STRUCTURAL OPTIMIZATION - THEORY & COMPUTATIONS			
Course Code	22CAS11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

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.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. , L_4 – Analyse

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_4 – Analyse, L_5 – Evaluate

Module-3

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse, L_5 – Evaluate

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse, L_5 – Evaluate

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.

Revised Bloom's Taxonomy Level	L_4 – Analyse, L_5 – Evaluate

Course outcomes:

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

1. Formulate structural optimization problems.
2. Carry out linear programming by solving a system of linear simultaneous equations.
3. Apply different non-linear programming methods
4. Apply constrained optimization techniques for structural engineering problems.
5. Undertake geometric and dynamic programming techniques to structural engineering problems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1)Spunt, L., Optimum Structural Design, Prentice Hall, 1971.

(2)Bhavikatti S. S., Structural optimization using sequential linear programming, Vikas publishing, 2003.

Reference Books

(1) Rao S. S., Optimization – Theory and Practice, Wiley Eastern Ltd. 1978
(2) Uri Kirsch, Optimum Structural Design, McGraw Hill, New York, 1981.
(3) Bronson R. and, Govindsami N., Operation Research, Schaum's Outline Series, 2017.

COMPUTATIONAL STRUCTURAL MECHANICS - CLASSICAL AND FE APPROACH			
Course Code	22CAS12	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Direct Stiffness Method – Trusses

Degrees of Static and Kinematic indeterminacies, Concepts of Stiffness and Flexibility, Local and Global Coordinate System, Analysis of indeterminate Trusses, with and without initial strains for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Numerical examples.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-2

Direct Stiffness Method - Continuous Beam, and Frames. Analysis of Continuous beams, for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Numerical examples. Element stiffness matrix formulation for 2D, Grids and 3D frames (Local and Global).

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3

FE Analysis using Bar Elements:

Element Stiffness matrix of two and three noded elements. Examples with constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and Initial strains due to temperature.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-4

Isoparametric formulation of Bar Elements. Element stiffness matrix of two noded element with constant area, linear variation in area, Consistent Load due to body force, Surface traction. Element stiffness matrix of three noded bar Element, Consistent load due to UDL, Linearly Varying Load, and Quadratic Varying Load.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply,

Module-5

FE Analysis using Beam Element. Element Stiffness matrix, Consistent Nodal loads, Concept of Reduced or Lumped Loads, Examples. Cantilever and Simply Supported beams.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply,

Course outcomes:

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

1. Apply direct stiffness method and analyse 2-D truss and frame structures
2. Formulate Finite Element method with respect to structures.
3. Formulate and apply FEM to bar and beam elements.
4. Apply knowledge of problem solving skills using computer aided methods.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1)Rajasekaran, S. and Shankarsubramanian, G., Computational Structural Mechanics, PHI New Delhi,2001.

(2)Weaver, W. and Gere, J. M., Matrix analysis of framed structures, CBS Publishers and Distributors Pvt. Ltd. 2004.

(3) Reddy. C. S, Basic Structural Analysis, TMH, New Delhi 2001

Reference Books

(1)Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley and Sons, New York. 2007

(2)Bathe. K. J., Finite element procedures in Engineering Analysis. PHI. NewDelhi, 2007.

(3) Rubinstein M.F, Matrix Computer Analysis of structures. Prentice-Hall, Eaglewood Cliffs, New Jersey, 1966.

(4) M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons, 2005

ADVANCED DESIGN OF RC STRUCTURAL ELEMENTS			
Course Code	22CAS13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Credits	04	Exam Hours	03

Module-1

Behaviour of RC Beams in Shear and Torsion: Modes of Cracking, Shear Transfer Mechanisms , Shear Failure Modes, Critical Sections for Shear Design , Influence of Axial Force on Design Shear Strength, Shear Resistance of Web Reinforcement, Compression Field Theory, Strut-and-Tie Model. Equilibrium Torsion and Compatibility Torsion, Design Strength in Torsion, Design Torsional Strength with Torsional Reinforcement- Space Truss Analogy and Skew Bending Theory- Numerical examples.
Lab: Experiment – 1& 2

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-2

Redistribution of Moments in RC Beams: Conditions for Moment Redistribution – Final shape of redistributed bending moment diagram. Advantages and disadvantages of Moment redistribution – Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment – curvature Relations of Reinforced Concrete sections. Moment redistribution for a two-span continuous beam. Curtailment of tension Reinforcement – code procedure – Numerical Examples.
Lab: Experiment – 3 & 4

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3

Design of Reinforced Concrete Deep Beams: Introduction, definition, Types of deep beams, Minimum thickness - Steps for designing Deep beams as per IS 456 - Detailing of Deep beams. Design examples.
Lab: Experiment – 5 & 6

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-4

Behaviour and Analysis of Compression Members: Effective Length Ratios of Columns in Frames, Code Charts – Numerical Examples, Short Columns - Modes of Failure in eccentric Compression, Axial Load, Moment Interaction equation**,** Interaction surface for a biaxial loaded column, concept of equilibrium approach and application to nonrectangular columns. Slender Column: Braced and Unbraced, Design Methods as per IS 456. Strength reduction and additional moment method. Design examples
Lab: Experiment – 7 & 8

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5

Flat Slab Design: Behaviour of Slab supported on Stiff, Flexible and no beams, Equivalent Frame Concept, ,Proportioning of Slab Thickness, Drop Panel and Column Head, Transfer of Shear from Slab to column, Direct Design Method, Equivalent Frame Method – Design Examples. FE analysis and design of Slab Panels based on Wood- Armer equations.
Lab: Experiment – 9 & 10

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Course outcomes:
At the end of the course the student will be able to:
1. Analyse the behaviour of RC beams.
2. Apply redistribution of moments in the analysis of RC beams
3. Analyse and design RC deep beams
4. Design compression members.
5. Design flat slabs.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks
(1) Krishna Raju, Advanced R.C. Design, CBS Publishers and Distributors, 1986.
(2) S. Pillai, Devdas Menon, Reinforced Concrete Design, Tata McGraw-Hill, 3rd Edition, 1999
(3) Varghese. P.C., Advanced Reinforced Concrete design, prentice, Hall of India, 2007.
(4) Gambhir M. L., Design of Reinforced Concrete Structures, PHI Pvt. Ltd. New Delhi, 2008
Reference Books
(1)Purushothaman, P., Reinforced concrete structural elements: Behaviour, analysis and Design, Tata McGraw Hill, 1986.
(2) Park R. and Paulay, T., Reinforced Concrete Structures, John Wiley and Sons. 2004.
(3) N. Subramanian, Design of Reinforced Concrete Structures, Oxford IBH.
(4) Relevant IS Codes

Note: Experiment 1: Excel programming to compute Concrete Mix Design.

Experiment 2: Excel programming to compute singly and doubly reinforced beam

Experiment 3: Excel programming to compute continuous beam

Experiment 4: Excel programming to compute continuous beam continued

Experiment 5: Excel programming to compute Deep beams

Experiment 6: Excel programming to compute Deep beams continued

Experiment 7: Excel programming to compute Short columns

Experiment 8: Excel programming to compute slender column

Experiment 9: Excel programming to compute simple Flat Slab

Experiment 10: Excel programming to compute simple Flat Slab continued.

STRUCTURAL DYNAMICS –THEORY AND COMPUTATIONS			
Course Code	22CAS14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	50
Credits	04	Exam Hours	03

Module-1

Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, principle of 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 of damping.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

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's integral. Principle of vibration measuring instruments–seismometer and accelerometer.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-3

Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of freedom systems, Shear building concept, free vibration of undamped multi-degree-of freedom systems – Natural frequencies and mode shapes – Orthogonality of modes.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

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.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

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).

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Course outcomes:

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

1. Evaluate the effect of structural vibrations on safety and reliability of structural systems.
2. Develop and solve equations of motion for free and forced response of structural systems.
3. Analyse damping and its influence on structural response.
4. Apply modal method to compute forced response of SDOF and MDOF systems.
5. Carry out dynamic analysis of beams using FEM.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Anil K. Chopra, Dynamics of structures – Theory and Applications, Pearson Education, 2nd Edition, 2012.

(2)Mario Paz, Structural dynamics - Theory and computations, 2 nd Edition, CBS Publisher and Distributors, New Delhi, 2004.

(3)Mukhopadyaya, Vibration, Dynamics and structural problems, Oxford IBH Publishers, 2000.

Reference Books

(1)Clough, Ray W and Penzien J, Dynamics of Structures, 2nd Edition, McGraw-Hill, New York, 1993

(2)Roy R. Craig, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2006.
(3) Timoshenko, S., Vibration Problems in Engineering, 2nd Edition, Van Nostrand Co., New York, 1955.

MECHANICS OF DEFORMABLE BODIES			
Course Code	22CAS15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

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.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

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.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

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.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

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.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply.,

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

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

Course outcomes:

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

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

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(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
Reference Books
(1)Valliappan C, “Continuum Mechanics Fundamentals”, Oxford IBH Publishing Co.Ltd.
(2) Sadhu Singh, “Applied Stress Analysis”, Khanna Publishers
(3) Xi Lu, “Theory of Elasticity”, John Wiley

RESEARCH METHODOLOGY AND IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

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.
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-2

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.
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. ■

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.
Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.
Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

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.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand

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, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and 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.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 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) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,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 Under an Act of Parliament, September 2013.

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.

SOFTWARE COMPUTATION LABORATORY –I			
Course Code	22CASL17	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Sl.NO	Experiments	RBT levels
1	Structural Analysis of 2D and 3D Trusses.	L1,L2,L3, L4, L5
2	Structural Analysis of Continuous Beams using different types of loadings and support conditions.	L1,L2,L3, L4, L5
3	Structural Analysis of 2D and 3D Rigid and Braced Frames for different types of loadings, support conditions	L1,L2,L3, L4, L5
4	Modelling and stress analysis of Beams subjected to different loadings using FEA.	L1,L2,L3, L4, L5
5	Modelling and stress analysis of Trusses using FEA.	L1,L2, L3
6	Flexural Behaviour of Slab Panels with different aspect ratio and boundary conditions using FEA.	L1,L2, L3
Exercises on Structural Analysis are aimed at using Finite element analysis based on Industry Standard Software		

Course outcomes:

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

1. Carry out structural analysis of 2-D and 3-D trusses.
2. Apply different types of loading and end conditions for analysis of continuous beams.
3. Analyse 2-D and 3-D rigid and braced frames having different configurations
4. Carry out FE analysis of Plane Stress and Plane Strain Problems
5. Analyse and interpret Flexural Behaviour of Slab Panels.

FINITE ELEMENT ANALYSIS OF STRUCTURAL SYSTEMS - CONCEPTS AND PROCEDURES			
Course Code	22CAS21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Approximate Solutions of differential equations Mathematical back ground, Need and importance of differential equations, Initial and boundary value problems, Differential equation for axial deformation of bars, exact solution for axial deformation of a uniform bar, tapered bar with linearly varying cross section (illustration about the difficulty). Axial Deformation of Bars with uniform cross section using Galerkin and Raleigh-Ritz Method.

Finite element method: Concept and basic procedure, Idealization of continuum using different types of elements (Bar, Beam, Membrane, Plate and Shell), Choice of displacement function, Generalized and Natural coordinates. Interpolation (shape) functions. Formulation using principle of virtual work.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand,

Module-2

Interpolation (shape) functions of Bar, Beam and Triangular elements, Bar elements: Generalized coordinate approach, Lagrange interpolation for Linear, quadratic and cubic variation in Generalized and natural coordinates. Beam elements: Two noded (Hermitian interpolation in generalized and natural coordinates). Triangular elements: Three nodes (Generalized and area coordinates), six nodes and transition elements with four and five nodes in area coordinates.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

Module-3

Interpolation (shape) functions of Rectangular and Solid elements Rectangular elements: Four nodes (Cartesian, natural coordinates and Lagrange formula), eight nodes (serendipity element) in natural coordinates, Nine nodes (Lagrange element) using Lagrange formula and transition elements with seven nodes in natural coordinates. Tetrahedral element: Four nodes, ten nodes (volume coordinates), Hexahedron (Brick element): Lagrange formula in natural coordinates.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

Module-4

Mapping techniques using interpolation functions. Mapping a Straight Line, Curve, and quadrilateral areas with straight and curved edges, Requirement for valid mapping Guidelines for Mapped Element Shapes. Numerical examples

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

Module-5

Numerical integration- Gauss quadrature. Line or one-Dimensional Integrals: One point, Two point and Three point formula. Procedure and Numerical examples. Area or two-dimensional Integrals: procedure and Numerical examples. Volume or three dimensional Integrals: procedure and Numerical examples.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply

Course outcomes:

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

1. Explain the basic theory behind the finite element method.
2. Formulate and analyse shape functions for different types of elements used in FEA.
3. Use the mapping techniques for different element shapes.
4. Solve numerical examples using finite element method for real structures.
5. Implement computer oriented procedures for FE based structural analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

(1)Zeinkiewicz, O. C. and Taylor R.L., The finite element method for solid and structural mechanics, Butterworh –Heinemann, 2013.

(2) Krishnamoorthy C. S., Finite Element Analysis: Theory and programming, Tata McGraw Hill Publishing Co. Ltd., 2017.

(3) M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons, 2005

Reference Books

(1)Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley and Sons, New York. 2007.

(2) Bathe. K.. J., Finite element procedures in Engineering Analysis. PHI. NewDelhi, 2002.

(3) David V Hutton, Fundamentals of finite element analysis, McGraw Hill, 2003

(4)Reddy J., An Introduction to Finite Element Methods, McGraw Hill Co., 2013

ANALYSIS OF PLATES AND SHELLS – CLASSICAL AND FE APPROACH			
Course Code	22CAS22	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Credits	04	Exam Hours	03

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
Lab: Experiment 1 & 2

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.

Module-2

Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids
Lab: Experiment 3 & 4

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. . L_3 – Apply

Module-3

Axially symmetric bending of shells of revolution, Closed cylindrical shells, water tanks, spherical shells and Geckler's approximation. Bending theory of doubly curved shallow shells.
Lab: Experiment 5 & 6

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse.

Module-4

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
Lab: Experiment 7 & 8

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5

FE approach: Finite Element Analysis of Thin Plate: Triangular Plate Bending Element, Rectangular Plate Bending Element, Finite Element Analysis of Thick Plate.
Lab: Experiment 9 & 10

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. . L_3 – Apply

Course outcomes:
At the end of the course the student will be able to:
1. Analyse the laterally loaded thin plate or shell like structural elements.
2. Design structures with shell elements like water tank.
3. Carry out the design and detailing of folded plate or shell like structural elements.
4. Use FEM to analyse thin plate structures.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Timoshenko and Krieger, Theory of Plates and Shells, McGraw-Hill Int Book Co., New York, 1959.

(2)Chandrashekara K, Theory of Plates, University Press, 2000.

(3) Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley and Sons, New York. 2007.

Reference Books

(1)Szilard. R, Theory and analysis of plates - Classical and numerical methods, Prentice Hall, New Jercy, 1974.

(2)Ugural A C, Stress in Plates and shells, McGraw-H ill International Book Company. 1999.

(3) Bathe. K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi, 2007

Note:

Experiment 1: Excel programming to analyze laterally loaded thin rectangular plates for pure bending.

Experiment 2: Excel programming to analyze laterally loaded thin rectangular plates for pure bending contd…

Experiment 3: Excel programming to analyze spherical shells.

Experiment 4: Excel programming to analyze cylindrical shells.

Experiment 5: Excel programming to analyze axially symmetric bending of shells of revolution

Experiment 6: Excel programming to analyze axially symmetric bending of closed cylindrical shells

Experiment 7: Excel programming to Design and Detailing of simple shell problems – spherical domes

Experiment 8: Excel programming to Design and Detailing of simple shell problems – water tanks

Experiment 9: Excel programming to Finite Element Analysis of Thin Plate: Triangular Plate

Experiment 10: Excel programming to analyze Finite Element Analysis of Thick Plate.

PYTHON AND ITS APPLICATION IN CIVIL ENGINEERING			
Course Code	22CAS231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Introduction Python Basics, Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program,Flow control, Boolean Values, Comparison Operators, Boolean Operators,Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules,Ending a Program Early with sys.exit(), Functions, def Statements with Parameters, Return Values and return Statements,The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling, A Short Program: Guess the Number.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2

The Lists, The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Example Program: Magic 8 Ball with a List, List-like Types: Strings and Tuples,References, Dictionaries and Structuring Data, The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things, Manipulating Strings, Working with Strings, Useful String Methods, Project: Password Locker, Project: Adding Bullets to Wiki Markup.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3

Structural Pattern Matching with Regular Expressions, Finding Patterns of Text Without Regular Expressions, Finding Patterns of Text with Regular Expressions,More Pattern Matching with Regular Expressions, Greedy and Nongreedy Matching, The findall() Method, Character Classes, Making Your Own Character Classes, The Caret and Dollar Sign Characters, The Wildcard Character, Review of Regex Symbols, Case-Insensitive Matching, Substituting Strings with the sub() Method, Managing Complex Regexes, Combining re .IGNORECASE, re.DOTALL, andre.VERBOSE, Project: Phone Number and Email Address Extractor

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-4

Classes and objects, Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying, Classes and functions, Time, Pure functions, Modifiers, Prototyping versus planning, Classes and methods, Object-oriented features, Printing objects, Another example, A more complicated example,Theinit method, The __str__ method, Operator overloading, Type-based dispatch, Polymorphism, Interface and implementation,Inheritance, Card objects, Class attributes, Comparing cards, Decks, Printing the deck, Add, remove, shuffle and sort, Inheritance, Class diagrams, Data encapsulation.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5

Implementation of python in analysis of s/s beam, cantilever beam, fixed, pin and rigid jointed frames; RCC design; design of beams, design of slabs; one way slab and two way slab, design of continuous beams; to find out shear strength of concrete for given grade of concrete using python (Theory and numerical problems)

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_5 – Evaluate, L_6 - Create

Course outcomes:

1. At the end of the course the student will be able to:
2. Demonstrate proficiency in handling of loops and creation of functions.
3. Identify the methods to create and manipulate lists, tuples and dictionaries. Discover the commonly used operations involving regular expressions and file system.
4. Interpret the concepts of Object-Oriented Programming as used in Python
5. Enhancing skills of students to apply modern techniques like python in civil engineering

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Al Sweigart,"Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)

(2) Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 13, 15, 16, 17, 18) (Download pdf/html files from the above links).

Reference Books

(1)Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372

(2) Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, O'Reilly Media, 2016. ISBN-13: 978-1491912058

(3) Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015. ISBN-13: 978-8126556014

(4) Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015. ISBN-13: 978-9332555365

(5) Dr.B.C.Punmia, Ashok kumarjain,arunkumarJain,"limit state design of reinforced concrete (As per IS 456:200), 1st Edition,Laxmi Publications (P) LtD, NEW Delhi-110002

DESIGN OF TALL STRUCTURES			
Course Code	22CAS232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

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

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

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.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Course outcomes:

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

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of strength and stability
3. Design and develop analytical skills.
4. Summarize the behavior of various structural systems.
5. Understand the concepts of P-Delta analysis

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Taranath B.S, "Structural Analysis and Design of Tall Buildings"- McGraw Hill

(2) Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities"- New Age International Limited

Reference Books
(1) Wilf gang Schuller, “High rise building structures”- John Wiley
(2) Bryan Stafford Smith &Alexcoull, “Tall building structures Analysis and Design”- John Wiley
(3) T.Y Lin &D.Stotes Burry, “Structural concepts and system for Architects and Engineers”-John Wiley
(4) Lynn S.Beedle, “Advances in Tall Buildings”- CBS Publishers and Distributors.

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES			
Course Code	22CAS233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Shear and Torsional Resistance: Shear and principal stresses, ultimate shear resistance, design of shear reinforcement, Torsion, Design of reinforcement for torsion.

Anchorage Zone Stresses in Post-Tensioned Members: Introduction, stress distribution in end block,investigations on Anchorage zone stresses, MagnelandGuyon's Methods, Comparative Analysis, Anchorage zonereinforcement

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2

Tension Members: Introduction, Ties, Pressure pipes – fabrication process,analysis, design and specifications. Cylindrical containersconstruction techniques, analysis, design andspecifications. **Compression Members:** Introduction, Columns, short columns, long columns,biaxially loaded columns, Design specifications.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-3

Statically indeterminate Structures: Introduction, Advantages of continuous members, effect ofprestressing in indeterminate structures, methods ofanalysis for secondary moments, concordant cable profile,Guyon's theorem, Ultimate load analysis, Design ofcontinuous beams and portal frames.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Module-4

Slab and Grid Floors: Types of floor slabs, Design of one way, two way and flat slabs. Distribution of prestressing tendons, Analysis and design of grid floors.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-5

Composite Beams: Introduction, types of composite beams, analysis forstresses, differential shrinkage, serviceability limit state.Design for flexural and shear strength.

Precast Elements: Introduction, Prestressed concrete poles-manufacturingtechniques, shapes and cross sectional properties, designloads, designs principles. Railway sleepers-classificationand Manufacturing techniques, design loads, analysis anddesign principles. Prestressed concrete pavements, slaband wall panels.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Course outcomes:

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

- Analyse , Design and detail PSC elements

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Krishna Raju, "Prestressed concrete", Tata Mc Graw Hill Book – Co., New Delhi.

(2) T.Y. Lin and Burn, "Design of prestress concrete structures", John Wiley, New York.

Reference Books

(1) Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Delhi Co ltd., New

(2) S. Ramamrutham, “Prestressed concrete”, Dhanpat Rai & Sons, Delhi.

COMPOSITE AND SMART MATERIALS			
Course Code	22CAS234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Introduction to Composite materials: Classifications and applications. of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices, coupling.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-2

Anisotropic elasticity: Unidirectional and anisotropic lamina, thermo-mechanical properties, micro- mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, anti-symmetric and general asymmetric laminates, mechanical coupling, laminate stacking,

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-3

Analysis of simple laminated structural elements: Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-4

Smart materials: Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-5

Beam modeling with strain actuator, bending extension relation.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Course outcomes:

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

1. Carry out classification and application of various types of fibres.
2. Explain thermo-mechanical properties of materials.
3. Analyse environmental effects and failure theories of composite materials.
4. Familiarise with smart materials and structures.
5. Carry out the analysis of a beam model with induced strain actuation.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Robart M Jones, Mechanic of Composite Materials, McGraw Hill Publishing Co, 2015..

(2)Bhagwan D Agarawal, and Lawrence J Brutman, Analysis and Performance of Fiber Composites, John Willy and Sons, 2006.

Reference Books

(1)MadujitMukhopadyay, Mechanics of composite materials and structures, University Press, 2004.

(2)Inderjit h Chopra, Lecture notes on Smart Structures, Department of Aerospace Engg., University of Maryland.

(3)Ceawley E. and Anderson E., Detailed models of piezo-ceramics actuation of beams, Proceedings of the 30th AIAA/ASME/ASCE/ASC – Structural dynamics and materials conference, Washington DC, April 1989.

SIESMIC RESISTANT DESIGN OF STRUCTURES			
Course Code	22CAS241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

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.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

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 during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_5 – Evaluate, L_6 - Create

Course outcomes:

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

1. Familiarise with the principles of engineering seismology.
2. Use the response spectrum principle in the earthquake resistant design of structures.
3. Analyse behaviour and performance of buildings during earthquakes.
4. Design RC buildings for different earthquake load combinations with ductile detailing of components.
5. Carry out performance based seismic evaluation and retrofitting of structures

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Anil K. Chopra, Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd edition,Prentice Hall, 2000.

(2) Vinod Hosur, Earthquake Resistant Design of Building Structures, , WILEY (india), 2012

(3) Duggal S. K., Earthquake Resistant Design of Structures, , Oxford University Press, 2013.

(4) Pankaj Agarwal, Manish Shrikande Earthquake resistant design of structures - PHI India, 2009.

Reference Books

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

(2) Minoru Wakabayashi, Design of Earthquake Resistant Buildings, , McGraw Hill Pub 1985.

(3) T Paulay and M J N Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons, 1992.

APPLICATIONS OF IOT IN CIVIL ENGINEERING			
Course Code	22CAS242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Internet of Things, promises, definition, scope, sensors for IoT applications, structure of IoT, IoT Map device
Industry Sensors: Definitions and Characteristics of first-generation sensors, advanced generation sensors, Integrated IoT sensors, Polytronics systems, Sensor Swarm, Printed Electronics and IoT generation Road Map

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-2

Basics of Networking, Communication Protocols, Sensor Networks, Machine to Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-3

Internet of Things devices and sensors for collecting job site data, construction crew management, construction equipment management, IoT adoption to enhance productivity, maintenance, safety and security in construction industry.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-4

Structural health monitoring using Internet of Things and Microelectromechanical systems (MEMS) – introduction to MEMS, wireless sensor networks, smart sensors.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-5

Piezo sensors, Piezo generators & IoT, case studies of IoT & MEMS application in civil infrastructure projects.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Course outcomes:

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

1. Understand the basics of IoT, types of sensors & devices used.
2. Understand the basics of networking for M2M communications & programming
3. Interpret the adoption of IoT in various civil engineering activities
4. Illustrate the use of IoT & MEMS in structural health monitoring

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

(1)AshwinPajankar, Internet of Things with Arduino and Bolt, BPB Publications (2018)

(2) Krishnan Saravanan, Implementation and Deployment of IoT Projects in Smart Cities, IGI Global Publications (2020)

(3)Qusay F Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-IEEE Press (2018)

(4) ICCCBE 2020, Proceedings of the 18th International Conference on Computing in Civil and Building Engineering, Springer (2020)

ADVANCES IN ARTIFICIAL INTELLIGENCE			
Course Code	22CAS243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Introduction: What is AI? Foundations of AI, History of AI, Agents and environments, The nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-2

Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First order logic, forward and Backward Chaining

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-3

Learning: Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, why learning works, Learning in Neural and Belief networks

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply, L_4 – Analyse.

Module-4

Practical Natural Language Processing: Practical applications, Efficient parsing, Scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image formation, Image processing operations for Early vision, Speech recognition and Speech Synthesis

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-5

Robotics: Introduction, Tasks, parts, effectors, Sensors, Architectures, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Course outcomes:

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

1. Explain the history of AI and formulate problems and search strategies.
2. Adopt different methods of reasoning and logic for problem identification.
3. Practice different forms of learning.
4. Carry out language processing and speech recognition and speech synthesis processes.
5. Study basics of robotics and AI based programming tools.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Stuart Russell, Peter Norvig: "Artificial Intelligence: A Modern Approach",2nd Edition, Pearson Education, 2007.

(2) Yagna Narayana B., Artificial Neural Networks., PHI, 2004

Reference Books

(1) E. Rich and K. Knight., Artificial Intelligence , 2nd Edition, McGraw Hill, 1991

(2) Patterson, D. W., Introduction to Artificial Intelligence and Expert Systems –PHI, 2005

(3)Giarratano, J. C., G. D. Riley, Expert Systems: Principles and Programming- 4 Ed, Thomson. 2005.

NUMERICAL METHODS AND PROGRAMMING

Course Code	22CAS244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Solutions of linear equations: Direct method – Cramer‘s rule, Gauss – Elimination method- Gauss –Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over –relaxation method. Eigen values and Eigen vectors: Jacobi Method for symmetric matrices- Given‘s method for symmetric matrices-Householder‘s method for symmetric matrices-Rutishauser method of arbitrary matrices – Power method

Revised Bloom’s Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-2

Interpolation: Linear Interpolation - Higher order Interpolation – Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation - piece- wise and spline Interpolation

Revised Bloom’s Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-3

Finite Difference and their Applications: Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulae using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson‘s extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas-Numerical solution to spatial differential equations.

Revised Bloom’s Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-4

Numerical Differentiation: Difference methods based on undetermined coefficients. Optimum choice of step length– Partial differentiation. Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson‘s method

Revised Bloom’s Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-5

Ordinary Differential Equation: Euler‘s method – Backward Euler method – Mid point method – single step method, Taylor‘s series method- Boundary value problems.

Revised Bloom’s Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Note:
1. Emphasis shall be on developing algorithms/ flow charts and converting them into working programs.
2. Programs can be written in C/ C++ / MATLAB or any other programing language that the students find suitable

Course outcomes:
At the end of the course the student will be able to:
1. Obtain solutions to linear equations by various methods
2. Carry out higher order interpolation of polynomials using finite difference method.
3. Apply finite difference method and find numerical solutions to spatial differential equations.
4. Carry out numerical integration to find solutions to engineering applications.
5. Find out solutions to ordinary differential equations using different methods

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Gerald, C.F. and Wheatley, P.O., Applied Numerical Analysis, 6ed., Pearson Education, 1999.

(2)Chapra, S.C. and Canale, R.P., Numerical Methods for Engineers with Programming and Software Applications, 3 Ed., Tata McGraw Hill, New Delhi, 1998.
Reference Books
(1) Schilling, R.J. and Harries, S.L., Applied Numerical Methods for Engineers using Matlab and C, Thomson Brooks/Cole, 2000

MINI PROJECT WITH SEMINAR			
Course Code	22CAS25	CIE Marks	100
Number of contact Hours/Week	0:4:2	SEE Marks	0
Credits	03	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

SOFTWARE COMPUTATION LABORATORY –II			
Course Code	22CASL26	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	03

Sl.NO	Experiments	RBT levels
1	Design of RCC beam elements using excel sheets	L1,L2,L3, L4, L5
2	Design of RCC elements column and footing using excel sheets	L1,L2,L3, L4, L5
3	Design of RCC slabs for different end conditions using excel sheets	L1,L2,L3, L4, L5
4	Structural Analysis of 2D beams with different loading and support conditions by using python	L1,L2,L3, L4, L5
Exercises on Structural Analysis are aimed at using Finite element analysis based on Industry Standard Software		

Course outcomes:

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

1. Carry out structural analysis of RC elements
2. Analysis of beams for different loading and support conditions.

DESIGN OF BRIDGES			
Course Code	22CAS31	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:0:2	SEE Marks	50
Credits	04	Exam Hours	03

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.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply,

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 wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply,

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 slab using 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.

Revised Bloom's Taxonomy Level	L_3 – Apply, L_4 – Analyse.,

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.

Revised Bloom's Taxonomy Level	L_3 – Apply, L_4 – Analyse.,

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.

Revised Bloom's Taxonomy Level	L_3 – Apply, L_4 – Analyse.,

Course outcomes:

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

1. 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.
2. 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.
3. Demonstrate the use of Pigeauds Method and Courbon's Method in the analysis of T beam bridge as per IRC, design to obtain the safe dimensions various components, optimum reinforcement required following IS code procedure.
4. Display the use of Courbon's Method in the analysis 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.
5. 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 SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

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

Reference Books

(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

RELIABILITY ANALYSIS AND DESIGN OF STRUCTURAL ELEMENTS			
Course Code	22CAS321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Concept of variability: Applications of Statistical principles to deal with randomness in basic variables, statistical parameters and their significance, Description of various probability distributions – Binomial, Poisson, Normal, Log-Normal, Beta, Gama, distributions. Testing of goodness– of – fit of distributions to the actual data using chi-square method.
Self Study Component: Fit of distributions to the actual data using K.S Method.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-2

Statistical regression and correlation: Least – square and chi – square methods, Operation on one Random variable, expectation, multiple random variables, reliability distributions – basic formulation, the hazard function. Self Study Component: Weibull distribution.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-3

Statistical Quality control in Civil Engineering: Characteristic strength and characteristic load, probability modeling of strength, geometrical dimensions, material properties and loading. Application problems Mean value method and its applications in structural designs, statistical inference, Comparison of various acceptance and rejection testing. Self Study Component: Probability mass function.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-4

Safety assessment of structures: Reliability analysis using mean value theorem – I, II and III order Reliability formats. Self Study Component: Importance sampling techniques.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-5

Reliability analysis by Simulation techniques: Simulation techniques, reliability index - reliability formulation in various limit states, reliability based design, application to design of RC, PSC and steel structural elements. Self Study Component: Concepts of system reliability.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Course outcomes:

1. Apply statistical principles for analyzing randomness in variables.
2. Test goodness of fit of distribution in the data.
3. Adopt different acceptance and rejection tests for strength and other parameters of measurement.
4. Carry out reliability analysis and compute reliability index, for the given design details.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1)Ranganthan R, "Reliability Analysis and Design of Structures", Tata McGraw Hill V publishing Co. Ltd., New Delhi.

(2) Srinath L S, "Reliability Engineering", East West Books (Madras) Pvt. Ltd., 2005.

(3) Agarwal, K K, “Reliability Engineering”, Apress Springer (India) Pvt. Ltd., 2007.

Reference Books

(1) John B.Kennedy and Adam M.Neville, “Basic Statistical Methods for Engineers and Scientists”, Harper and Row Publishers, New York.

(2) Ang A.H.S and Tang W.H., “Probability concepts in Engineering planning and Design”, John Wiley and sons, New York, Vol. I and II.

(3) Andrzej S. N and Kevin, R. C., “Reliability of Structures”, McGraw Hill Company, KOGA, 2012.

(4) Devaraj V., and Ravindra, R., “Reliability Based Analysis and Design for Civil Engineers”, IK International Publishing House Pvt. Ltd., 2017.

STRUCTURAL HEALTH MONITORING			
Course Code	22CAS322	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Introduction to Structural Health Monitoring Definition of structural health monitoring (SHM), Motivation for SHM, SHM as a way of making materials and structures smart, SHM and biomimetics, Process and pre-usage monitoring as a part of SHM, SHM as a part of system management, Passive and active SHM,NDE, SHM and NDECS, Variety and multidisciplinarity: the most remarkable characters of SHM, Birth of the SHM Community

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-2

Vibration-Based Techniques for SHM Basic vibration concepts for SHM, Local and global methods, Damage diagnosis as an inverse problem, Model-based damage assessment, Mathematical description of structural systems with damage, General dynamic behavior, Statespace description of mechanical systems, Modeling of damaged structural elements, Linking experimental and analytical data, Modal Assurance Criterion (MAC) for mode pairing, Modal Scaling Factor (MSF), Co-ordinate Modal Assurance Criterion (COMAC), Damping, Expansion and reduction, Updating of the initial model, Damage 10 Hourslocalization and quantification, Change of the flexibility matrix, Change of the stiffness matrix, Strain-energy-based indicator methods and curvature modes, MECE error localization technique, Static displacement method, Inverse eigen sensitivity method, Modal force residual method, Kinetic and strain energy-based sensitivity methods, Forced vibrations and frequency response functions, Solution of the equation system, Regularization, Parameter subset selection, Other solution methods, Variances of the parameters, Neural network approach to SHM, The basic idea of neural networks, Neural networks in damage detection, localization and quantification, Multi-layer Perceptron (MLP), A simulation example, Description of the structure, Application of damage indicator methods, Application of the modal force residual method and inverse eigen sensitivity method, Application of the kinetic and modal strain energy methods, Application of the MultiLayer Perceptron neural network, Time-domain damage detection methods for linear systems, Parity equation method, Kalman filters, AR and ARX models, Damage identification in non-linear systems, Extended Kalman filter, Localization of damage using filter banks, A simulation study on a beam with opening and closing crack, Applications, I-40 bridge,,Steelquake structure, Application of the Z24 bridge, Detection of delamination in a CFRP plate with stiffeners

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-3

Fiber-Optic Sensors Classification of fiber-optic sensors, Intensity-based sensors, Phasemodulated optical fiber sensors, or interferometers, Wavelength based sensors, or Fiber Bragg Gratings (FBG), The fiber Bragg grating as a strain and temperature sensor, Response of the FBG to uniaxial uniform strain fields, Sensitivity of the FBG to temperature, Response of the FBG to a non-uniform uniaxial strain field, Response of the FBG to transverse stresses, Photoelasticity in a plane stress state, Structures with embedded fiber Bragg gratings, Orientation of the optical fiber optic with respect to the reinforcement fibers, Ingress/egress from the laminate, Fiber Bragg gratings as 10 Hours L2, L3damage sensors for composites, Measurement of strain and stress variations, Measurement of spectral perturbations associated with internal stress release resulting from damage spread, Examples of applications in aeronautics and civil engineering, Stiffened panels with embedded fiber Bragg gratings, Concrete beam repair

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-4

SHM with Piezoelectric Sensors The use of embedded sensors as acoustic emission (AE) detectors, Experimental results and conventional analysis of acoustic emission signals, Algorithms for damage localization, Algorithms for damage characterization, Available industrial AE systems, New concepts in acoustic emission, State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research, Lamb wave structure interrogation, Sensor technology, Tested structures (mainly metallic or composite parts), Acousto-ultrasonic signal and data reduction methods, The full implementation of SHM of localized damage with guided waves in composite materials, Available industrial acoustoultrasonic systems with piezoelectric sensors, Electromechanical impedance, E/M impedance for defect detection in metallic and composite parts, The piezoelectric implant method applied to the evaluation and monitoring of viscoelastic properties.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-5

SHM Using Electrical Resistance Composite damage, Electrical resistance of unloaded composite, Percolation concept, Anisotropic conduction properties in continuous fiber reinforced polymer, Influence of temperature, Composite strain and damage monitoring by electrical resistance, 0° unidirectional laminates, Multidirectional laminates, Randomly distributed fiber reinforced polymers, Damage localization. Low Frequency Electromagnetic Techniques Theoretical considerations on electromagnetic theory, Maxwell's equations, Dipole radiation, Surface impedance, Diffraction by a circular aperture, Eddy currents, Polarization of dielectrics, Applications to the NDE/NDT domain, Dielectric materials, Conductive 10 Hours L3, L4materials, Hybrid method, Signal processing, Timefrequency

transforms, The continuous wavelet transform, The discrete wavelet transform, Multiresolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method, Hybrid method.

Revised Bloom's Taxonomy Level	$L_3 -$ Apply, $L_4 -$ Analyse

Course outcomes:

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

1. Emphasise the importance of structural health monitoring as part of system management.
2. Adopt vibration based techniques for health monitoring of a few structural elements and components.
3. Use fibre-optic and other types of sensors for estimating damage in a structural element.
4. Characterise the defect or damage in a structural element using piezo-electric sensors or acoustic emission methods.
- Apply general principles of structural health monitoring using magnetic, electric and hybrid methods.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, WileyISTE, 2006

2. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.

Reference Books

1. Douglas E Adams, Health Monitoring of Structural Materials and ComponentsMethods with Applications, John Wiley and Sons, 2007.

2. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.

3. Smart Materials and Structures, Gandhi and Thompson

4. Structural Health Monitoring: Current Status and Perspectives

STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH			
Course Code	22CAS323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

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 pinned-pinned, fixed- fixed, fixed-free and fixed-pinned columns. Self Study Component: Beam column subjected to partial UDL, couples.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.

Module-2

Buckling of frames and beams. Elastic, Energy method: Approximate calculation of critical loads for a cantilever, Exact critical load for hinged-hinged column using energy approach, Buckling of bar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of shear force on critical load. Self Study Component: Columns subjected to non-conservative follower and pulsating forces.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-3

Stability analysis by finite element approach: Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational DOF) – element stiffness and Element geometric stiffness matrices – Assembled stiffness and geometric stiffness matrices for a discretised column with different boundary conditions – Evaluation of critical loads for a discretised (two elements) column (both ends built-in). Buckling of pin jointed frames (maximum of two active DOF).Symmetrical single bay portal frame. Self Study Component: Write algorithm and program to generate elastic bending stiffness matrix and geometric stiffness matrix for beam element.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

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. Torsional Buckling – Pure torsion of thin-walled bars of open cross section. Non-uniform torsion of thin -walled bars of open cross section. Self Study Component: Lateral buckling of simply supported I beam subjected to udl.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.. L_3 – Apply

Module-5

Buckling of rectangular plate: Buckling of uniformly compressed simply supported rectangular plate – Uniaxial and biaxial loading, Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides. Self Study Component: Buckling of rectangular plates under the action of shearing stresses.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Note: Self study is for 5 marks only in CIE and not in SEE

Course outcomes:

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

1. Idealize the concepts of beam column structural behavior, stability of column and compute Euler's critical load for different boundary conditions.
2. Comprehend the energy method, bars on elastic foundation, successive approximation method for stability analysis.
3. Comprehend finite element method in stability analysis to simple plane truss and 2D beams and frames.
4. Grasp the concept of lateral buckling of beams, torsional buckling of beams and buckling of rectangular plate type structures.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Stephen P. Timoshenko, James M. Gere, "Theory of Elastic Stability", McGraw-Hill, New Delhi.

(2)Zeiglar.H,"Principles of Structural Stability", Blaisdall Publication.

(3) Rajasekaran.S, "Computational Structural Mechanics", Prentice-Hall, India.

Reference Books

(1) Robert D Cook, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, New York.

(2) Ray W Clough and J Penzien, "Dynamics of Structures", McGraw-Hill, New Delhi.

(3) Ashwini Kumar, "Stability of Structures", Allied Publishers Limited, 1998.

(4) Timoshenko and kriger, "Theory of plates and shells", McGraw –Hill Internal Book Company.

DESIGN OF OFFSHORE STRUCTURES			
Course Code	22CAS324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Types of offshore structures and their conceptual development- Fixed, Compliant, Floating-Analytical models for offshore structures- Behaviour under static and dynamic loads- Materials and construction of jacket and gravity platforms- Statutory regulations- Allowable stresses- Design methods and Code Provisions- Design specification of API, DNV, Lloyd's and other Classification Societies.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-2

Environmental loads- Wind, wave, current and ice loads- Calculation based on maximum base shear and overturning moments- Design wave height and spectral definition- Morison's Equation-Maximum wave force on offshore structure- Concept of return waves- Principles of static and dynamic analyses of fixed platforms-Use of approximate methods- Principles of WSD and LRFD- Allowable stresses and partial safety factors- Design of structural elements.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-3

Introduction to tubular members- Slenderness effect- Column buckling-Tubular joints- Possible modes of failure, Eccentric connections and offset connections-Cylindrical and rectangular structural members- Inplane and multi plane connections- Parameters of inplane tubular joints.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-4

Kuang's formulae- Elastic stress distribution- Punching shear stress- Overlapping braces- Stress concentration- Chord collapse and ring stiffener spacing- Stiffened tubes- External hydrostatic pressure- Fatigue of tubular joints- Fatigue behaviour- S-N curves- Palmgren-Miner cumulative damage rule- Design of tubular joints as per API Code.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-5

Design against accidental loads- Fire, Blast and Collision- Behaviour of steel at elevated temperatureFire rating for Hydrocarbon fire- Design of structures for high temperature- Blast mitigation-Blast walls- Collision of boats and energy absorption. Corrosion- Corrosion mechanism- Types of corrosion- Offshore structure corrosion zones- Biological corrosion- Preventive measures of corrosion- Principles of cathode protection systems- Sacrificial anode method and impressed current method- Online corrosion monitoring- Corrosion fatigue.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Course outcomes:

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

CO1. Acquire knowledge and skills to carry out basic tasks regarding dimensioning and structural design of offshore structures.

CO2. Estimation of maximum forces on an offshore structure due to operational loads and conduct static and dynamic analyses of fixed platforms.

CO3. Acquire training in the design of jacket platforms, tubular joints and concrete gravity platforms.

CO4. Estimate the resistance of platforms against fatigue and accidental loads.

CO5. Attain knowledge in the physics of corrosion and methods to monitor and prevent corrosion.

1.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

IS Codes : IS 875 Parts (1 to 5), IS 1893, IRC 6-2014,

Textbook/ Textbooks

1)Reddy, D. V and Arockiasamy, M., Offshore Structures Vol.1 & 2, Kreiger Publ. Co.1991.
2) Morgan, N., Marine Technology Reference Book, Butterworths, 1990.

Reference Books

(1) Srinivasan Chandrasekaran, Dynamic Analysis and Design of Ocean Structures. Springer, 2015.

(2)B.C Gerwick, Jr. Construction of Marine and Offshore Structures, CRC Press, Florida, 2000

(3) Clauss, G, Lehmann, E &Ostergaard, C, Offshore Structures, Vol. 1 & 2, Springer-Verlag,1992.

(4)DNV-RP-C203- fatigue Design of Offshore Steel Structures, 2011.

(5)DNV-RP-C204- Design Against Accidental Loads, 2010.

(6)DNV-RP-B101-Corrosion Protection of Floating Protection and Storage Units, 2007

(7).API RP 2A. Planning, Designing and Constructing Fixed Offshore Platforms, API. 2000

CONCRETE TECHNOLOGY

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

SEMESTER – III

Subject Code	**22CAS331**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Prerequisites: Knowledge of Material Science and Concrete Technology

Course objectives: The objective of the course is to provide students to obtain an in-depth knowledge of a wide variety of advanced topics in concrete technology and practice. Concrete, being the popular materials for the construction material for civil infrastructure building, is undergoing significant changes in the recent times, in relation to the constituent materials used, production technology, testing methods and performance requirements.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Cement, Chemical composition, hydration of cement, Types of cement, manufacture of OPC by wet and dry, process (flow charts only) Testing of cement - Field testing, Fineness by sieve test and Blaine's air permeability test, Normal consistency, testing time, soundness, Compression strength of cement and grades of cement, Quality of mixing water.	**8 Hours**	L1,L2 and L3
Module-2		
Fine aggregate - grading, analysis, Specify gravity, bulking, moisture content, deleterious materials. Coarse aggregate – Importance of size, shape and texture.Grading of aggregates - Sieve analysis, specific gravity, Flakiness and elongation index, crushing, impact and abrasion tests.	**8 Hours**	L1,L2 and L3

Module -3		
Workability - factors affecting workability, Measurement of workability - slump, flow tests, Compaction factor and vee-bee consistometer tests, Segregation and bleeding, Process of manufactures of concrete : Batching, Mixing, Transporting, Placing, Compaction, Curing. Chemical admixtures - plasticizers, accelerators, retarders and air entraining agents, Mineral admixtures - Fly ash, Silica fumes, rice husk ash and GGBS.	**8 Hours**	L1,L2 and L3
Module -4		
Factors affecting strength, w/c ratio, gel/space ratio, maturity concept, Effect of aggregate properties, relation between compressive strength, and tensile strength, bond strength, modulus of rupture, Accelerated curing, aggregate - cement bond strength, Testing of hardened concrete - compressive strength, split tensile strength, Flexural strength, factors influencing strength test results.	**8 Hours**	L1,L2 and L3
Module -5		
Elasticity - Relation between modulus of elasticity and Strength, factors affecting modulus of elasticity, Poisson , Ratio, Shrinkage - plastic shrinkage and drying shrinkage, Factors affecting shrinkage, Creep - Measurement of creep, factors affecting creep, effect of creep, Durability - definition, significance, permeability, Sulphate attack, Chloride attack, carbonation, freezing and thawing – remedial measures. Concept of Concrete Mix design, variables in proportioning , exposure conditions, Procedure of mix design as per IS 10262-2009, Numerical examples of Mix Design	**8 Hours**	L1,L2 and L3

Course outcomes:

a. On complete of this course the students will able to understand the construction material, meeting the demanding performance requirements based on men, machines and materials.
b. Innovative special concrete with mixes, applications and limitations
c. Testing methods developed to increase the scope of concrete usage as an advanced material

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, therewill 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. "Concrete Technology" - Theory and Practice, M.S.Shetty, S.Chand and Company, New Delhi, 2002.
2. "Concrete Technology" – M.L.Gambhir, TATA McGRAW HILL, New Delhi.

Recommended Reading:

1. "Properties of Concrete"Neville, A.M. : , ELBS, London
2. "Concrete Technology" – A.R.Santakumar. Oxford University Press (2007)"
3. "Concrete Mix Design" - N.Krishna Raju, Sehgal - publishers.
4. "Recommended guidelines for concrete mix design" - IS:10262,BIS Publication

Basic Construction Materials

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

SEMESTER – III

Subject Code	**22CAS332**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Prerequisites: basic knowledge about physics and chemistry of materials

Course objectives:

The course intends to provide basic information on the structure and properties of construction materials.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Introduction and usage of Stone / Brick / Mortar in construction field	**8 Hours**	**L1, L2**
Module-2		
Introduction and usage of Cement and Concrete in construction field	**8 Hours**	**L1, L2**
Module-3		
Introduction and usage of Steel / Aluminium / Copper in construction field	**8 Hours**	**L1, L2**
Module-4		
Introduction and usage of Composite materials / FRP / Polymers and Plastics in construction field	**8 Hours**	**L1, L2**
Module-5		
Introduction and usage of Wood / Glass in construction field	**8 Hours**	**L1, L2**

Course Outcomes:

After studying this course:

- the student should be able to link the material choice with the application in construction

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, therewill 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. S. K. Duggal, “Building Materials”, (Fourth Edition)New Age International (P) Limited, 2016 National Building Code(NBC) of India

2. P C Vergese, “Building Materials”, PHI Learning Pvt.Ltd

3. Building Materials and Components, CBRI, 1990,India

4. Jagadish. K.S, “Alternative Building Materials Technology”, New Age International,2007.

5. M. S. Shetty, “Concrete Technology”, S. Chand & Co. New Delhi.

STRENGTH OF MATERIALS

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

SEMESTER – III

Subject Code	**22CAS333**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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 nonlinear 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 Hours**	**RBT Level**
Module-1		
Simple Stress and Strain 1.1 Introduction, 1.2 Properties of Materials, 1.3 Stress, Strain, Hook‟s law, Stress – Strain Diagram for structural steel and non ferrous materials, 1.4 Volumetric strain, expression for volumetric strain, 1.5 Elastic Constants: Relationship among elastic constants, 1.6 Total elongation of tapering bars of circular and rectangular cross sections. Elongation due to self weight.	**8 Hours**	**L1,L2**
Module-2		
Bending moment and shear force in beams 4.1 Introduction, 4.2 Shearing force and Bending moment in beam, 4.3 Sign convention, 4.4 Relationship between loading, shear force and bending moment, 4.5 Shear force and bending moment equations, SFD and BMD with salient values for cantilever beams, simply supported beams and overhanging beams considering gravity loads(point, udl and uvl) and Couple.	**8 Hours**	**L2,L3**
Module -3		
Bending stress, shear stress in beams 5.1 Introduction – Bending stress in beam, 5.2 Assumptions in pure bending theory, 5.3 Derivation of Pure bending equation, 5.4 Modulus of rupture, section modulus, 5.5 Flexural rigidity, 5.6 Expression for horizontal shear stress in beam, 5.7 Shear stress diagram for rectangular, „I‟ and „T‟ section (Flitched beams not included).	**8 Hours**	**L2,L3,L4**

Module -4		
Deflection of beams 6.1 Introduction – Definitions of slope, deflection, 6.2 Elastic curve-derivation of differential equation of flexure, 6.3 Sign convention 6.4 Slope and deflection for standard loading classes using Macaulay‟s method for prismatic beams and overhanging beams subjected to point loads, UDL and Couple.	**8 Hours**	**L2,L3,L4**
Module -5		
Torsion of circular shafts 7.1 Introduction – Pure torsion-torsion equation of circular shafts, 7.2 Strength and stiffness, 7.3 Torsional rigidity and polar modulus, 7.4 Power transmitted by shaft of solid and hollow circular sections.	**8 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) fromeach module.
- Each full question will have sub questions covering all the topics under amodule.
- The students will have to answer 5 full questions, selecting one full questionfrom each module.

Reference Books:

1. Strength of Materials, Subramanyam, Oxford University Press, Edition 2008
2. Mechanics of Materials, B.C Punmia Ashok Jain, Arun Jain, Lakshmi Publications, New Delhi.
3. Strength of Materials, Basavarajaiah and Mahadevappa Universities Press (2009).
4. Strength of Materials, Singer Harper and Row Publications.
5. Elements of Strength of Materials, Timoshenko and Young Affliated East-West Press.
6. Mechanics of Materials, James M. Gere, Barry J.Goodno (India Edition), Cengage Learning.

REPAIR AND REHABILITATION OF STRUCTURES			
Course Code	22CAS334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	Exam Hours	03

Module-1

Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure,

Revised Bloom's Taxonomy Level	L_2 – Understanding..L_3 – Apply

Module-2

Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.L_3 – Apply

Module-3

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, Sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels,coating and cathodic protection

Revised Bloom's Taxonomy Level	L_2 – Understanding..L_3 – Apply

Module-4

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

Revised Bloom's Taxonomy Level	L_2 – Understanding..L_3 – Apply

Module-5

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

Revised Bloom's Taxonomy Level	L_3 – Apply, L_4 – Analyse.

Course outcomes:

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

1. Emphasise on the importance of structural maintenance, causes of deterioration and repair strategies.
2. Analyse the cause and effect of climate, chemicals and errors in design and construction of concrete structures.
3. Use proper materials and techniques for the repair of damaged structures.
4. Adopt various techniques of repair and rehabilitation of structures.
5. Monitor the health and choose appropriate technique for demolition of dilapidated structures.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks
(1) Santakumar A.R, Concrete Technology. Oxford University press, 2nd Ed., 2018.
(2)Richardson B. A., Defects and Deterioration in Buildingts, E F & N Spon press, London, 2001.
Reference Books
(1)Gupta B. L. and Amit Gupta Maintenance and Repair of Civil Structures, Standard Publications.
(2)Mehta, P.K and Montevic. P.J., Concrete- Microstructure, Properties and Materials, ICI, 1997.
(3)Ranso, W. H., Concrete Repair and Maintenance Illustrated, RS Means Company Inc., 1981

PROJECT WORK PHASE – 1			
Course Code	22CAS34	CIE Marks	100
Number of contact Hours/Week	0:6:0	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	22CASI36	CIE Marks	50
Number of contact Hours/Week	2	SEE Marks	50
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	22CAS41	CIE Marks	100
Number of contact Hours/Week	8	SEE Marks	100
Credits	18	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■