# ADVANCED DESIGN OF RC STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – I**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE12** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:** An undergraduate course on Design of RC structures.

**Course objectives:**

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

| **Modules** | **Teaching Hours** | **RBT Level** |
|---|---|---|
| **Module-1** | | |
| • Design of R C slabs by yield line method<br>• Design of flat slabs | **10 Hours** | **L1, L2, L3, L4, L5** |
| **Module-2** | | |
| • Design of grid or coffered floors<br>• Design of continuous beams with redistribution of moments | **10 Hours** | **L1, L2, L3, L4, L5** |
| **Module -3** | | |
| • Design of R C Chimneys | **10 Hours** | **L1, L2, L3, L4,** |
| **Module -4** | | |
| • Design of R C silos<br>• Design of R C bunkers | **10 Hours** | **L1, L2, L4, L5** |
| **Module -5** | | |
| **Formwork:**<br>Introduction, Requirements of good formwork, Materials for forms, choice of formwork, Loads on formwork, Permissible stresses for timber, Design of formwork, Shuttering for columns, Shuttering for slabs and beams, Erection of Formwork, Action prior to and during | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| concreting, Striking of forms. Recent developments in form work. | | |

**Course outcomes:**

On completion of this course, students are able to:

1. Achieve Knowledge of design and development of problem solving skills
2. Understand the principles of Structural Design.
3. Design and develop analytical skills.
4. Summarize the principles of Structural Design and detailing
5. Understands the structural performance.

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**


1. A Park and Paulay,, “Reinforced Reinforced and Prestressed Concrete”
2. Bungale. S. Taranath., "Structural Analysis and Design of Tall Buildings", McGraw Hill Book Company,New York, 1999
3. Hsu T. T. C. and Mo Y. L., “Unified Theory of Concrete Structures”, John Wiley & Sons, 2010
4. Krishnamurthy, K.T., Gharpure S.C. and A.B. Kulkarni – “Limit design of reinforced concrete structures”,Khanna Publishers, 1985
5. UnnikrishnaPillai and Devdas Menon., “Reinforced concrete Design’, Tata McGraw Hill PublishersCompany Ltd., New Delhi, 2006
6. Varghese, P.C., “Limit State Design of Reinforced Concrete”, Prentice Hall of India, 2007
7. Varghese. P. C., “Advanced Reinforced Concrete Design”, Prentice-Hall of India, New Delhi, 2000
8. Krishna Raju. N., “Advanced Reinforced Concrete Design”, CBS Publishers & Distributors
9. Pillai S. U. and Menon D., “Reinforced Concrete Design”, Tata McGraw-Hill, 3rd Ed, 1999
10. Shah.H.J, “Reinforced Concrete”, Vol-1 and Vol-2, Charotar, 8th Edition – 2009 and 6th Edition – 2012 respectively.
11. Gambhir.M.L, “Design of Reinforced Concrete Structures”, PHI Pvt. Ltd, New Delhi, 2008

# STRUCTURAL DYNAMICS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

| | | | |
|---|---|---|---|
| Subject Code | **18CSE14** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**Basics of Mechanics, Strength of Materials, Structural Analysis

**Course objectives:**

The objective of this course is to makestudents to learn principles ofStructural Dynamics, To implement these principles through different methods and to apply the same for free and forced vibration of structures. To evaluate the dynamic characteristics of thestructures

| **Modules** | **Teaching Hours** | **RBT Level** |
|---|---|---|
| **Module-1** | | |
| Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, principleof virtual displacement and energy principles .<br><br>Dynamics of Single degree-of-freedom systems: Mathematical models of Single-degree-of-freedom systems system, Free vibration response of damped and undamped systems including methods for evaluation ofdamping. | **10 Hours** | **$L_1$, $L_2$, $L_5$** |
| **Module-2** | | |
| Response of Single-degree-of-freedom systems to harmonic loading including support motion, vibration isolation, transmissibility.<br>Numerical methods applied to Single-degree-of-freedom systems – Duhamel integral.<br>Principle of vibration measuring instruments–seismometer and accelerometer. | **10 Hours** | **$L_3$, $L_4$, $L_5$** |
| **Module -3** | | |
| Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of-freedom systems, Shear building | **10 Hours** | **$L_1$, $L_2$, $L_4$, $L_5$** |

| | | |
|---|---|---|
| concept, free vibration of undamped multi-degree-of-freedom systems – Natural frequencies and mode shapes – Orthogonality of modes. | | |
| **Module -4** | | |
| Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shear buildings for forced vibration for harmonic loading with damping using normal mode approach. | **10 Hours** | **$L_3$, $L_4$, $L_5$** |
| **Module -5** | | |
| Approximate methods: Rayleigh's method, Dunkarley's method, Stodola's method.<br>Dynamics of Continuous systems: Flexural vibration of beams with different end conditions.<br>Stiffness matrix, mass matrix (lumped and consistent). | **10 Hours** | **$L_2$, $L_4$** |

**Course outcomes:**

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of StructuralDynamics
- Design and develop analyticalskills.
- Summarize the Solution techniques for dynamics of Multi-degree freedom systems
- Understand the concepts of damping instructures.

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**

1. Dynamics of Structures – "Theory and Application toEarthquakeEngineering"- 2nd ed., Anil K. Chopra, Pearson Education.
2. Earthquake Resistant Design ofBuildingStructures,Vinod Hosur, WILEY (India)
3. Vibrations, structural dynamics- M. Mukhopadhaya : Oxford IBH
4. Structural Dynamics- Mario Paz: CBS publishers.
5. Structural Dynamics- Clough & Penzien: TMH
6. Vibration Problems in Engineering Timoshenko, S, Van-Nostrand Co.

<table>
<tr><td colspan="6">STRUCTURAL ENGINEERING LAB-1<br>[As per Choice Based Credit System (CBCS) scheme]<br>SEMESTER – I</td></tr>
<tr><td>Subject Code</td><td>18CSEL16</td><td>CIE Marks</td><td colspan="3">40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>SEE Marks</td><td colspan="3">60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>42</td><td>Exam Hours</td><td colspan="3">03</td></tr>
<tr><td colspan="6">CREDITS – 02</td></tr>
<tr><td colspan="6">Prerequisites: Concrete Technology, Special Concrete, Structural Analysis, Structural Dynamics</td></tr>
<tr><td colspan="6">Course objectives:<br>The objective of this course is to make students to learn principles of design of experiments, To investigate the performance of structural elements. To evaluate the different testing methods and equipments.</td></tr>
<tr><td colspan="4">Modules</td><td>Teaching Hours</td><td>RBT Level</td></tr>
<tr><td colspan="4">1. Experiments on Concrete, including Mix design</td><td>12 Hrs</td><td rowspan="4">L1, L2, L3, L4, L5, L6</td></tr>
<tr><td colspan="4">2. Testing of beams for deflection, flexure and shear</td><td>12 Hrs</td></tr>
<tr><td colspan="4">3. Experiments on vibration of multi storey frame models for Natural frequency and modes.</td><td>12 Hrs</td></tr>
<tr><td colspan="4">4. Use of Non destructive testing (NDT) equipments – Rebound hammer, Ultra sonic pulse velocity meter and Profometer</td><td>06Hrs</td></tr>
<tr><td colspan="6">Course outcomes:On complete of this course the students will able to<ul><li>Achieve Knowledge of design and development of experimenting skills.</li><li>Understand the principles of design of experiments</li><li>Design and develop analytical skills.</li><li>Summarize the testing methods and equipment’s.</li></ul></td></tr>
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# ADVANCED DESIGN OF STEEL STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – II**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE21** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**

- Engineering Mechanics
- Strength of Materials
- Structural Analysis
- Design of Steel structures

**Course objectives:**This course will enable students to

1. Understand the background to the design provisions for hot-rolled and cold-formed steel structures, including the main differences between them.
2. Proficiency in applying the provisions for design of columns,beams, beam-columns
3. Design structural sections for adequate fireresistance

| Modules | Teaching Hors | RBT Level |
|---|---|---|
| **Module-1** | | |
| **Laterally Unrestrained Beams:** Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discretelateralrestraints,Mono-symmetricandnon-uniformbeams – Design Examples. Concepts of -Shear Center, Warping, Uniform and Non-Uniform torsion. | **10 Hours** | **L1,L2** |
| **Module-2** | | |
| **Beam- Columns in Frames:** Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames,Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 – | **10 Hours** | **L2,L3,L4** |

| | | |
|---|---|---|
| Examples | | |
| **Module -3** | | |
| **Steel Beams with Web Openings:**<br><br>Shape of the web openings, practical guide lines, and Force distribution and failure patterns. Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties.<br>Vierendeel girders (design for given analysis results) | **10 Hours** | **L3,L4** |
| **Module -4** | | |
| **Cold formed steelsections:**<br><br>Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions-numerical examples, beam design, column design. | **10 Hours** | **L2,L3,L4** |
| **Module -5** | | |
| **Fire resistance:**<br><br>Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance Ratings.<br>Numerical Examples. | **10 Hours** | **L4,L5** |

**Course outcomes:**

After studying this course, students will be able to:

- Able to understand behavior of Light gauge steel members
- Able to understand design concepts of cold formed/unrestrained beams
- Able to understand Fire resistance concept required for present days.
- Able to analyze beam column behavior

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**


1. N. Subramanian, “Design of Steel Structures”, Oxford, IBH
2. Duggal,S.K. Design of Steel Structures, TataMcGraw-Hill
3. IS 800: 2007, IS 801-2010 , IS 811-1987
4. BS5950 Part- 8,
5. INSDAG Teaching Resource Chapter 11 to 20:www.steel-insdag.org

6. SP 6 (5)-1980

# FINITE ELEMENT METHOD OF ANALYSIS

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – II**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE22** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**

- Computational structural Mechanics
- Theory of Elasticity

**Course objectives:**

- To provide the fundamental concepts of the theory of the finite element method
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of softwares

| **Modules** | **Teaching Hors** | **RBT Level** |
|---|---|---|
| **Module-1** | | |
| Basic concepts of elasticity, Kinematic and Static variables for various types of structural problems, Approximate methods of structural analysis – Rayleigh–Ritz method, Finite difference method, Finite element method. Variation method and minimizationof Energy approach of element formulation, Principles offinite element method, advantages and disadvantages, Finite element procedure, Finite elements used for one, two and three dimensional problems, C0, C1 and C2 type elements, Element aspect ratio, Mesh refinement vs. higher order elements,Numbering of nodes to minimize bandwidth. | **10 Hours** | **L1, L2** |

| Module-2 | | |
|---|---|---|
| Nodal displacement parameters, Convergence criterion, Compatibility requirements, Geometric invariance, Shape function,Polynomial form of displacement function, Generalized and Natural coordinates,Lagrangianinterpolation function, shape functions for one, two &three dimensional elements. | **10 Hours** | **L1, L2, L4, L5** |
| **Module -3** | | |
| Isoparametric elements, Internal nodes and higher order elements, Serendipity and Lagrangianfamily of Finite Elements, Sub-parametric and Super-parametric elements, Condensation of internal nodes, Jacobian transformation Matrix, Development of strain-displacement matrix and stiffness matrix, consistent load vector, numericalintegration. | **10 Hours** | **L1, L2, L4, L5** |
| **Module -4** | | |
| Application of Finite Element Method for the analysis of one & two dimensional problems: Analysis of plane trusses and beams, Application to planestress/strain, Axisymmetric problems using CST and Quadrilateral Elements | **10 Hours** | **L1, L2, L3, L4, L5** |
| **Module -5** | | |
| Application to Plates and Shells, Non-linearity: material, geometric and combined non- linearity, Techniques for Non-linear Analysis. | **10 Hours** | **L1, L2** |

**Course Outcome:**

After successful completion of this the course, students shall be able to:

- Explain the basic theory behind the finite element method.
- Formulate force-displacements relations for 2-D elements
- Use the finite element method to analyze real structures.
- Use a Finite Element based program for structural analysis

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**

1. Zeinkeiwich, O.C. and Tayler, R.L., The Finite Element Method for Solid and Structural Mechanics, Butterworth-Heinemann,2013
2. Krishnamoorthy,C.S.,FiniteElementAnalysis: Theory andprogramming, Tata McGraw Hill Publishing Co. Ltd., 2017
3. Desai, C., and Abel, J. F., Introduction to the Finite Element Method: A Numerical method for Engineering Analysis, East West Press Pvt. Ltd.,1972
4. Cook, R.D., Malkas, D.S. and Plesha., M.E., Concepts and applications of Finite Element Analysis, John Wiley and Sons., 2007
5. Reddy, J., An Introduction to Finite Element Methods, McGraw Hill Co., 2013
6. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall
7. Shames,I.H.andDym,C.J.,EnergyandFiniteElementMethodsinStructural Mechanics, McGraw Hill, New York,1985

# EARTHQUAKE RESISTANT STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – II**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE23** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**

- Structural Dynamics

**Course objectives:**

The objective of this course is to make students to learn principles of engineering seismology, To design the reinforced concrete buildings for earthquake resistance. To evaluate the seismic response of the structures

| **Modules** | **Teaching Hors** | **RBT Level** |
|---|---|---|
| **Module-1** | | |
| Introduction to engineering seismology, Geological and tectonic features of India, Origin and propagation of seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems. | **10 Hours** | **L1, L2** |
| **Module-2** | | |
| The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS-1893. | **10 Hours** | **L2, L3, L4, L5** |

| Module -3 | | |
|---|---|---|
| Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behaviour of masonry buildings duringearthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions. | **10 Hours** | **L2, L4, L5** |
| **Module -4** | | |
| Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls. | **10 Hours** | **L2, L4, L5** |
| **Module -5** | | |
| Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures. | **10 Hours** | **L2, L5, L6** |

**Course Outcome:**On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of engineering seismology
- Design and develop analytical skills.
- Summarize the Seismic evaluation and retrofitting of structures.
- Understand the concepts of earthquake resistance of reinforced concrete buildings.

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**


1. Dynamics of Structures – Theory and Application to Earthquake Engineering-

2nd ed. – Anil K. Chopra, Pearson Education.

2. Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (india)

3. Earthquake Resistant Design of Structures, Duggal, Oxford University Press.

4. Earthquake resistant design of structures - Pankaj Agarwal, Manish Shrikande - PHI India.

5. IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993

6. Design of Earthquake Resistant Buildings, Minoru Wakabayashi, McGraw Hill Pub.

7. Seismic Design of Reinforced Concrete and Masonry Buildings, T Paulay and M J N Priestley, John Wiley and Sons.

| **STRUCTURAL ENGINEERING LAB-2**<br>[As per Choice Based Credit System (CBCS) scheme]<br>**SEMESTER – II** | | | |
|---|---|---|---|
| Subject Code | **18CSEL26** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 03 | SEE Marks | 60 |
| Total Number of Lecture Hours | 42 | Exam Hours | 03 |
| **CREDITS – 02** | | | |

**Prerequisites:** Structural Analysis, Structural Dynamics and Design of RC structures

**Course objectives:**

The objective of this course is to make students
To analyze the structure using FE based Software
To learn principles of design
To investigate the performance of structural elements.
To design the structural components using excel sheets

| **Modules** | **Teaching Hours** | **RBT Level** |
|---|---|---|
| 1. Static and Dynamic analysis and design of Multistory Building structures using any FE based software | **12 Hrs** | **L1, L2, L3, L4, L5, L6** |
| 2. Design of RCC and Steel Tall structures using any FE based software | **12 Hrs** | |
| 3. Analysis of folded plates and shells using any FE software. | **06 Hrs** | |
| 4. Preparation of EXCEL sheets for structural design | **12 Hrs** | |

**Course outcomes:**On complete of this course the students will able to

- Achieve Knowledge of design and development of programming skills.
- Understand the principles of structural analysis and design
- Design and develop analytical skills.
- Summarize the performance of structures for static and dynamic forces.

## SPECIAL CONCRETE

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – I**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE15** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**Knowledge of Material Science and Concrete Technology

**Course objectives:**

The objective of this course is to make students to:

- Provides a comprehensive treatment of the constituent materials of concrete
- Learn the principles of Concrete mix design, and assess the performance of various cement-based materials including normal and high strength concrete as well as special cement composites.
- To differentiate between different types of concrete and Learn characterize and predict the behaviour of special concrete

| Modules | Teaching Hours | RBT Level |
|---|---|---|
| **Module-1** | | |
| **Constituent materials:** Role of constituents, Components of modern concrete, Rheology, Mineral and Chemical admixtures and their effect on properties of concrete<br><br>**Special cements:** Need, Classifications, Blended cements, modified hydraulic cements, calcium aluminate cements, calcium sulphate based binders, calcium sulfo aluminate cements, shrinkage compensating (or) expansive cements, macro defect-free cements, phosphate cements, fast setting cements, their Performance and prescriptive specifications, Methods of mix proportioning: IS method, ACI method and BS method | **10 Hours** | **L1, L2, L5** |
| **Module-2** | | |
| **Light Weight concrete:** Introduction, classification, strength and elastic properties, durability, mix proportioning. | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| **High density concrete:** Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods.Self-compacting Concrete (SCC), General characteristics, Properties, microstructure. Robustness and methods of mix proportioning and applications | | |
| **Module -3** | | |
| **Other concretes for special properties**: High-volume fly ash concretes, geo-polymer concrete, pervious concrete, aerated concrete, ultrahigh performance concretes, Reactive powder concrete, Bacterial concrete, Heat resistant and refractory concrete. Their significance, materials, general consideration strength and durability aspects.<br>Mixture proportioning and parameters in the development of Special concreting operations: Guniting and shotcreting, pre-placed aggregate, anti-washout concretes, concrete pumping, tremie placement for underwater applications. | **10 Hours** | **L1, L2, L5** |
| **Module -4** | | |
| **Fibre reinforced concrete:** Fibre materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, Toughness and impact resistance, Elastic modulus, creep, and drying shrinkage, strength and behaviour in tension, compression and flexure, crack arrest and toughening mechanism, durability, applications.<br>**Ferro cement:** Materials, mechanical properties, cracking of ferrocement, Types and methods of construction, strength and behaviour in tension, compression and flexure, Design of ferrocement in tension, durability, and applications. | **10 Hours** | **L1, L2, L5** |
| **Module -5** | | |
| **High strength concretes:** Materials and mix proportion, Microstructure, stress-strain relation, fracture, drying shrinkage, and creep.<br>Mass concrete and Roller compacted concrete: Constituents, mix proportioning, properties in fresh and | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| hardened states, applications and limitations.<br><br>Different NDT techniques for performance evaluation of structures: Rebound hammer, Ultrasonic pulse velocity meter, Profometer, Ground Penetrating Radar (GPR), Core test, Carbonation and Corrosion assessment | | |

**Course outcomes:**

On completion of this course, students are able to:

- Identify the functional role of ingredients of concrete and apply this knowledge to mix design philosophy
- Acquire and apply fundamental knowledge in the fresh and hardened properties of concrete for special properties.
- Evaluate the effect of the environment on service life performance, properties and failure of structural concrete and demonstrate techniques of measuring the Non Destructive Testing of concrete structure.
- Understand the concepts, mix proportioning and methods of special concreting operations.

**Question paper pattern:**
The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**


1. Neville A.M, "Properties of Concrete" Pearson Education Asia,2000
2. P. Kumar Mehta, Paul J.N. Monterio,ONCRETE:Microstructure,Properties and Materials", Tata McGraw Hill
3. A.R.Santhakumar, (2007) "Concrete Technology"-Oxford University Press, New Delhi, 2007
4. Gambhir "Concrete Technology" TMH.
5. Short A and Kinniburgh.W, "Light Weight Concrete"- Asia Publishing House, 1963
6. Aitcin P.C. "High Performance Concrete"-E and FN, Spon London 1998 7. Rixom.R. and Mailvaganam.N., "Chemical admixtures in concrete"- E and FN, Spon London 1999
7. Rudnai.G., "Light Weight concrete"-Akademiaikiado, Budapest, 1963 9. http://qcin.org/CAS/RMCPC/
8. http://nptel.ac.in

## MECHANICS OF DEFORMABLE BODIES

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – I**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE13** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**Strength of Materials

**Course objectives:**

Course objectives: The objective of this course is to make students to learn principles of Analysis of Stress and Strain, To predict the stress-strain behaviour of continuum. To evaluate the stress and strain parameters and their inter relations of the continuum

| **Modules** | **Teaching Hours** | **RBT Level** |
|---|---|---|
| **Module-1** | | |
| Theory of Elasticity: Introduction: Definition of stress and strain and strain at a point, components of stress and strain at appoint of Cartesian and polar coordinates. Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases. | **10 Hours** | **L1, L2** |
| **Module-2** | | |
| Transformation of stress and strain at a point,Principal stresses and principal strains, invariants ofstress and strain, hydrostatic and deviatric stress,spherical and deviatric strains max. shear strain. | **10 Hours** | **L2, L3** |
| **Module -3** | | |
| Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axisymmetric problems, stress concentration due to the presence of a circular hole in plates. | **10 Hours** | **L2, L3** |
| **Module -4** | | |

| | | |
|---|---|---|
| Elementary problems of elasticity in three dimensions, stretching of a prismatic bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in solid media. Applications of finite difference equations in elasticity. | **10 Hours** | **L2, L3, L4** |
| **Module -5** | | |
| Theory of Plasticity: Stress – strain diagram in simpletension, perfectly elastic, Rigid – Perfectly plastic, Linear work – hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress – space representation of yield criteria through Westergard stress space, Tresca and Von-Mises criteria of yielding | **10 Hours** | **L1, L2** |

**Course outcomes:**

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of stress-strain behaviour of continuum
- Design and develop analytical skills.
- Describe the continuum in 2 and 3- dimensions
- Understand the concepts of elasticity and plasticity

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**


1. Timoshenko &Goodier, "Theory of Elasticity", McGraw Hill
2. Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing company, New Delhi, 1994.
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers
4. Verma P.D.S, "Theory of Elasticity", Vikas Publishing Pvt. Ltd
5. Chenn W.P and Hendry D.J, "Plasticity for Structural Engineers", Springer Verlag
6. Valliappan C, "Continuum Mechanics Fundamentals", Oxford IBH Publishing Co.Ltd.
7. Sadhu Singh, "Applied Stress Analysis", Khanna Publishers
8. Xi Lu, "Theory of Elasticity", John Wiley.

## COMPUTATIONAL STRUCTURAL MECHANICS

[As per Choice Based Credit System (CBCS) scheme]

**SEMESTER – I**

| | | | |
|---|---|---|---|
| Subject Code | **18CSE11** | CIE Marks | 40 |
| Number of Lecture Hours/Week | 04 | SEE Marks | 60 |
| Total Number of Lecture Hours | 50 | Exam Hours | 03 |

**CREDITS – 04**

**Prerequisites:**

- Engineering Mechanics
- Strength of Materials
- Structural Analysis
- Matrix Algebra

**Course objectives:**

- To understand basic concepts of Matrix Methods of Structural Analysis
- To analyse the behavior of plane trusses, continuous beams, and portal frames

| Modules | Teaching Hours | RBT Level |
|---|---|---|
| **Module-1** | | |
| **Basic concepts of structural analysis and methods of solving simultaneous equations:** Introduction, Types of framed structures, Static and Kinematic Indeterminacy, Equilibrium equations, Compatibility conditions, Principle of superposition, Energy principles, Equivalent joint loads, Methods of solving linear simultaneous equations- Gauss elimination method, Cholesky method and Gauss-Siedal method. | **10 Hours** | **L1, L2, L3** |
| **Module-2** | | |
| **Fundamentals of Flexibility and Stiffness Methods:** Concepts of stiffness and flexibility, Local and Global coordinates,Development of element flexibility and element stiffness matrices for truss, beam and grid elements, Force-transformation matrix,Development of global flexibility matrix for continuous beams, plane trusses and | **10 Hours** | **L1, L2, L3 L4, L5** |

| | | |
|---|---|---|
| rigid plane frames, Displacement-transformation matrix, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames. | | |
| **Module -3** | | |
| **Analysis using Flexibility Method (including secondary effects):**<br>Continuous beams, plane trusses and rigid plane frames | **10 Hours** | **L1, L2, L3 L4, L5** |
| **Module -4** | | |
| **Analysis using Stiffness Method (including secondary effects):**<br>Continuous beams, plane trusses and rigid plane frames | **10 Hours** | **L1, L2, L4, L5** |
| **Module -5** | | |
| **Direct Stiffness Method:**<br>Stiffness matrix for truss element in local and global coordinates, Analysis of plane trusses, Stiffness matrix for beam element, Analysis of continuous beams and orthogonal frames. | **10 Hours** | **L1, L2, L5** |

**Course outcomes:**

Upon completing this course, the students will be able to:

- Formulate force displacement relation by flexibility and stiffness method
- Analyze the plane trusses, continuous beams and portal frames by transformation approach
- Analyse the structures by direct stiffness method

**Question paper pattern:**

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

**Reference Books:**


1. Weaver, W., and Gere, J.M., ***Matrix Analysis of Framed Structures***, CBS Publishers and distributors pvt. Ltd., 2004.
2. Rajasekaran, S., and Sankarasubramanian, G., ***Computational Structural Mechanics***, PHI, New Dehi, 2001.
3. Martin, H, C., ***Introduction to Matrix Methods of Structural Analysis***, McGraw-Hill, New York, 1966.
4. Rubinstein, M.F., ***Matrix Computer Analysis of Structures,*** Prentice-Hall, Englewood Cliffs, New Jersey, 1966.
5. Beaufait, F.W., Rowan, W. H., Jr., Hoadely, P. G., and Hackett, R. M.,

***Computer Methods of Structural Analysis***, Prentice-Hall, Englewood Cliffs, New Jersey, 1970.
6. Kardestuncer, H., ***Elementary Matrix Analysis of Structures***, McGraw-Hill, New York, 1974.