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): Continuous beams, plane trusses and rigid plane frames	**10 Hours**	**L1, L2, L3 L4, L5**
Module -4		
Analysis using Stiffness Method (including secondary effects): Continuous beams, plane trusses and rigid plane frames	**10 Hours**	**L1, L2, L4, L5**
Module -5		
Direct Stiffness Method: 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.

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 • Design of flat slabs	**10 Hours**	**L1, L2, L3, L4, L5**
Module-2		
• Design of grid or coffered floors • 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 • Design of R C bunkers	**10 Hours**	**L1, L2, L4, L5**
Module -5		
Formwork: 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

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.

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 . 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. Numerical methods applied to Single-degree-of-freedom systems – Duhamel integral. 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. Dynamics of Continuous systems: Flexural vibration of beams with different end conditions. 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.

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 **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. 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. **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. Mass concrete and Roller compacted concrete: Constituents, mix proportioning, properties in fresh and	**10 Hours**	**L1, L2**

hardened states, applications and limitations. 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

STRUCTURAL ENGINEERING LAB-1
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	**18CSEL16**	CIE Marks	40
Number of Lecture Hours/Week	03	SEE Marks	60
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS – 02

Prerequisites: Concrete Technology, Special Concrete, Structural Analysis, Structural Dynamics

Course objectives:
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.

Modules	**Teaching Hours**	**RBT Level**
1. Experiments on Concrete, including Mix design	**12 Hrs**	**L1, L2, L3, L4, L5, L6**
2. Testing of beams for deflection, flexure and shear	**12 Hrs**	
3. Experiments on vibration of multi storey frame models for Natural frequency and modes.	**12 Hrs**	
4. Use of Non destructive testing (NDT) equipments – Rebound hammer, Ultra sonic pulse velocity meter and Profometer	**06Hrs**	

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

- Achieve Knowledge of design and development of experimenting skills.
- Understand the principles of design of experiments
- Design and develop analytical skills.
- Summarize the testing methods and equipment's.

M.Tech Name of the programme (XXX)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
SEMESTER - I

RESEARCH METHODOLOGY AND IPR
(Professional Core Course) and (Common to all M.Tech Programmes)

Course Code	18RMI17	CIE Marks	40
Number of Lecture Hours/Week	02	Exam Hours	03
Total Number of Lecture Hours	25	SEE Marks	60

Credits - 02

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.■

Module-1		**Teaching Hours**
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **Reviewing the literature:** Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **Design of Sample Surveys:** Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout		**05 Teaching Hours**
Interpretation and Report Writing (continued): of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. ■		**05**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and the art of writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.■

Graduate Attributes (As per NBA): Problem analysis, Investigation, Design, Individual and teamwork, Communication skills, Professionalism.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

1	Research Methodology: Methods and Techniques	C.R. Kothari, Gaurav Garg	New Age International	4th Edition, 2018
2	ResearchMethodologyastep-by-stepguideforbeginners. (For the topic Reviewing the literature	Ranjit Kumar	SAGE PublicationsLtd	3rd Edition, 2011
3	Study Material (For the topic Intellectual Property under module 5)	Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body		

Reference Books

1	Research Methods: the concise knowledge base	Trochim	Atomic Dog Publishing	2005
2	Conducting Research Literature Reviews: From the Internet to Paper	Fink A	Sage Publications	2009

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: 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. Vierendeel girders (design for given analysis results)	**10 Hours**	**L3,L4**
Module -4		
Cold formed steelsections: 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: 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. 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.

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES

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

SEMESTER – II

Subject Code	**18CSE241**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites: Design of PSC structures, Concrete Technology

Course objectives:

This course will enable students to

- Design pre-stressed elements
- Understand the behavior of pre-stressed elements.
- Understand the behavior of pre-stressed sections

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Losses of Prestress : Loss of prestress in pre-tensioned and post tensionedmembers due to various causes like elastic shortening ofconcrete, shrinkage of concrete, creep of concrete, relaxation ofsteel, slip in anchorage, bending of member and frictional loss –Analysis of sections for flexure.	**10 Hours**	**L1, L2**
Module-2		
Design of Section for Flexure: Allowable stresses, Elastic designof simple beams having rectangular and I-section for flexure, kernlines, cable profile and cable layout. **Design of Sections for Shear**: Shear and Principal stresses,Improving shear resistance by different prestressing techniqueshorizontal,sloping and vertical prestressing, Analysis ofrectangular and I–beam, Design of shear reinforcement, Indiancodeprovisions.	**10 Hours**	**L2, L3**

Module -3		
Deflections of Prestressed Concrete Beams: Short termdeflections of uncracked members, Prediction of long-termdeflections, load–deflection curve for a PSC beam, IS coderequirements for maximum deflections.	**10 Hours**	**L2, L3, L4**
Module -4		
Transfer of Prestress in Pretensioned Members : Transmissionof prestressing force by bond, Transmission length, Flexural bondstresses, IS code provisions, Anchorage zone stresses in posttensioned members, stress distribution in End block, Anchoragezone reinforcements.	**10 Hours**	**L1, L2, L3**
Module -5		
Statically Indeterminate Structures: Advantages anddisadvantages of continuous PSC beams,Primary and secondarymoments, P and C lines, Lineartransformation, concordant andnon-concordant cableprofiles, Analysis of continuous beams.	**10 Hours**	**L1, L2, L3**
Course Outcomes: After studying this course, students will be able to: • Analyse , Design and detail PSC elements		
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. Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Delhi Co ltd., New 2. Krishna Raju, "Prestressed concrete", Tata Mc Graw Hill Book – Co ., New Delhi. 3. T.Y. Lin and Burn, "Design of prestress concrete structures", John Wiley, New York. 4. S. Ramamrutham, "Prestressed concrete", Dhanpat Rai & Sons, Delhi.		

STABILITY OF STRUCTURES

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

SEMESTER – II

Subject Code	**18CSE242**	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
- Finite Element Analysis
- Theory of Elasticity

Course objectives:

The objective of this course is to make students to learn principles of stability of structures, To analyse the structural elements for stability. To evaluate the use of strain energy in plate bending and stability.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Beam – Column Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series, Euler's formulation using fourth order differential equation for pined – pined, fixed – fixed, fixed – free and fixed – pinnedcolumn.	**10 Hours**	**L1, L2**
Module-2		
Buckling of frames and continuous beams. Elastic Energy method: Approximate calculation of critical loads for a cantilever. Exact critical load for hinged – hinged column using energy approach. Buckling ofbar on elastic foundation. Bucklingof cantilevercolumn under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of	**10 Hours**	**L2, L3**

shear force on critical load. Column subjected to pulsatingforces.		
Module -3		
Stability analysis by finite element approach Derivation of shape function for a two noddedBernoulli–Euler beam element (lateral and translation of) – element stiffness and element geometric stiffness matrices – assembled stiffness and geometric stiffness matrices for a discretised column withdifferent boundary condition – calculation of critical loads for a discretised (two elements) column (both endsbuilt in). Buckling of pin jointed frames (maximum of two active DOF) – symmetrical single bay portalframe.	**10 Hours**	**L2, L3, L4**
Module -4		
Lateral buckling of beams Differential equation –pure bending – cantilever beam with tip load – simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open crosssection.	**10 Hours**	**L1, L2, L3**
Module -5		
Expression for strain energy in plate bending with in plate forces (linear and non – linear). Buckling of simply supported rectangular plate– uniaxial load and biaxial load. Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditionalongthe other two sides	**10 Hours**	**L1, L2, L3**
Course Outcomes: On completion of this course, students are ableto: • AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills. • Understand the principles of strength andstability • Design and develop analyticalskills. • Appraise the Stability analysis by finite elementapproach. • Understand the concepts of Lateral buckling ofbeams.		

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. Stephen P.Timoshenko, James M Gere, "Theory of Elastic Stability"-2nd Edition, McGraw – Hill, NewDelhi.
2. Robert D Cook et.al, "Concepts and Applications of Finite Element Analysis"-3rd Edition, John Wiley and Sons, NewYork.
3. S.Rajashekar, "Computations and Structural Mechanics"-Prentice – Hall,India.
4. Ray W Clough and J Penzien, "Dynamics of Structures" - 2nd Edition, McGraw Hill, NewDelhi
5. H.Zeiglar, "Principles of Structural Stability"-BlaisdallPublications

Design of Precast & Composite Structures

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

SEMESTER – II

Subject Code	**18CSE243**	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, Design of RC structures, Structural Analysis

Course objectives:

1. Understand the concepts and techniques of precast construction and Select or design precast elements suitable for project specific requirements
2. Design precast systems to ensure integrity and safety of the structure and to avoid progressive collapse and Design composite floors and beam elements

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Concepts , components, Structural Systems and Design of precast concrete floors Need and types of precast construction, Modular coordination, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections. **Design of precast Concrete Floors:** Theoretical and Design Examples of Hollow core slabs,. Precast Concrete Planks, floor with composite toppings with and without props.	**10 Hours**	**L1,L2**
Module-2		
Design of precast reinforced and prestressed Concrete beams Theoretical and Design Examples of ITB – Full section precast, Semi Precast, propped and unpropped conditions. Design of RC Nibs	**10 Hours**	**L3,L4**
Module -3		
Design of precast concrete columns and walls Design of braced and unbraced columns with corbels subjected to pattern and full loading. Design of Corbels Design of RC walls	**10 Hours**	**L3,L4**

subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints.		
Module -4		
Design of Precast Connections and Structural Integrity Beam bearing, Beam half Joint,Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.	**10 Hours**	**L3,L4**
Module -5		
Design of Steel Concrete Composite Floors and Beams **Composite Floors:** Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example **Composite Beams:** Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.	**10 Hours**	**L3,L4**
Course Outcomes:		
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. Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983. 2. David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989 3. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III 4. R.P.Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994. 5. IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete. 6. INSDAG Teaching Resource Chapter 21 to 27: www.steel-insdag.org		

RELIABILITY ANALYSIS OF STRUCTURES

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

SEMESTER – II

Subject Code	**18CSE244**	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 Mathematics

Course objectives:

1. To impart the concept knowledge on data analysis and probability in the context of structural engineering.
2. To demonstrate uncertainty in structural engineering with respect to randomness of variables and knowledge of probability distributions.
3. To demonstrate principles of structural reliability in order to assess safety due to randomness of variables.
4. To perform computations of structural reliability using various methods at component and system level.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Preliminary Data Analysis: Graphical representation- Histogram, frequency polygon, Measures of central tendency- grouped and ungrouped data, measures of dispersion, measures of asymmetry. Curve fitting and Correlation: Fitting a straight line, curve of the form $y = ab^x$, and parabola, Coefficient of correlation.	**10 Hours**	**L2, L3,L4**
Module-2		
Probability Concepts: Random events-Sample space and events, Venn diagram and event space, Measures of probability interpretation, probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram,	**10 Hours**	**L2, L4**

statistical independence, total probability theorem and Baye's theorem..		
Module -3		
Random variables: Probability mass function, probability density function, Mathematical expectation, Chebyshev's theorem. Probability distributions: Discrete distributions- Binomial and Poison distributions, Continuous distributions- Normal, Log normal distributions.	**10 Hours**	**L2, L4**
Module -4		
Reliability Analysis: Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability Methods-First Order Second Moment Method (FOSM), Point Estimate Method (PEM), and Advanced First Order Second Moment Method (Hasofer-Lind's method)	**10 Hours**	**L2, L3,L4**
Module -5		
Simulation Techniques: Monte Carlo simulation- Statistical experiments, Confidence limits ,sample size and accuracy, Generation of random numbers- random numbers with standard uniform distribution, continuous random variables (normal and lognormal), discrete random variables. System reliability: series, parallel and combined systems.	**10 Hours**	**L2,L3,L4 L5**

Course Outcomes: Students will be able to

1. Understand the concepts of statistics for probabilistic analysis and importance of uncertainty (randomness) in structural analysis and design.
2. Apply the theoretical principles of randomness of variables in structural engineering through density functions.
3. Analyze components of structure to assess safety using concepts related to structural reliability by various methods.
4. Evaluate the safety reliability index at system level.

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. Ranganathan, R. (1999). "Structural Reliability Analysis and design"- Jaico publishing house, Mumbai, India.
2. Devaraj.V&Ravindra.R,(2017),'Reliability based Analysis and Design for Civil Engineers',I.K.International Publishing House Pvt.Ltd,India
3. Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"- Volume –I, John Wiley and sons, Inc, New York.
4. Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"-Volume –II, John Wiley and sons, Inc, New York.
5. Milton, E. Harr (1987). "Reliability based design in civil engineering"- Mc Graw Hill book Co.
6. Nathabandu, T., Kottegoda, and Renzo Rosso (1998). Statistics, "Probability and reliability for Civil and Environmental Engineers"- Mc Graw Hill international edition, Singapore.
7. AchintyaHaldar and SankaranMahadevan (2000). "Probability, Reliability and Statistical methods in Engineering design"- John Wiley and Sons. Inc.

ADVANCED STRUCTURAL ANALYSIS

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

SEMESTER – II

Subject Code	**18CSE251**	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
- Structural Analysis

Course objectives:

Students will be given provided with the knowledge of mathematics, science, and engineering in the in the analysis of following structural systems curved beams, Beams on elastic foundation, shear centre and unsymmetrical bending and buckling of non-prismatic columns and beam column.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Curved Beams Curved beams, Introduction, assumptions, derivation of WINKLER BACH equation, Radius to the neutral surface of simple geometric figures, Limitation, Stress distribution in open curved members such as Hooks and chain links, Stress distribution in closed rings and chain links. Deformations of open and closed rings.	**10 Hours**	**L1,L2,L3**
Module-2		
Beams on Elastic Foundations Governing differential equation for elastic line, Interpretation of constants, Infinite beam with point load, moment & UDL with problems. Semi-infinite beams with point load and moment UDL with problems over fixed and hinged support conditions.	**10 Hours**	**L3,L4**

Module -3		
Shear Centre Concept of shear center in torsion induced bending of beams, expression to the Shear Centre for Symmetrical and Unsymmetrical Sections, Derivation of shear centre for angles, channel, semicircular and built-up sections with numerical problems	**10 Hours**	**L3,L4**
Module -4		
Unsymmetrical Bending (Asymmetrical Bending) Theory behind unsymmetrical bending, Assumptions, obtaining the stresses in beams, simply supported and cantilever unsymmetrical beams subjected to inclined loading, Deflections of unsymmetrical simply supported and cantilever beams with numerical problems.	**10 Hours**	**L3,L4**
Module -5		
Buckling of Non Prismatic Columns and Beam-Column Principle behind Euler's theory of buckling, Governing differential equation applied to buckling of columns and evaluation of constants for various boundary conditions, Obtaining the characteristic equation for the buckling load of non-prismatic compound columns, Analysis of Beam-column, conceptual theory of magnification stresses and deformations subjected to axial and different types of lateral loads with numerical problems.	**10 Hours**	**L3,L4**

Course Outcomes: Students will be able to

- Apply Winkler Bach and Strain Energy principles to obtain stresses and deformation in curved members
- Derive the expressions to Foundation pressure, Deflection, Slope, BM and SF of infinite and semi-infinite Beams resting on Elastic Foundation
- Obtain the equations for the shear centre for symmetrical and unsymmetrical from fundamental.
- Extrapolate the bending theory to calculate the stresses and deformations in unsymmetrical bending.
- Develop the characteristic equation for the buckling load of compound column and stresses and deformations in beam-column

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.

Text Books

1) Krishna Raju N &Gururaj D R "Advanced mechanics of solids and structures", NAROSA Publishers Company Delhi.
2) Srinath L.S. "Advanced Mechanics of Solids", Tenth Print, Tata McGraw Hill publishing company. New Delhi, 1994.

Reference Books

1) Vazirani V N and Ratwani M M "Advanced theory of structures and Matrix Method". 5th Edition, Khanna publishers, Delhi 1995.
2) HetenyiM."Beams on elastic foundation" 3rd printing, University of Michigan, USA, 1952.
3) Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, New Delhi, 1974.
4) Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers

DESIGN OF HIGH RISE STRUCTURES

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

SEMESTER – II

Subject Code	**18CSE252**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites:

- Special Concrete
- Structural Dynamics

Course objectives:

The objective of this course is to make students to learn principles of stability of tall buildings, To design the tall buildings for earthquake and wind resistance. To evaluate the performance of tall structures for strength and stability

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads	**10 Hours**	**L1, L2**
Module-2		
Wind loading: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design.	**10 Hours**	**L1, L3, L4, L5**
Module -3		
Behavior of Various Structural Systems: Factors affecting growth, Height and structural form; High rise behavior, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger – braced and hybrid mega system.	**10 Hours**	**L2, L3**

Module -4		
Analysis and Design: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional analyses.	**10 Hours**	**L2, L3, L4**
Module -5		
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, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkage effects, temperature effects and fire	**10 Hours**	**L2, L3, L4, L5**

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 strength and stability
- Design and develop analytical skills.
- Summarize the behavior of various structural systems.
- Understand the concepts of P-Delta 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. Taranath B.S, "Structural Analysis and Design of Tall Buildings"- McGraw Hill
2. Wilf gang Schuller, "High rise building structures"- John Wiley
3. Bryan Stafford Smith &Alexcoull, "Tall building structures Analysis and Design"- John Wiley
4. T.Y Lin &D.Stotes Burry, "Structural concepts and system for Architects and Engineers"- John Wiley
5. Lynn S.Beedle, "Advances in Tall Buildings"- CBS Publishers and Distributors.
6. Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures-Design and Construction practices for middle level cities"- New Age International Limited

DESIGN OF INDUSTRIAL STRUCTURES

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

SEMESTER – II

Subject Code	**18CSE253**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites: Design of Steel structures

Course objectives:

The objective of this course is to make students to learn principles of Design of industrial building, To design different components of industrial structures and to detail the structures. To evaluate the performance of the Pre-engineered buildings

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Analysis of industrial building for Gravity and Wind load. Analysis and design of framing components namely, girders, trusses, gable frames	**10 Hours**	**L2, L3, L4**
Module-2		
Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections.	**10 Hours**	**L2, L3, L4**
Module -3		
Analysis of transmission line towers for wind load and design of towers including all connections.	**10 Hours**	**L2, L3, L4**
Module -4		
Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.	**10 Hours**	**L1, L2, L4**
Module -5		
Concept of Pre- engineered buildings, Design of compression and tension members of cold formed light gauge sections,	**10 Hours**	**L2, L3, L4**

Design of flexural members (Laterally restrained / laterally unrestrained).		

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

- Achieve Knowledge of design and development of problem solving skills.
- Understand the industrial building and the components.
- Design and develop analytical skills.
- Summarize the principles of Structural Design and detailing
- Understands the concept of Pre- engineered 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. Bureau of Indian Standards, IS800-2007, IS875-1987, IS-801-1975. Steel Tables, SP 6 (1) – 1984
2. N Subramanian- "Design of Steel Structure" oxford University Press
3. B.C. Punmia, A.K. Jain "Design of Steel Structures", Laxmi Publications, New Delhi.
4. Ramchandra and VirendraGehlot " Design of Steel Structures " Vol 1 and Vol.2, Scientific Publishers, Jodhpur
5. Duggal "Limit State Design of Steel Structures" TMH

Structural Health Monitoring

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

SEMESTER – II

Subject Code	**18CSE254**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites:

Basic understanding of finite element analysis; structural dynamics, probability and statistics; signal processing; linear algebra; MATLAB; and functional analysis.

Course objectives:

Structural Health Monitoring examines the use of low-cost, long term monitoring systems to keep civil infrastructure under constant surveillance, ensuring structural integrity. Moreover, the tools and skills the students will learn in this course can be implemented to develop sustainable maintenance and rehabilitation schemes and programs.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction to Structural Health Monitoring (SHM): Definition & motivation for SHM, SHM - a way for smart materials and structures, SHM and bio mimetic - analog between the nervous system of a man and a structure with SHM, SHM as a part of system management, Passive and Active SHM, NDE, SHM and NDECS, basic components of SHM, materials for sensor design.	**10 Hours**	**L1,L2**
Module-2		
Application of SHM in Civil Engineering: Introduction to capacitive methods, capacitive probe for cover concrete, SHM of a bridge, applications for external post tensioned cables, monitoring historical buildings.	**10 Hours**	**L2,L3,L4**

Module -3		
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.	**10 Hours**	**L3,L4**
Module -4		
Condition Survey & NDE of Concrete Structure: Definition and objective of Condition survey, stages of condition survey (Preliminary, Planning, Inspection and Testing stages), possible defects in concrete structures, quality control of concrete structures - Definition and need, Quality control applications in concrete structures, NDT as an option	**10 Hours**	**L3,L4**
Module -5		
Rehabilitation and Retrofitting of Concrete Structure: Repair rehabilitation & retrofitting of structures, damage assessment of concrete structures, Materials and methods for repairs and rehabilitation, modelling of repaired composite structure, structural analysis and design - Importance of re-analysis, execution of rehabilitation strategy, Case studies.	**10 Hours**	**L3,L4,L5**

Course Outcomes: Students will be able to

a. Diagnosis the distress in the structure understanding the causes and factors
b. Assess the health of structure using static field methods.
c. Assess the health of structure using dynamic field tests.
d. Suggest repairs and rehabilitation measures of the structure

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. *"Guide Book on Non-destructive Testing of Concrete Structures", Training course series No. 17,* International Atomic Energy Agency, Vienna, 2002.
2. *"Hand Book on Seismic Retrofitting of Buildings",* Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.
3. Daniel Balageas, Claus - Peter FritzenamI Alfredo Guemes, "*Structural Health Monitoring",* Published by ISTE Ltd., U.K. 2006.
4. Douglas E Adams *"Health Monitoring of Structural Materials and Components-Methods with Applications",* John Wiley and Sons, 2007.
5. *Hand book on "Repair and Rehabilitation of RCC Building",* Published by Director General, CPWD, Govt. of India, 2002.
6. J. P. Ou, H. Li and Z. D. Duan, *"Structural Health Monitoring and Intelligent Infrastructure",* Vol1, Taylor and Francis Group, London, UK, 2006.
7. Victor Giurglutiu, Academic *"Structural Health Monitoring with Wafer Active Sensors",* Academic Press Inc, 2007.

STRUCTURAL ENGINEERING LAB-2
[As per Choice Based Credit System (CBCS) scheme]
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.

DESIGN OF CONCRETE BRIDGES

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

SEMESTER – III

Subject Code	**18CSE31**	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 Analysis
- Highway Engineering
- Design of RC Structures

Course objectives:

- The students will be exposed to the Engineering aspects of concrete bridges
- Various loads that act on the bridges as per IRC.
- Analysis for the maximum BM and SF at critical section using load distributing theories.
- Design of various components using limit state method with reinforcement details.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction & Design of Slab Culvert Bridge Engineering and its development in past, Ideal site selection for Bridges, Bridge classifications, Forces acting on Bridge. Analysis for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of slab culvert using limit state method with reinforcement details.	**10 Hours**	**L1,L2,L3**
Module-2		
Box Culvert Introduction to box culvert, advantage of structural continuity, Analysis for maximum BM and SF at critical sections using moment distribution method for various load combinations such as Dead, Surcharge, Soil, Water and Live load as per IRC class A, B, AA tracked and	**10 Hours**	**L2,L3**

wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.		
Module -3		
T Beam Bridge Components of T Beam Bridge, Load transfer mechanism, Proportioning the of Components, Analysis of **Slab** using **Pigeauds Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Slab**using limit state method with reinforcement details. Analysis of **Cross Girder** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of slabusing limit state method with reinforcement details. Analysis of **Main Girder** using **Courbon's Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Main Girder** using limit state method with reinforcement details.	**10 Hours**	**L2,L3**
Module -4		
PSC Bridge Introduction to Pre & Post Tensioning, Proportioning of Components, Analysis & Structural Design of Slab, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle, Calculations of Prestressing Force, Calculations of Stresses, Cable profile, Design of End Block, Detailing of Main Girder.	**10 Hours**	**L3,L4**
Module -5		
Balanced Cantilever Bridge Introduction & Proportioning of Components, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle Design of Simply Supported Portion, Cantilever Portion, Articulation, using limit state method with reinforcement details.	**10 Hours**	**L3,L4**

Course outcomes:

After studying this course, students will be able to:

- Describe historical growth, select ideal site and bridge, calculate values of design parameters of slab culvert at critical section as per IRC, design and detailing required for the execution of the project.
- Carry out analysis of box culvert as per IRC to obtain the values of design

parameters and to design and detail the components following IS code procedure.

- Demonstrate the use of **Pigeauds Method** and**Courbon's Method**in theanalysis of T beam bridge as per IRC, design to obtain the safe dimensions various components, optimum reinforcement required following IS code procedure.
- Display the use of **Courbon's Method**in theanalysis of PSC bridge as per IRC, design to obtain the safe value of prestressing force, obtain the dimensions of various components to keep the stresses within codal provisions following IS code procedure.
- Analysis a balanced cantilever bridge as per IRC and to obtain the safe values of design parameters and to design and detail the components as per IS code procedure

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Essentials of Bridge Engineering by Dr D Johnson Victor, Oxford & IBH Publishing Co New Delhi

2. Design of Bridges by Dr N Krishna Raju, Oxford & IBH Publishing Co New Delhi

References:

1. Principles and Practice of Bridge Engineering by S P Bindra, Dhanpat Rai & Sons New Delhi
2. IRC 6 -1966 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses, The Indian Road Congress New Delhi
3. IRC 21 - 1966 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
4. IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) BIS New Delhi
5. IS 1343 - Indian Standard Prestressed Concrete Course Code of Practice BIS New Delhi

DESIGN CONCEPTS OF SUBSTRUCTURES

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

SEMESTER – III

Subject Code	**18CSE321**	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 Geotechnical Engineering

Course objectives:

The objective of this course is to make students to learn principles of subsoilexploration, To design the sub structures. To evaluate the soil shear strength parameters.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction, Site investigation, In-situ testing of soils, Subsoil exploration, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts.	**10 Hours**	**L2, L4, L5**
Module-2		
Concept of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C-Φ soils, Footings on layered soils and sloping ground, Design for Eccentric or Moment Loads	**10 Hours**	**L2, L4, L5**
Module -3		
Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soilstructure interaction, different methods of modeling the soil. Combined footings (rectangular & trapezoidal), strap footings & wall footings, Raft – super structure interaction effects & general concepts of structural design, Basement slabs	**10 Hours**	**L2, L4, L5**

Module -4		
Deep Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles.	**10 Hours**	**L2, L3, L4, L5**
Module -5		
Types of caissons, Analysis of well foundations,Design principles, Well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – general concepts.	**10 Hours**	**L2, L3, L4, L5**

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 subsoil exploration
- Design and develop analytical skills.
- Identify and evaluate the soil shear strength parameters.
- Understand the concepts of Settlement analysis.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Swami Saran – "Analysis & Design of Substructures"- Oxford & IBH Pub. Co. Pvt. Ltd., 1998.
2. Nainan P Kurian – "Design of Foundation Systems"- Narosa Publishing House, 1992.

3. R.B. Peck, W.E. Hanson & T.H. Thornburn – "Foundation Engineering"- Wiley Eastern Ltd.,Second Edition, 1984.
4. J.E. Bowles – "Foundation Analysis and Design"- McGraw-Hill Int. Editions, Fifth Ed., 1996.
5. W.C. Teng – "Foundation Design"- Prentice Hall of India Pvt. Ltd., 1983.
6. Bureau of Indian Standards:IS-1498, IS-1892, IS-1904, IS-6403, IS-8009, IS-2950, IS-11089, IS-11233, IS-2911 and all other relevant codes

REPAIR AND REHABILITATION OF STRUCTURES

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

SEMESTER – III

Subject Code	**18CSE322**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites: Concrete Technology, Design of RC structures

Course objectives:

The objective of this course is to make students to learn principles of subsoil exploration, To design the sub structures. To evaluate the soil shear strength parameters.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
General: Introduction, Cause of deterioration of concrete structures, Diagnostic methods & analysis, preliminary investigations, experimental investigations using NDT, load testing, corrosion mapping, core drilling and other instrumental methods, Quality assurance for concrete construction, as built concrete properties strength, permeability, thermal properties and cracking.	**10 Hours**	**L3, L5**
Module-2		
Influence on Serviceability and Durability: Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, and cathodic protection.	**10 Hours**	**L3, L4, L5**
Module -3		
Maintenance and Repair Strategies: Definitions: Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance, Preventive	**10 Hours**	**L2, L3, L5**

measures on various aspects. Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration, testing techniques		
Module -4		
Materials for Repair: Special concretes and mortars, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiberreinforced concrete. Techniques for Repair: Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shot Crete Epoxy injection, Mortar repair for cracks, shoring and underpinning	**10 Hours**	**L2**
Module -5		
Examples of Repair to Structures: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure, engineered demolition techniques for dilapidated structures - case studies	**10 Hours**	**L2, L5**

Course outcomes:

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the cause of deterioration of concrete structures.
- Design and develop analytical skills.
- Summarize the principles of repair and rehabilitation of structures
- Understands the concept of Serviceability and Durability.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Sidney, M. Johnson “Deterioration, Maintenance and Repair of Structures”.

2. Denison Campbell, Allen & Harold Roper, “Concrete Structures – Materials, Maintenance and Repair”- Longman Scientific and Technical

3. R.T.Allen and S.C. Edwards, “Repair of Concrete Structures”-Blakie and Sons

4. Raiker R.N., “Learning for failure from Deficiencies in Design, Construction and Service”- R&D Center (SDCPL

THEORY OF PLATES AND SHELLS

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

SEMESTER – III

Subject Code	**18CSE323**	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 and Mechanics of Deformable Bodies

Course objectives:

The objective of this course is to make students to learn different methods of analysis and design of plates and shells, To critically detail the plates, folded plates and shells. To evaluate the performance of spatial structures.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction to plate theory, Small deflection of laterally loaded thin rectangular plates for pure bending. Navier's and Levy's solution for various lateral loading and boundary conditions (No derivation), Numerical examples	**10 Hours**	**L1, L2**
Module-2		
Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.	**10 Hours**	**L2, L3**
Module -3		
Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids	**10 Hours**	**L2, L3**
Module -4		
Axially symmetric bending of shells of revolution, Closed cylindrical shells, water tanks, spherical shells and	**10 Hours**	**L2, L3**

Geckler's approximation. Bending theory of doubly curved shallow shells.		
Module -5		
Design and detailing of folded plates with numerical examples Design and Detailing of simple shell problems – spherical domes, water tanks, barrel vaults and hyperbolic paraboloid roofs	**10 Hours**	**L2, L3, L4**

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 Analysis and Design
- Design and develop analytical skills.
- Summarize the performance of shells
- Understand the concepts of energy principle.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Timoshenko, S. and Woinowsky-Krieger, W., "Theory of Plates and Shells" 2nd Edition, McGraw-Hill Co., New York, 1959

2. Ramaswamy G.S. – "Design and Constructions of Concrete Shell Roofs" – CBS Publishers and Distributors – New Delhi – 1986.

3. Ugural, A. C. "Stresses in Plates and Shells", 2nd edition, McGraw-Hill, 1999.

4. R. Szilard, "Theory and analysis of plates - classical and numerical methods", Prentice Hall,1994.

5. Chatterjee.B.K. – "Theory and Design of Concrete Shell", – Chapman & Hall, New York-third edition, 1988.

OPTIMIZATION TECHNIQUES

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

SEMESTER – III

Subject Code	**18CSE324**	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 Mathematics

Course objectives:

The objective of this course is to make students to learn principles of optimization, To implement the optimization Concepts for the structural engineering problems. To evaluate different methods of optimization.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.	**10 Hours**	**L1, L2, L4**
Module-2		
Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.	**10 Hours**	**L2, L4, L5**
Module -3		
Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation	**10 Hours**	**L2, L3, L4, L5**

methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods		
Module -4		
Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems. Formulation and solution of structural optimization problems by different technique	**10 Hours**	**L2, L3, L4, L5**
Module -5		
Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/ geometric programming. **Dynamic programming:** Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming	**10 Hours**	**L4, L5**

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 optimization.
- Design and develop analytical skills.
- Summarize the Linear, Non-linear and Geometric Programming
- Understands the concept of Dynamic programming

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Spunt, "Optimum Structural Design"- Prentice Hall
2. S.S. Rao, "Optimization – Theory and Practice"- Wiley Eastern Ltd.
3. Uri Krisch, "Optimum Structural Design"- McGraw Hill
4. Richard Bronson, "Operation Research"- Schaum's Outline Series
5. Bhavikatti S.S.- "Structural optimization using sequential linear programming"- Vikas publishing house

FRACTURE MECHANICS APPLIED TO CONCRETE

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

SEMESTER – III

Subject Code	**18CSE331**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites: Concrete Technology and Mechanics of Deformable Bodies

Course objectives: This course will enable students to

1. To compute the stress intensity factor, strain energy release rate and the stress and strain fields around a crack tip for linear and non linear materials.
2. Know experimental methods to determine the fracture toughness.
3. Use the design principles of materials and structures using fracture mechanics approach.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Stress concentration in elastic materials Theory of stress concentration in elastic materials, stress concentration factors around circular and elliptic holes. Influence of ratio of radii on stress concentration factor in elliptic hole.	**10 Hours**	**L1,L2**
Module-2		
Linear Elastic Fracture mechanics Modeling a crack as a flat elliptic hole by Inglis and the limitations of the model, Griffith theory of brittle fracture, theories of linear elastic fracture mechanics, stress intensity factors, Irwin's definition. Fracture toughness K_{Ic}, K_{IIc} ,K_{IIIc}& corresponding values of GC.	**10 Hours**	**L2,L3**
Module -3		
Elasto-plastic fracture mechanics Crack-tip plasticity in metals. Irwin's modification for elasto-plastic material, J integral, CMOD, CTOD. Mixed mode problems and evaluation of critical fracture parameters.	**10 Hours**	**L2,L3,L4**

Module -4		
Fracture of Concrete Limitations of theories of linear elastic fracture mechanics in concrete, Review of concrete behaviour in tension and compression, Kaplan's experiments, concept of fracture energy, definition of a quasi brittle material, concept of softening.	**10 Hours**	**L2,L3,L4**
Module -5		
Advanced concepts in fracture behavior of concrete Definition of fracture energy by RILEM, Influence of size on fracture behavior, Bazant's size effect law, size dependent & independent fracture energies. Application of fracture mechanics in design of concrete structures.	**10 Hours**	**L2,L3,L4**

Course outcomes:

After studying this course, students will be able to:

- Apply principles of fracture mechanics.
- Design concrete structures using fracture mechanics approach.
- Explain the importance of fracture mechanics.
- Take special care of very large sized structures.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Timoshenko &Goodier, "Theory of Elasticity", McGraw Hill
2. Valliappan S. "Continuum Mechanics Fundamentals" (1982), Oxford IBH, ND. New Delhi.
3. Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition,MartinusNijhoff (1987).
4. T. L. Anderson, "Fracture Mechanics- Fundamentals and Applications", CRC press
5.Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing company, New Delhi, 1994
6. Bhushan LKarihaloo"Fracture mechanics and structural concrete ",John Wiley &

Sons Inc,
7.Zdenek P. Bazant, Jaime Planas,“Fracture and Size Effect in Concrete and Other Quasibrittle Materials” CRC press

DESIGN OF MASONRY STRUCTURES

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

SEMESTER – III

Subject Code	**18CSE332**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites: Construction Technology and Strength of Materials

Course objectives:

The objective of this course is to make students to learn performance of masonry structures, To design the masonry structures for earthquake resistance. To evaluate the strength and stability of the masonry structures.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction, Masonry units, materials and types: History of masonry Characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units – strength, modulus of elasticity and water absorption. Masonry materials – Classification and properties of mortars, selection of mortars.	**10 Hours**	**L1,L2**
Module-2		
Strength of Masonry in Compression: Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, Failure theories of masonry under compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength	**10 Hours**	**L2,L3**
Module -3		
Flexural and shear bond, flexural strength and shear strength:	**10 Hours**	**L3,L4**

Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength		
Module -4		
Design of load bearing masonry buildings: Permissible compressive stress, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels; Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall; Design of load bearing masonry for buildings up to 3 to 8 storeys using BIS codal provisions	**10 Hours**	**L3,L4**
Module -5		
Earthquake resistant masonry buildings: Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS codal provisions. Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure	**10 Hours**	**L3,L4,L5**

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 design and construction of masonry structures
- Design and develop analytical skills.
- Summarize the masonry Characteristics.
- Evaluate the strength and stability of the masonry structures.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Hendry A.W., “Structural masonry”- Macmillan Education Ltd., 2nd edition
2. Sinha B.P & Davis S.R., “Design of Masonry structures”- E & FN Spon
3. Dayaratnam P, “Brick and Reinforced Brick Structures”- Oxford & IBH
4. Curtin, “Design of Reinforced and Prestressed Masonry”- Thomas Telford
5. Sven Sahlin, “Structural Masonry”-Prentice Hall
6. Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, “Alternative Building Materials and Technologies”-New Age International, New Delhi & Bangalore
7. IS 1905, BIS, New Delhi.
8. SP20(S&T),New Delhi

DESIGN OF FORMWORK

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

SEMESTER – III

Subject Code	**18CSE333**	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 Structural Mechanics

Course objectives: Students will be

- Given basic knowledge material science and engineering aspects of form work
- Selection and the design of form work to achieve safety, economical and effective supporting system
- Plan various activities on site for obtaining optimum movement of machinery, material and labour for timely completion of projects.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Form Materials and Pressures on Formwork: Lumber – Types – Finish – Sheathing boards - Working stresses – Repetitive member stress – Plywood – Types and grades – Textured surfaces and strength – Reconstituted wood – Steel – Aluminum Form lining materials – Hardware and fasteners – Nails in Plywood – Bolts lag screw and connectors – Bolt loads. Pressures on Formwork - Concrete density – Height of discharge – Temperature – Rates of Placing – Consistency of concrete – Live loads and wind pressure – Vibration Hydrostatic Adjustment for non standard condition.	**10 Hours**	**L1,L2**
Module-2		
Shores and Form Design: Simple wood stresses – Slenderness ratio – Allowable loads – Tubular steel shores - Patented shores – Site Preparation - Size and spacing – Steel Tower Frames – Safety practices – Horizontal shoring for multi-levels – More concentrated shore loads - T-heads – Two tier wood shores – Ellis shores – Dayton sure grip and Baker Roos	**10 Hours**	**L2,L3**

shores – SafwaySymons shores – Beaver Advance shores - Dead shores – Raking and Flying shores Basic simplification – Beam formulas – Allowable stresses		
Module -3		
Planning, Site Equipment and Plant for Form Work: Overall Planning – Detailed Planning – Standard units – Corner units – Schedule for column formwork – Formwork elements – Planning at Tender stage – Development of basic system – Planning for maximum reuse – Economical form construction – Planning examples – Crane size, effective scheduling estimate – Recheck plan details – Detailing the forms. Crane arrangement – Site layout plan – Transporting plant – Formwork beams – Formwork ties – Wales – Scaffold frames - Form accessories – Vertical transport table form work.	**10 Hours**	**L1,L2,L3**
Module -4		
Deflection bending lateral stability: Shear, Bearing – Examples in wall forms – Slab forms – Beam form – Ties, Anchors and Hangers – Column forms – Examples in each.	**10 Hours**	**L3,L4**
Module -5		
Dome Forms, Tunnel Forms, Slipforms and Safety Practices for Scaffolds: Shells of translation and revolution - Hemispherical – Parabolic - Barrel vaults – Hypar Shells – Conoidal Shells - Folded plates – Shell form design – Building the form – Placing concrete – Strength requirements – Tunnel forming components – Curb and Invert forms	**10 Hours**	**L3,L4**

Course outcomes: Students will be able to

- Reproduce the properties of various materials used in the form work and estimate the pressures over which the form work has to support
- Describe various structural aspects of shores, choose appropriate shore required as per the situation and design the shores as per the prevailing practice.
- Plan the various activities to arrive at optimum movement of machinery in erecting the effective form work which will be economical.
- Provide lateral stability to control deflection to be in safe limits using different forms of holdings
- Extrapolate the engineering aspects of form work for special applications in

domes and shell for of constructions

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Robert L. Peurifoy and Garold D. Oberlender, "Formwork for Concrete Structures", Third Edition McGraw-Hill, 1996.
2. Hurd, M.K., "Formwork for Concrete", Special Publication No. 4 Sixth Edition, American Concrete Institute, Detroit, 1995.

Reference Books:

1. Michael P. Hurst, "Formwork", Construction Press, London and New York, 1997.
2. Austin, C.K., "Formwork for Concrete", Cleaver – Hume Press Ltd., London 1996.
3. Tudor Dinescu and Constantin Radulescu, "Slipform Techniques", Abacus Press, Turn Bridge Wells, Kent, 1992.
4. "Guide for Concrete Formwork", American Concrete Institute Detroit, Michigan, 1996.
5. "Safety Requirements for Scaffolding", American National Standards Institute, New York, 1994.

COMPOSITE MATERIALS

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

SEMESTER – III

Subject Code	**18CSE334**	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites: Basic knowledge on material properties, Matrix Method of Structural Analysis and Mechanics of Deformable Bodies

Course objectives: Students will be

To impart knowledge of composite materials in the context of structural engineering application. To impart a skill of analyzing macro and micro mechanical behaviour of composites. To develop introductory knowledge about manufacturing of composites and its failure theories.

Modules	**Teaching Hors**	**RBT Level**
Module-1		
Introduction: Introduction to Composite materials, classifications (thermoset and thermoplastic) and civil/structural engineering applications. Constituent materials of composites – Reinforcements and matrix. Rule of mixture. Selection of materials. Manufacturing techniques – Hand layup method and compression moulding method. Basics of fiber reinforced composite (Synthetic and natural FR Polymer composites). Advantages and Limitations of composites.	**10 Hours**	**L1, L2, L4**
Module-2		
Macro-mechanical Behaviour of a Lamina: Introduction, Stress-Strain Relations For Anisotropic Materials. Stiffness's, compliances, and engineering constants for orthotropic materials. Restrictions on engineering constants. Numerical problems.	**10 Hours**	**L3, L4, L5**
Module -3		
Macro-mechanical Behaviour of a Lamina contd… Stress-strain relations for plane stress in an orthotropic material. Stress-strain relations for a lamina of arbitrary orientation. Invariant properties of an orthotropic lamina.	**10 Hours**	**L3, L4, L5**

Strengths of an orthotropic lamina, thermal and mechanical stress analysis. Numerical problems.		
Module -4		
Micro-mechanical behaviour of a lamina: introduction, mechanics of materials approach to stiffness. Determination of E_1. Determination of E_2. Determination of v_{12}. Determination of G_{12}. Numerical problems.	**10 Hours**	**L3, L4, L5**
Module -5		
Classical composite lamination theory, cross and angle – play laminates, symmetric, anti-symmetric and general symmetric laminates. Mechanical coupling. Analysis of simple laminated structural elements ply-stress and strain, lamina failure theories concepts- Maximum Stress Failure Criterion, Maximum Strain Failure Criterion and Tsai-Hill Failure Criterion. Numerical Problems.	**10 Hours**	**L3, L4, L5**

Course outcomes:

On successful completion of the course, the student will be able to:

1. Define and classify the composite materials.
2. Analyze the macro-mechanical behaviour of composites.
3. Derive the engineering constants of composites.
4. Select the appropriate constituent materials for composite manufacture.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Mechanics of Composite Materials and Structures by M. Mukhopadhya-Universities Press 2009
2. RobartM.Jones, " **Mechanical of Composite Materials**"- McGraw Hill Publishing Co.
3. Bhagwan D Agarvalm, and Lawrence J Brutman, " **Analysis and Performance of Fiber Composites**"- John Willy and Sons.
4. Autar K. Kaw, Mechanics of Composite Materias, Second edition., CRC Press, 2006.