy modeling and energy auditing in green building ratings - Consultancy scope and services for green rating systems - Codes and certification programs - Green rating registration - Documentation and management - Inspection and evaluation - Deep energy retrofits - Green remodel ratings - International green construction codes and ratings - Case study on existing green building.

**Total: 45**

**REFERENCES:**


1. Ross Spiegel G., "Green Building Materials A Guide to Product Selection and Specification", 3rd Edition, John Wiley & Sons, 2010.
2. Jagadish K.S., "Alternative Building Materials and Technologies", New Age International Pvt. Ltd. Publishers, 2008.
3. Sam Kubba, "Handbook of Green Building Design and Construction", 2nd Edition, Butterworth-Heinemann Publications, 2016.

| COURSE OUTCOMES:<br>On completion of the course, the students will be able to | | BT Mapped (Highest Level) |
|---|---|---|
| CO1: | model the concepts of green building | Applying (K3) |
| CO2: | execute the existing green building rating systems | Applying (K3) |
| CO3: | discover alternate construction materials and methods | Analyzing (K4) |
| CO4: | examine the green buildings | Analyzing (K4) |
| CO5: | design the codes for certification of green construction. | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | 3 | | 1 |
| CO2 | 2 | | 3 | | 1 |
| CO3 | 2 | | 3 | | 1 |
| CO4 | 2 | | 3 | | 1 |
| CO5 | 2 | | 3 | | 1 |

1- Slight , 2 - Moderate , 3 – Substantial, BT – Bloom’s Taxonomy

## 18SEE10 DESIGN OF BRIDGES

(IRC 5 - 1998, IRC 6 -2010 , IRC 18 - 2000, IRC 21-2000, IRC 22 - 1986, IRC 24 – 2001 & IRC 83 part I, II & III – 2002 codes are permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | This course offers the design of bridges such as RCC bridges, design principles of steel and prestressed concrete bridges, design principles of substructure and design of different types of bearings as per IRC loadings standards, Indian Railway standards bridge rules and most codes. It aims at determination of safe as well as economical section using different kinds of material used in construction and maintenance. |
| Prerequisites | Knowledge in Mechanics of Materials, Mechanics of Deformable bodies, Structural Analysis, Basic RCC Design and Design of Steel Structures. |

**UNIT – I** **9**

**Introduction:** Classification - Investigations and planning - Choice of type - I.R.C.specifications for road bridges - Standard live loads, other forces acting on bridges, general design considerations.

**UNIT – II** **9**

**Short Span Bridges:** Load distribution theories - Analysis and design of slab culverts - Tee beam and slab Bridges.

**UNIT – III** **9**

**Long Span Girder Bridges:** Design principles of continuous bridges - Box girder bridges - Balanced cantilever bridges.

**UNIT – IV** **9**

**Design of Prestressed Bridges:** Minimum section Modules – Stress at transfer and service loads – Prestressing forces – Eccentricity of cables – End Block – Advantages of prestressed concrete bridges – Design of post tensioned prestressed concrete slab bridge deck – Design of post tensioned prestressed Tee beam and slab bridge.

**UNIT – V** **9**

**Bearings and Substructures:** Types of bearings - Design of masonry and concrete piers and abutments - Types of bridge foundations - Design of principles of deep foundations.

**Total: 45**

**REFERENCES:**


1. Ponnuswamy S., "Bridge Engineering", 2nd Edition, Tata McGraw Hill, 2008.
2. Johnson Victor D., "Essentials of Bridge Engineering", 5th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2001.
3. Srinivasulu P. and Vaidyanathan C., "Handbook of Machine Foundations", 1st Edition, Tata McGraw Hill, 2002.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | apply knowledge in IRC specification | Applying (K3) |
| CO2: | analyze and design the short span bridges | Analyzing (K4) |
| CO3: | formulate the procedure to design the long span bridges | Analyzing (K4) |
| CO4: | analyze and design the prestressed concrete bridges | Analyzing (K4) |
| CO5: | simplify the stresses in sub-structure and design the piers and abutments | Analyzing (K4) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | | 1 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE11 DESIGN OF TALL BUILDINGS

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To study the behavior, analysis and design of tall buildings |
| Prerequisites | Structural Analysis, Design of concrete structures and Design of steel structures |

**UNIT – I** **9**

**Loading and Design Principles:** Loading - Gravity loading - Wind loading - Earthquake loading - Blast loading - Equivalent lateral force, modal analysis - Static and Dynamic approach - Analytical and wind tunnel experimental methods - Strength and stability - Stiffness and drift limitations - Human comfort criteria - Creep, shrinkage and temperature effects.

**UNIT – II** **9**

**Behaviour of Various Structural Systems:** Factors affecting growth - Height and Structural form - High rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

**UNIT – III** **9**

**Analysis and Design:** Modelling for approximate analysis - Accurate analysis and reduction techniques - Analysis of buildings as total structural system considering overall integrity and major subsystem interaction - Analysis for member forces, drift and twist - Multistoried general three dimensional analysis.

**UNIT – IV** **9**

**Structural Elements:** Sectional shapes - Properties and resisting capacity, design, deflection, cracking, prestressing, shear flow - Design for differential movement - Creep and shrinkage effects - Temperature effects and fire resistance.

**UNIT – V** **9**

**Stability of Tall Buildings:** Overall buckling analysis of frames - Wall-frames - Approximate methods - Second order effects of gravity of loading - P-Delta analysis - Simultaneous first-order and P-Delta analysis - Translational, Torsional instability, out of plumb effects - Stiffness of member in stability - Effect of foundation rotation.

**Total: 45**

**REFERENCES:**


1. Bungale S. and Taranath B.S., “Tall Building Design”, 1st Edition, CRC Press, 2017.
2. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, 3rd Edition, John Wiley and Sons Inc., 2005.
3. Nigel Clark and Bill Price, “Tall Buildings: A Strategic Design Guide”, 2nd Edition, RIBA Publishing, 2015.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | adapt the various types of loads and their effects on tall buildings | Applying (K3) |
| CO2: | explain the behavior of various structural systems in tall buildings | Understanding (K2) |
| CO3: | analyze the tall buildings by approximate, accurate and simplified methods | Analyzing (K4) |
| CO4: | design the structural elements of tall buildings | Applying (K3) |
| CO5: | examine the stability of tall buildings | Analyzing (K4) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 3 | | |
| CO2 | 3 | | 3 | | |
| CO3 | 3 | | 3 | | 3 |
| CO4 | 3 | | 3 | | 3 |
| CO5 | 3 | | 3 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE12 DESIGN OF STRUCTURES FOR DYNAMIC LOADS

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | This course give the detailed concept to analysis and design the reinforced concrete structures against the seismic, blast, impact, wind loads. |
| Prerequisites | Structural Dynamics, Earthquake Resistant Design of Structures, Design of Concrete Structures |

**UNIT – I** **9**

**Introduction:** Design philosophy to resist earthquake, cyclone, flood, blast and Impact - National and International codes of practices - Behavior of concrete, steel, masonry and soil, under impact and cyclic loads - Energy absorption capacity - Ductility of material and the structure. **Effects of Cyclone and Flood:** Effect of cyclones on buildings and special structures - safety and precautionary steps in design.

**UNIT – II** **9**

**Design Against Earthquakes:** Earthquake characterization - Response spectra - Seismic coefficient and response spectra methods of estimating loads - Response of framed, braced frames and shear wall buildings - Design as per BIS codes of practice - Ductility based design.

**UNIT – III** **9**

**Design Against Blast and Impact:** Characteristics of internal and external blast - Impact and impulse loads - Explosions - Threats - wave scaling law - Fire loading - Pressure distribution on buildings above ground due to external blast - Underground explosion - Design of buildings for blast and impact as per BIS codes of practice.

**UNIT – IV** **9**

**Design Against Wind:** Characteristics of wind - Basic and Design wind speeds - Aeroelastic and Aerodynamic effects - Design as per BIS code of practice including Gust Factor approach - along wind and across wind response - effect on tall buildings, towers, chimney, roofs, window glass, cladding and slender structures - vibration of cable supported bridges and power lines due to wind effects - tornado effects

**UNIT – V** **9**

**Special Considerations:** Detailing for ductility - passive and active control of vibrations - new and favorable materials - response of dams, bridges, buildings - strengthening measures - safety analysis - methods of strengthening for different disasters - Maintenance and modification to improve hazard resistance.

**Total: 45**

**REFERENCES:**


1. Bela Goschy, "Design of Building to withstand Abnormal Loading", 1st Edition, Butterworths, 1990.
2. Paulay T. and Priestley M.J.N., "A Seismic Design of Reinforced Concrete and Masonry Building", 1st Edition, John Wiley and Sons, 2009.
3. Dowding C.H., "Blast Vibration - Monitoring and Control", 2nd Edition, Prentice Hall Inc., 2004.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | explain the design philosophies and code of practice for dynamic loads | Understanding (K2) |
| CO2: | analyze and design the structures against seismic loads using the BIS codes of practice | Analyzing (K4) |
| CO3: | analyze and design the structures against the blast and impact loading | Analyzing (K4) |
| CO4: | evaluate the effect of wind load on the structures and design as per BIS code | Analyzing (K4) |
| CO5: | discuss the special consideration for safety analysis of the building | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 1 | | | | 2 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 2 | | 1 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

## 18SEE13 DESIGN OF OFFSHORE STRUCTURES

(IS4561 Part 1 – 1974, IS4561 Part 2 – 1989, IS4561 Part 3- 1974, IS4561 Part 4 - 1989, IS4561 Part 5 – 1980, IS9527 Part 1 – 1981, IS9527 Part 3 – 1983, IS9527 Part 4 – 1981, IS10020 Part 4 – 1981, IS875 Part 3 – 1987, SP64 – 2001 codes are permitted)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | The objective is to get the wave theories, offshore structural modeling and design. |
| Prerequisites | Design of concrete structures and design of steel structures |

**UNIT – I** | **9**

**Wind Effects:** Wind on Structures - Rigid Structures - Flexible Structures - Static and dynamic effects.

**UNIT – II** | **9**

**Wave Hydrodynamics:** Wave generation and propagation small and finite amplitudes wave theories - Wave energy and pressure distribution.

**UNIT – III** | **9**

**Wave Loading:** Wave forces on vertical–inclined–cylinderical structures - Environmental loadings - Use of Morrison equation.

**UNIT – IV** | **9**

**Offshore Structure Modelling:** Different types of structures - Foundation modeling - Static methods of analysis - Dynamics of Offshore Structures - Software applications.

**UNIT – V** | **9**

**Design of Offshore Structures:** Loads - Design of platforms – Derricks – Helipads - Design principles and examples of Jacket Towers - Mooring cables.

**Total: 45**

**REFERENCES:**


1. Chakrabarti S.K., "Hydrodynamics of Offshore Structures", NIT Press/Computational Mechanics Publications, 2003.
2. Prof. Srinivasan Chandrasekaran, "Dynamic Analysis and Design of Offshore Structures", 2nd Edition, Springer Singapore, 2018.
3. API, "Recommended Practice for Planning, Designing and Construction, Fixed Offshore Platforms", American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | apply the concepts of wind effects in offshore structures | Applying (K3) |
| CO2: | apply the concept of wave theories | Applying (K3) |
| CO3: | analysis the forces in offshore structures | Analyzing (K4) |
| CO4: | formulate the offshore structure modeling | Applying (K3) |
| CO5: | design the offshore structures | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 2 | | 3 |
| CO4 | 3 | | 2 | | 3 |
| CO5 | 3 | | 2 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

## 18SEE14 MECHANICS OF COMPOSITE MATERIALS AND STRUCTURES

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To gain knowledge about analysis, failure, fracture and stress strain relations of composite materials |
| Prerequisites | Nil |

**UNIT – I** **9**

**Introduction to Composite Materials:** Definitions - Classification - Advantages - Commonly used fiber and matrix constituents - Composite construction - Properties of unidirectional Long Fiber composites - Short Fiber composites and processing of FRP Composites.

**UNIT – II** **9**

**Fiber Reinforced Composite Structures and Environmental Issues:** Introduction - Composite structural design - Design spiral - Design criteria - Design allowable - Material selection in composite design - Selection of configuration - Manufacturing process - Laminate selection - Laminate design procedure and environmental issues.

**UNIT – III** **9**

**Analysis of Laminated Composite Plates:** Governing equations for bending and buckling of laminated plates - Deflection and buckling of simply supported Angle-ply and cross-ply laminates - Laminate stiffness, Shear deformation plate theory, Static, dynamic and stability analysis for simpler cases of composite plates.

**UNIT – IV** **9**

**Failure and Fracture of Composites:** Netting analysis - Failure criterion - Maximum stress - Maximum strain - Application of fracture mechanics to composite materials - Sandwich Construction.

**UNIT – V** **9**

**Stress Strain Relations:** Stress - Strain relations for orthotropic and anisotropic materials - Linear elasticity for Anisotropic materials - Rotations of stresses, strains, residual stresses - Transformation of stress and strain and restriction on elastic constants.

**Total: 45**

**REFERENCES:**

1. Mukhopadhyay M., “Mechanics of Composite Materials and Structures”, 2nd Edition, University Press, India, 2012.
2. Jones R.M., “Mechanics of Composite Materials”, 2nd Edition, Taylor and Francis, Newyork, 2013.
3. Autar K. Kaw, “Mechanics of Composite Materials”, 4th Edition, CNC-Taylor and Francis, India, 2015.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | explain various composite materials and its applications | Understanding (K2) |
| CO2: | select material, select configuration and manufacturing process of composite materials | Applying (K3) |
| CO3: | analyze problems on bending, buckling, vibration and failure criterion of laminated plates | Analyzing (K5) |
| CO4: | identify the failure and apply the fracture mechanics to composite materials | Applying (K3) |
| CO5: | solve mechanics of composite materials problems by using classical methods | Evaluating (K5) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 3 | | 3 |
| CO2 | 3 | | 3 | | 3 |
| CO3 | 3 | | 3 | | 3 |
| CO4 | 3 | | 3 | | 3 |
| CO5 | 3 | | 3 | | 3 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE15 DESIGN OF SUBSTRUCTURES

(IS 1904 - 1986, IS 6403-1981, IS 8009 – 1976 Part 1 & 2, IS 2950 - 1981, IS 456 -2000, IS 2911 Part 1 to 4 -2010, IS 2810-1979, IS 2974 -1992 Part 1- 5, IS 5249-1992, IS 13301 – 1992 are permitted)

| L | T | P | Credit |
|---|---|---|---|
| **3** | **0** | **0** | **3** |

| | |
|---|---|
| Preamble | The objective of this course is to offer a comprehensive knowledge on design principles of shallow foundation, design of raft foundation and design of pile foundations. This subject aims at equipping students with sufficient knowledge on estimating the load carrying capacity and group action of piles. In addition, students would be able to emphasis on geotechnical aspects on machine foundation, tunnels and conduits. |
| Prerequisites | Soil Mechanics and Foundation Engineering |

**UNIT– I** **9**

**Shallow Foundations:** Types of foundations and their specific applications – Depth of foundation – Bearing capacity and settlement estimates – Structural design of isolated-strip-rectangular -trapezoidal and combined footings – strap – balanced footings – raft foundation – Approximate flexible method of raft design - Compensated foundations-Concepts of Soil Liquefaction

**UNIT – II** **9**

**Deep Foundations:** Types of piles and their applications – Load carrying capacity - Settlements - Group action - Design of piles and pile caps - Design of under reamed piles.

**UNIT – III** **9**

**Foundations for Bridges and other Miscellaneous Structures:** Drilled shaft foundations and caissons for bridges - Foundations for towers - Chimneys - Silos.

**UNIT – IV** **9**

**Machine Foundations:** Types - General requirements and design criteria - General analysis of machine foundations - Soil system - Stiffness and damping parameters - Tests for design parameters - Guidelines for design of reciprocating engines - Impact type machines, rotary type machines, and framed foundations.

**UNIT – V** **9**

**Tunnel and Conduits:** Introduction - Longitudinal and transverse profile of tunnel structure - Tunnel protection against fire - Advanced systems of anti-water insulation of underground structures - Loading types of shallow and deep tunnels - Introduction to TBM - Instrumentation and monitoring.

**Total: 45**

**REFERENCES:**


1. Nayak N.V., "Foundation Design Manual for Practicing Engineers", 2nd Edition, Dhanpatrai and Sons, 2012.
2. Braja M. Das, "Principles of Foundations Engineering", 7th Edition, Cengage Learning, 2011.
3. Megaw T.M. and Bartlett J.V., "Tunnels: planning, design, construction", 3rd Edition, John Wiley & Sons, Ellis Horwood, 1983.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1 : | analyze and design different types of shallow and raft foundations | Analyzing (K4) |
| CO2 : | estimate the load carrying capacity of the piles and pile group and design various types of piles | Analyzing (K4) |
| CO3 : | design the foundations for bridges and chimneys | Evaluating (K5) |
| CO4 : | examine the structural aspects of machine foundation | Applying (K3) |
| CO5 : | explain the components, loading type and monitoring of TBM | Understanding (K2) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 2 | | 3 |
| CO2 | 3 | | 2 | | 3 |
| CO3 | 3 | | 3 | | 3 |
| CO4 | 3 | | 1 | | 3 |
| CO5 | 1 | | | | 2 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

## 18SEE16 METRO TRANSPORTATION SYSTEM AND ENGINEERING

(Common to Structural Engineering & Construction Engineering and Management branches)

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

| | |
|---|---|
| Preamble | To impart knowledge on the basic elements of metro transportation system |
| Prerequisites | Nil |

**UNIT – I** **9**

**General :** Overview of Metro transportation system; Need of Mass transport system; Types of mass transport systems; Peak Hour Peak Direction Traffic(PHPDT) demand studies and selection of suitable mass transport system; Comparison of Bus Rapid Transit (BRT) Vs PHPDT; Train operation plan; prediction of Number of Rake, Car, and Head way; Mathematical model for the selection of best fit routing.

**UNIT – II** **9**

**Alignment:** Site survey; Factors influencing the alignment; Land acquisition within right of way; Horizontal and Vertical Curves; Super elevation; Points and Crossing; Types of crossings; Loop line; Shunting neck; Limiting train speed Vs alignment curvature; Rail and Road Vehicle access (RRV).

**UNIT – III** **9**

**Tunnel, Ramp, At Grade and Elevated corridor:** Types of Tunnel and various construction methods; Cut and cover, Mined tunnel, Bored tunnel, NATM, Box/Pipe pushing; type of Cross passages and its requirements as per NFPA standard; Damage assessment studies and Instrumentation & Monitoring methods; Risk and mitigation measures of underground construction, Ramp and At Grade corridor; Types of elevated corridor, Construction methods of Viaduct, Portal and Girder system; Bearings and movement joints; Difference between Mono and Metro Rail system.

**UNIT – IV** **9**

**Stations:** Type of stations; selection of type and its locations; Components of elevated and under-ground (UG) stations, Platform level, Concourse level, Roof level, Paid & Unpaid areas, Public & Equipment operation room areas; Necessity of OTE, UPE, Draught relief and Vent shafts in UG stations, Tunnel ventilation Fan, Power supply and SCADA system. Size of station based on emergency evacuation methods as per NFPA standard; Fire and Ventilation system; Construction methods of Under-ground and Elevated stations; Cut and cover and Retaining wall system, Diaphragm wall and Pile systems.

**UNIT – V** **9**

**Depot:** Types of depot; Components of Depot; Stabling Yard; Infrastructure Shed, type of bogie wash, turn table; Auto coach wash plant; Depot Control Center (DCC) and its operations, Integrated Control Center (ICC); Test track; Power supply stations, ASS and TSS; Water and Sewage Treatment plant.

**Total: 45**

**REFERENCES:**


1. Avishai Ceder, "Urban Transit Systems and Technology", 2nd Edition, John Wiley & Sons, New York, 2017.
2. Vukan R. Vuchic, "Public Transit Planning and Operation", 3rd Edition, CRC Press, 2016.
3. William D. Middleton, "Metropolitan Railways: Rapid Transit in America", 1st Edition, Indiana University Press, 2003.

| **COURSE OUTCOMES:**<br>On completion of the course, the students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| CO1: | summarize the various elements of metro transportation system | Understanding (K2) |
| CO2: | adapt the various alignments in metro transportation system | Applying (K3) |
| CO3: | implement the concept of ramp and elevated corridor in metro transportation system | Applying (K3) |
| CO4: | plan the various stations in metro transportation system | Applying (K3) |
| CO5: | organize the various depot in metro transportation system | Applying (K3) |

**Mapping of COs with POs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | | 3 | | 2 |
| CO2 | 3 | | 3 | | 2 |
| CO3 | 3 | | 3 | | 2 |
| CO4 | 3 | | 3 | | 2 |
| CO5 | 3 | | 3 | | 2 |

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy