VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022 - 24

M.Tech Computer Aided Design of Structures (CCS)

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

SEMESTER – I			
Subject:	**STRUCTURAL OPTIMIZATION**		
Subject Code	**22CCS11**	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:

- Linear Algebra
- Calculus
- Basics of programing algorithms.

Course objectives:

This course will enable students to

1. Learn the need and concepts of design optimization.
2. Implement optimization concepts in structural engineering problems
3. Evaluate different methods of optimization.

Modules

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.

Teaching-Learning Process	**L1, L2, L4**

Module -2

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

Teaching-Learning Process	**L2, L4, L5**

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

Teaching-Learning Process	**L2, L3, L4,L5**

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

Teaching-Learning Process	**L2, L3, L4,L5**

Module -5

Geometric programming: Geometric programming, conversion of NLP as a sequence of LP / geometric programming. Dynamic programming: Dynamic programming conversion of NLP as a sequence of LP/ Dynamic

programming.

Teaching-Learning Process	**L4, L5**

Course outcomes (CO):

On completion of this course, students are 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 question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

1. Spunt, L., Optimum Structural Design, Prentice Hall, 1971.
2. Rao S. S., Optimization – Theory and Practice, Wiley Eastern Ltd. 1978
3. Uri Kirsch, Optimum Structural Design, McGraw Hill, New York, 1981.
4. Bronson R. and, Govindsami N., Operation Research, Schaum's Outline Series, 2017.
5. Bhavikatti S. S., Structural optimization using sequential linear programming, Vikas publishing, 2003.
7. Fox. R. L., Optimization Methods for Engineering Design, Addison Wesley, 1971
8. Narsingk Deo, System simulation with digital computer, Prentice Hall of India, New Delhi, 1989
9. Stark. R.M. Nicholls. R .L. Mathematical Foundations for Design, McGraw Hill New York, 1972.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=wEdZLKMMZ8o&list=PLwdnzlV3ogoXKKb9nABDWYltTDgi37lYD
https://www.youtube.com/watch?v=GMTvoKRfxQw&list=PLGbjwqYC00hsy6XGalOBAphm2tdeLbgK0
https://www.youtube.com/watch?v=fszNBvdfKrY

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**		**X**					**X**	**X**	**X**
CO2	**X**	**X**		**X**					**X**	**X**	**X**
CO3	**X**	**X**		**X**					**X**	**X**	**X**
CO4	**X**	**X**		**X**					**X**	**X**	**X**
CO5	**X**	**X**		**X**					**X**	**X**	**X**

SEMESTER – I			
Subject:	**COMPUTATIONAL STRUCTURAL MECHANICS**		
Subject Code	**22CCS12**	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			

Pre-requisites:

- Basics of Mathematics
- Engineering Mechanics
- Strength of Materials

Course objectives: This course will enable students to

- Idealize the actual structural systems, for the purpose of analysis, in the form of an acceptable simple frame work consisting of one dimensional elements being connected at joint locations.
- Achieve problem solving skills using computer aided methods.
- Implementation procedures of such methods in computer programs.

Modules

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.

Teaching-Learning Process	**L1-L5**

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. Elementstiffness matrix formulation for 2D, Grids and 3D frames (Local and Global).

Teaching-Learning Process	L1-L5

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.

Teaching-Learning Process	L1-L3

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, Quadratic Varying Load.

Teaching-Learning Process	L1-L3

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.

Teaching-Learning Process	L1-L3

Course Outcomes(CO):

After studying this course, students shall 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 question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

- Rajasekaran, S. and Shankarsubramanian, G., Computational Structural Mechanics, PHI New Delhi, 2001.
- Weaver, W. and Gere, J. M., Matrix analysis of framed structures, CBS Publishers and Distributors Pvt. Ltd. 2004.
- Reddy. C. S, Basic Structural Analysis, TMH, New Delhi 2001.
- 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.
- Bathe. K. J., Finite element procedures in Engineering Analysis. PHI. New Delhi, 2007.
- Rubinstein M.F, Matrix Computer Analysis of structures. Prentice-Hall, Eaglewood Cliffs, New Jersey,1966.
- M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons, 2005.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=Wa9ZSWlrpnk&list=PLbRMhDVUMngeZatm4MIOKG4sHxXuB_yri
https://www.youtube.com/watch?v=oMSoFeCZL5k&list=PL8pjaLEv3XhmeAp8aEWfp7t2bf2Nh2dYy

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	

SEMESTER – I			
Subject:	**ADVANCED DESIGN OF RC STRUCTURAL ELEMENTS**		
Subject Code	**22CCS13**	CIE Marks	**50**
Teaching Hours/Week(L:P:SDA)	3:2:0	SEE Marks	**50**
Total Number ofLecture Hours	50	Exam Hours	**03**
CREDITS – 04			

Prerequisites

- Design of RCC structural elements (UG Course).
- Basic knowledge of IS 456:2000

Course objectives: This course will enable students to

- Analyse the behaviour of elements subjected to shear and Torsion.
- Use the concept of redistribution of moments in design.
- Develop equations for the design of different RC elements.
- Evaluate the performance of RC structures.

Modules

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

Teaching-Learning Process	**L1, L2, L3, L4,L5**

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

Teaching-Learning Process	**L1, L2, L3, L4,L5**

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

Teaching-Learning Process	**L1, L2, L3, L4,L5**

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 non- rectangular columns. Slender Column: Braced and Unbraced, Design Methods as per IS 456. Strength reduction and additional moment method. Design examples.

Lab: Experiment 7 & 8

Teaching-Learning Process	**L1, L2, L3, L4,L5**

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

Teaching-Learning Process	**L1, L2, L3, L4,L5**

Course outcomes:

On completion of this course, students 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 question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

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
5. Shah H. J., Reinforced Concrete, Vol-1 and Vol-2, Charotar, 8th Edition 2009 and 6th Edition 2012 respectively.
6. Purushothaman, P., Reinforced concrete structural elements: Behaviour, analysis and Design, Tata McGraw Hill, 1986.
7. Park R. and Paulay, T., Reinforced Concrete Structures, John Wiley and Sons. 2004.
8. N. Subramanian, Design of Reinforced Concrete Structures, Oxford IBH.
9. 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.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=undsd92MM8w&list=PLbQO4xhI7wEDIYv90NoF7veaJIohpuf0Q

Skill Development Activities Suggested:

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X	X					X	
CO2	X	X		X	X					X	
CO3	X	X		X	X					X	
CO4	X	X		X	X					X	
CO5	X	X		X	X					X	

SEMESTER – I			
Subject:	**STRUCTURAL DYNAMICS**		
Subject Code	**22CCS14**	CIE Marks	**50**
Teaching Hours/Week (L:P:SDA)	**3:0:2**	SEE Marks	**50**
Total Number of Lecture Hours	**40**	Exam Hours	**03**
CREDITS – 04			

Prerequisites:

- Structural Analysis 1 and 2 (Undergraduate courses).
- Matrix method of analysis.

Course objectives: This course will enable students to,

1. Understand effect of structural vibrations on safety and reliability of structural systems.
2. Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
3. Apply modal methods to calculate the forced response of these systems.
4. Use finite element methods for the analysis of the vibrations of structures.

Modules

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.

Teaching-Learning Process	**L1, L2, L3**

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.

Teaching-Learning Process	**L1, L2, L3**

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.

Teaching-Learning Process	**L1, L2, L3**

Module -4

Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shear buildings for forced vibration for harmonic loadingwith damping using normal mode approach.

Teaching-Learning Process	**L1, L2, L3**

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).

Teaching-Learning Process	**L1, L2, L3**

Course outcomes (CO):

After studying this course, students 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 question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

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. Vinod Hosur, Earthquake Resistant Design of Building Structures, Wiley (India), 2012.
4. Mukhopadyaya, Vibration, Dynamics and structural problems, Oxford IBH Publishers, 2000.
5. Clough, Ray W and Penzien J, Dynamics of Structures, 2nd Edition, McGraw-Hill, New York, 1993.
6. Roy R. Craig, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2006.
7. Timoshenko, S., Vibration Problems in Engineering, 2nd Edition, Van Nostrand Co., New York, 1955.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=0KiYC8QQOiM&list=PLyVhmjhvTvDbqByamCNEYw2zDBOscOHRb
https://www.youtube.com/watch?v=Jlzo8OzoZ_c&list=RDQMjbIvZOwDdoM&start_radio=1

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – I			
Subject:	**MECHANICS OF DEFORMABLE BODIES**		
Subject Code	**22CCS15**	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:

- Strength materials
- Engineering Mathematics basics.

Course objectives:

This course will enable students to,

- Familiarise with the principles of analysis of stress and strain.
- Predict the stress-strain behaviour of continuum.
- Evaluate stress and strain parameters and their inter-relation of the continuum.

Modules

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.

Teaching-Learning Process	**L1, L2, L3**

Module -2

Transformation of stress and strain at a point, Principal stresses and principal strains, invariants of stress and strain, hydrostatic and deviatric stress, spherical and deviatric strains max. shear strain.

Teaching-Learning Process	**L1, L2, L3**

Module -3

Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axisymmetric problems, stress concentration due to the presence of a circular hole in plates.

Teaching-Learning Process	**L1, L2, L3**

Module -4

Elementary problems of elasticity in three dimensions, stretching of a prismatic bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in solid media. Applications of finite difference equations in elasticity.

Teaching-Learning Process	**L1, L2, L3**

Module -5

Theory of Plasticity: Stress – strain diagram in simple tension, 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

Teaching-Learning Process	**L1, L2, L3**

Course outcomes (CO):

After completing this course, students will be able to:

1. Familiarise with stress – strain in Cartesian and polar coordinates and their constitutive relations.
2. Transform stress-strain at a point and analyse hydrostatic, deviatoric stresses.
3. Analyse problems with plane stress and plane strain models.
4. Solve elementary problems of elasticity in 3-dimensions.
5. Carry out analysis using theory of plasticity and analyse theories of failure.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Text Books:

1. Timoshenko & Goodier, Theory of Elasticity, McGraw Hill, 2010.
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, 1978.
4. Verma P.D.S, Theory of Elasticity, Vikas Publishing Pvt. Ltd., 1997.
5. Chenn W.P and Hendry D.J, Plasticity for Structural Engineers, Springer Verlag, 1988.
6. Valliappan C, Continuum Mechanics Fundamentals, Oxford IBH Publishing Co.Ltd., 1977.
7. Sadhu Singh, Applied Stress Analysis, Khanna Publishers, 2000.
8. Xi Lu, Theory of Elasticity, John Wiley, 1990.

Web links and Video Lectures (e-Resources):
https://www.youtube.com/watch?v=lfEh3yWTBuM
https://www.youtube.com/watch?v=eICv1p8WjgI&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X	X					X	
CO2	X	X		X	X					X	
CO3	X	X		X	X					X	
CO4	X	X		X	X					X	
CO5	X	X		X	X					X	

RESEARCH METHODOLOGY AND IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Teaching Hours	40	Total Marks	100
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. ■

Teaching-Learning Process	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. ■

Teaching-Learning Process	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.

Teaching-Learning Process	L – Remember,L – 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.

Teaching-Learning Process	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.

Teaching-Learning Process	L_1 – Remember,L_2 – Understand

Course outcomes:

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

- Co1: Discuss research methodology and the technique of defining a research problem
- Co2: Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Co3: Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Co4: Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Co5: 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.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=E2gGF1rburw
https://www.youtube.com/watch?v=5fvpsqPWZac&list=PLyqSpQzTE6M8PuzP1p2hNPXgpbOBhFgja

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X	X	X	X	X	X	X	X	X	X
CO2	X	X	X	X	X	X	X	X	X	X	X
CO3	X	X	X	X	X	X	X	X	X	X	X
CO4	X	X	X	X	X	X	X	X	X	X	X
CO5	X	X	X	X	X	X	X	X	X	X	X

SEMESTER – I			
Subject	**Computational Structural Laboratory - I**		
Subject Code	22CCSL17	CIE Marks	**50**
Teaching Hours/Week (L:P:SDA)	1:2:0	SEE Marks	**50**
Total Number ofLecture Hours	42	Exam Hours	**03**
CREDITS – 02			

Prerequisites: Structural Analysis 1 and 2 and Computer programming basics

Course objectives: This course will enable students to

- Use industry standard software in a professional set up.
- Enable finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design.
- Develop customized design automation tools.

Experiments

1. Structural Analysis of 2D and 3D Trusses

Teaching-Learning Process	**L1, L2, L3, L4,L5**

2. Structural Analysis of Continuous Beams using different types of loadings and support conditions.

Teaching-Learning Process	**L1, L2, L3, L4, L5**

3. Structural Analysis of 2D and 3D Rigid and Braced Frames for different types of loadings , support conditions, section orientations and stiffness variation between columns and beams, Member offsets, End release, Tension only members, Active and Inactive member specifications, Soil – Structure Interaction Problems using Winkler Springs.

Teaching-Learning Process	**L1, L2, L3, L4, L5**

4. Excel Spread Sheet for analysis of truss, beams and frames, using DirectStiffness Method.

Teaching-Learning Process	**L1, L2, L3, L4, L5**

5. Program Development for Design of RC Structural Elements using VBAor MATLAB or C++.

Teaching-Learning Process	**L1, L2, L3, L4,L5**

Exercises 1 to 3 on Structural Analysis are aimed at using Excel or MATLAB and Industry StandardSoftwares.

Course Outcomes (CO): After studying this course, students 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. Solve Soil-structure interaction problems using Winkler springs.
5. Develop programs to carryout design of RC structural elements.

Web links and Video Lectures (e-Resources):
https://www.youtube.com/watch?v=cGTebUY2xQc&list=PLNJ364_NfpLWcp0Hck9f2rOJUIudOlaYi

Skill Development Activities Suggested

- **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO2	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO3	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO4	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO5	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**

SEMESTER – II			
Subject	**ADVANCED DESIGN OF STEEL STRUCTURES**		
Subject Code	**22CCS21**	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:

- Engineering Mechanics
- Strength of Materials
- Structural Analysis
- Design of Steel Structures.

Course objectives:

This course will enable students to

- Carry out the designs of steel structures made from hot-rolled and cold-formed structural steel.
- Become Proficient in applying the codal provisions for design of columns, beams, beam-columns junctions, etc.

Modules

Module -1

Laterally Unrestrained Beams: Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, Mono-symmetric and non-uniform beams–Design Examples. Concepts of -Shear Center, Warping, Uniform and Non-Uniform torsion.

Teaching-Learning Process	**L1, L2, L3L4, L5**

Module -2

Beam- Columns in Frames: Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 – Examples.

Teaching-Learning Process	**L1, L2, L3L4, L5**

Module -3

Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties, Vierendeel girders (design for given analysis results)

Teaching-Learning Process	**L1, L2, L3L4, L5**

Module -4

Cold formed steel sections: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions, numerical examples-beam design, column design.

Teaching-Learning Process	**L1, L2, L3L4, L5**

Module -5

Fire resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance ratings-Numerical Examples.

Teaching-Learning Process	**L1, L2, L3L4, L5**

Course outcomes:

After studying this course, students will be able to:

1. Analyse the laterally unrestrained beams as per Codal provisions.
2. Carry out designs of steel columns and beam-column joints in frames.
3. Design castellated beams for given sectional properties.
4. Design of beams and columns made up of cold formed steel sections.
5. Learn different aspects of fire resistance in steel structures.

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Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

- IS 800: 2007, IS 801:2010, IS 811:1987 and BS 5950 – part 8 to be allowed along with Steel Tables in Exam

Reference Books:

1. N. Subramanian, Design of Steel Structures, Oxford, IBH, 2008.
2. Duggal, S. K., Design of Steel Structures, Tata McGraw-Hill, 2000.
3. IS 800: 2007, IS 801-2010 , IS 811-1987
4. BS 5950 Part- 8,
5. INSDAG Teaching Resource Chapter 11 to 20:www.steel-insdag.org
6. SP 6 (5)-1980

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=qJV5zdx7NJs

https://www.youtube.com/watch?v=5eZneS83pBg&list=PLyqSpQzTE6M_nweVk5N8okOAVl0BNPUXX

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X				X		X	
CO2	X	X		X				X		X	
CO3	X	X		X				X		X	
CO4	X	X		X				X		X	
CO5	X	X		X				X		X	

SEMESTER – II			
Subject:	**FINITE ELEMENT ANALYSIS OF STRUCTURAL SYSTEMS - CONCEPTS AND PROCEDURES**		
Subject Code	**22CCS22**	CIE Marks	**50**
Teaching Hours/Week (L:P:SDA)	**3:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**50**	Exam Hours	**03**
CREDITS – 04			

Pre-requisites:

- Differential Equations
- Theory of Elasticity
- Numerical methods

Course objectives:

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

Modules

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.

Lab: Experiment 1 & 2

Teaching-Learning Process	**L1, L2**

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.

Lab: Experiment 3 & 4

Teaching-Learning Process	**L1, L2, L3**

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.

Lab: Experiment 5 & 6

Teaching-Learning Process	**L1, L2, L3**

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

Lab: Experiment 7& 8

Teaching-Learning Process	**L1, L2, L3**

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.

Lab: Experiment 9 & 10

Teaching-Learning Process	**L1, L2, L3**

Course Outcomes(CO):

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

1. Explain the basic theory behind the finite element method.
2. Formulate and analyze 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 question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

- Zeinkiewicz, O. C. and Taylor R.L., The finite element method for solid and structural mechanics, Butterworh –Heinemann, 2013.
- Krishnamoorthy C. S., Finite Element Analysis: Theory and programming, Tata McGraw Hill Publishing Co. Ltd., 2017.
- M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons, 2005.
- 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.
- Bathe. K.. J., Finite element procedures in Engineering Analysis. PHI. NewDelhi, 2002.
- David V Hutton, Fundamentals of finite element analysis, McGraw Hill, 2003.
- Reddy J., An Introduction to Finite Element Methods, McGraw Hill Co., 2013

Note: Lab Experiment 1: Excel programming for computation of Axial Deformation of Bars with uniform cross section.

Lab Experiment 2: Excel programming for computation of Axial Deformation of Bars with uniform cross section contd…

Lab Experiment 3: Excel programming for Analysis of two nodded beam element

Lab Experiment 4: Excel programming for Analysis of three nodded beam element

Lab Experiment 5: Programming for analysis of serendipity element

Lab Experiment 6: Programming for analysis of Lagrange element

Lab Experiment 7: Programming for Mapping a Straight Line

Lab Experiment 8: Programming for quadrilateral areas

Lab Experiment 9: Programming for Numerical integration - Line or one-Dimensional Integrals

Lab Experiment 10: Programming for Numerical integration - quadrilateral areas.

Web links and Video Lectures (e-Resources): **https://www.youtube.com/watch?v=lbghRDnb-LQ&list=PLFA5C164D77D3B971** **https://www.youtube.com/watch?v=UOp6JEiJctA&list=PLSGws_74K018SmggufD-pbzG3thPIpF94**
Skill Development Activities Suggested • **Conduction of technical seminars on recent research activities** • **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**		**X**	**X**					**X**	**X**
CO2	**X**	**X**		**X**	**X**					**X**	**X**
CO3	**X**	**X**		**X**	**X**					**X**	**X**
CO4	**X**	**X**		**X**	**X**					**X**	**X**
CO5	**X**	**X**		**X**	**X**					**X**	**X**

THEORY OF PLATES AND SHELLS			
Course Code	22CCS231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Credits	03	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

Teaching-Learning Process	L_1 – Remembering,$_2$ – Understanding.

Module-2

Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids

Teaching-Learning Process	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.

Teaching-Learning Process	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

Teaching-Learning Process	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.

Teaching-Learning Process	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.

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.

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

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=tA_LGwTvre4&list=PLwdnzlV3ogoXQR59FK4dNDzxb5I65IIuu

https://www.youtube.com/watch?v=CkolEAtY6jY

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	

SEMESTER – II			
Subject:	**GEOTECHNICAL ASPECTS OF FOUNDATIONS AND EARTH RETAINING STRUCTURES**		
Subject Code	**22CCS232**	CIE Marks	**50**
Teaching Hours/Week(L:P:SDA)	**3:0:0**	SEE Marks	**50**
Total Number ofLecture Hours	**40**	Exam Hours	**03**
CREDITS – 03			

Prerequisites:
Geotechnical Engineering at UG level

Course objectives: This course will enable students to,

- Plan a subsurface exploration
- Evaluate appropriate bearing capacity correction factors to use in design
- Select the appropriate deep foundation type for different soil profiles.

Compute earth pressure and implement the design procedure for earth retaining structures.

Modules

Module -1	
Bearing Capacity of Soils: Generalized Bearing Capacity Equation; Field tests for Bearing Capacity and settlement estimation; Settlement of shallow foundations - Elastic and consolidation settlements; Settlement estimates from penetration tests; Settlement tolerance; Allowable bearing pressure.	
Teaching-Learning Process	**L1, L2, L3**
Module -2	
Design Parameters for Substructures: Factors influencing selection of depth of Foundation, Subgrade Reaction, Winkler hypothesis and Beams on Elastic Foundation Approach; Soil Line Method; Foundations on expansive soils. Geotechnical failure of foundations during earthquake – Earthquake Resistant design of Shallow foundation – Liquefaction and Remedial measures.	
Teaching-Learning Process	**L1, L2, L3**
Module -3	
Pile Foundations: Classification of pile foundations and general considerations of design; Ultimate load capacity of piles; Pile settlement; Analysis of single pile and pile group; laterally loaded piles and ultimate lateral resistance. Uplift resistance of piles and anchored foundations; under reamed Pile; Pile load tests; Design examples.	
Teaching-Learning Process	**L1, L2, L3**
Module -4	
Retaining structures: Earth pressure theories, Fill Walls, Concrete/Gravity walls, Mechanically Stabilized Earth (MSE) walls- Analysis and Design,; Sheet pile walls, internally braced excavations (struts), externally braced excavations (tieback excavations), Soil Nailing.	
Teaching-Learning Process	**L1, L2, L3**
Module -5	
Elements of Soil Dynamics and Design of Machine Foundations: IS 2974 Parts I to IV, Machine- Foundation System , Block Foundations, Frame Foundations, Design Criteria, Tuning of Foundation, DOF of a Rigid Block Foundation, Linear Elastic Spring, Elastic Half Space Analog, Parameters influencing Dynamic Soil Parameters, Soil Mass Participation, Effect of Embedment, Soil Damping, Machine Parameters, Vibration Isolation System.	
Teaching-Learning Process	**L1, L2, L3**

Course outcomes(CO):

On completion of this course, students will be able to:

1. Analyze the parameters which decide the bearing pressure various soil
2. Decide upon the type of foundation suitable for different sol types and depths.
3. Design pile foundations in different soil conditions.
4. Compute various parameters required for the design the retaining structures
5. Explain soil dynamics and design machine foundation

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from eachmodule.

Reference Books:

1. Bowles J.E, Foundation Analysis and Design, McGraw Hill. New York, 1996.
2. Murthy V. N. S., Advanced Foundation Engineering., CBS Publications, New Delhi, 2007.
3. Swami, S., Soil Dynamics and Machine Foundation, Galgotia Publications Pvt Ltd, New Delhi. 1999.
4. N.H. Som, and Das S.C., Theory and Practice of Foundation Design, PHI, Learning Pvt Ltd., New Delhi, 2009
5. Leonards. G.A, Foundation Engineering, McGraw Hill. 1962
6. Tschebotoriff. G.P. Foundations, Retaining and Earth Structures, McGraw Hill, New York, 1973.
7. Srinivasulu. P. and Vaidyanathan, V.. Handbook of Machine Foundations, Tata McGraw-Hill Publishing Company, New Delhi.2000
8. N.H. Som, and Das S.C., Theory and Practice of Foundation Design, PHI, Learning Pvt Ltd., New Delhi, 2009
9. Tomlinson, M.J., Pile Design and Construction Practice, E & FN Spon, London, 1994.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=lsYFtwwlHIw&list=PLbRMhDVUMngeiZjKPTPEFl1CByXmYX3Kv
https://www.youtube.com/watch?v=LIAAhaeeA8Q

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – II			
Subject:	**ADVANCED CONCRETE TECHNOLOGY AND DESIGN OF MASONRY STRUCTURES**		
Subject Code	**22CCS233**	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 indepth 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

Module -1

Fibre reinforced concrete:
History, mechanism, different types of fibres, Aspect ratio, Volume of fibres, orientation of fibres, balling effect, properties of fibre reinforced concrete, applications of fibre reinforced concrete. Types of Fibre reinforced concrete.

Ferro cement:
Definition, different materials used, casting techniques, properties of Ferro cement, applications.

Teaching-Learning Process — **L1, L2, L3**

Module -2

Light Weight Concrete:
Introduction, classification, properties, strength and durability, mix proportioning and problems

High Density Concrete:
Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods.

Teaching-Learning Process — **L1, L2, L3**

Module -3

Ready mix concrete:
Concept, ready mix concrete plants, difficulties faced and their solution , use of admixtures in ready mix concrete, economics and quality control aspects of ready mix concrete.

High Performance Concrete:
Constituents, mix proportioning, properties in fresh and hardened states, applications & limitations

Teaching-Learning Process — **L1, L2, L3**

Module -4

Polymer concrete:
Polymers, resins, polymerization, different types of polymer concrete like polymer impregnated concrete, polymer concrete (Resin concrete) and polymer modified concrete, their properties and applications.

Self-compacting concrete:
Development of SCC, basic principles and requirements, workability tests for SCC, mix design of SCC, acceptance criteria for SCC, adoption of SCC in the precast industry, present status of SCC

Teaching-Learning Process — **L1, L2, L3**

Module -5

Design of load bearing masonry wall

Permissible stresses: Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric vertical and lateral load, permissible tensile stress and shear stresses. Design Considerations: Effective height of walls and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars.

Teaching-Learning Process	**L1, L2, L3**

Course outcomes(CO):

a. Co1: 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. Co2: Innovative special concrete with mixes, applications and limitations
c. Co3: Testing methods developed to increase the scope of concrete usage as an advanced material
d. Co4: Understand the principles of design and construction of masonry structures

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

1. Krishnaraju.N-"Design of concrete mixes" CBS Publication and distributors, Delhi.
2. Mehta P K & P J M Monteiro, “Concrete”, Prentice Hall, New Jersey (Special Student Edition by Indian Concrete Institute Chennai)
3. Neville. A. M “Properties of Concrete”, ELBS Edition, Longman Ltd., London
4. Rafat Siddique “Special Structural Concretes”, Galgotia publications, New Delhi
5. Santhakumar A R, “Concrete Technology”, Oxford University Press.
6. Shetty M S “Concrete Technology”, S. Chand publishing House Ltd., New Delhi
7.Henry, A.W., “Structural Masonry”, Macmillan Education Ltd., 1990.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=RWck4EnfdSE&list=PLyqSpQzTE6M-81uKP3sjj0lZX_nnrOwpV
https://www.youtube.com/watch?v=SdWh05agJtg&list=PLyqSpQzTE6M_k_G-Lwpb4UUxYUQ-garG1

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	

SEMESTER – II			
Subject:	**DESIGN OF STRUCTURAL SYSTEMS FOR BRIDGES**		
Subject Code	**22 CCS234**	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:

- Structural Analysis
- Highway Engineering
- Design of RC structures.

Course objectives: This course will enable students to

- Understand and use the basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.
- Develop an intuitive feeling about the sizing of bridge elements and the conceptual design part
- Assess the load flow mechanism and loads on bridges.
- Design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements.

Modules	Teaching Hours	RBT Levels
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.		
Teaching-Learning Process	**L1, L2, L3**	
Module -2		
Box Culvert: Introduction to box culvert, advantage of structural continuity, Analysis for maximum BM and SF at critical sections using moment distribution method for various load combinations such as Dead, Surcharge, Soil, Water and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.		
Teaching-Learning Process	**L1, L2, L3**	
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.		
Teaching-Learning Process	**L1, L2, L3,L4**	
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		
Teaching-Learning Process	**L1, L2, L3,L4**	
Module -5		

Balanced Cantilever Bridge: Introduction & Proportioning of Components, Analysis of Main Girder Using Courbon's Method for IRC Class AA, Tracked vehicle Design of Simply Supported Portion Cantilever Portion, Articulation, using limit state method with reinforcement details.

Teaching-Learning Process	**L1, L2, L3**

Course outcomes(CO):

After completing this course, students will be able to:

1. Analyse the bridge structure for dead load and different class of live loads
2. Carry out design Box culvert for various load combinations.
3. Design and provide reinforcement details for T beam bridges using limit state method.
4. Analyse and design pre and post tensioned bridges.
5. Design balanced cantilever bridges including reinforcement details.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

1. Krishna Raju N, Design of Bridges, 5th Ed. Oxford, IBH Publications New Delhi, 2019.
2. Johnson Victor, Essential of Bridge Engineering, Oxford, IBH Publications, New Delhi, 2017.
3. Ponnuswamy, S., Bridge Engineering, Tata McGraw H ill, 2008.
4. IRC112 - 2011 Code of Practice for Concrete Road Bridges and Railway Board Codes
5. Jagadeesh. T.R. and Jayaram. M.A., "Design of BridgeStructures", Prentice Hall of India ,2004.
6. Raina V.K." Concrete Bridge Practice" Tata McGraw H ill Publishing Company, New Delhi, 1991.
7. IITK-RDSO Guidelines on Seismic design of Railway Bridges- Provisions with Commentary and Explanatory Examples, 2010.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=RB2k5hSYO3U&list=PLXKZsEFKU_HHtsCMaAIPB3tr5Ht2Bdge

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**								**X**	
CO2	**X**	**X**								**X**	
CO3	**X**	**X**								**X**	
CO4	**X**	**X**								**X**	
CO5	**X**	**X**								**X**	

SEMESTER – II			
Subject	**DESIGN OF PRECAST CONCRETE AND COMPOSITE STRUCTURES**		
Subject Code	**22CCS241**	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:

- Basics of Strength of materials,
- Structural Analysis

Course objectives: This course will enable students to

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

Modules

Module -1

Concepts , components, Structural Systems and Design of precast concrete floors. Need and types of precast construction, Modular coordination, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections. Design of precast Concrete Floors: Theoretical and Design Examples of Hollow core slabs,. Precast Concrete Planks, floor with composite toppings with and without props.

Teaching-Learning Process	**L1, L2, L3,L4**

Module -2

Design of precast reinforced and prestressed Concrete beams, Theoretical and Design Examples of ITB – Full section precast, Semi Precast, propped and unpropped conditions. Design of RC Nibs.

Teaching-Learning Process	**L1, L2, L3,L4**

Module -3

Design of precast concrete columns and walls, Design of braced and unbraced columns with corbels subjected to pattern and full loading. Design of Corbels. Design of RC walls subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints.

Teaching-Learning Process	**L1, L2, L3**

Module -4

Design of Precast Connections and Structural Integrity. Beam bearing, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of StructuralTies.

Teaching-Learning Process	**L1, L2, L3**

Module -5

Design of Steel Concrete Composite Floors and Beams Composite Floors: Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example Composite Beams: Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.

Teaching-Learning Process	**L1, L2, L3,L4**

Course outcomes(CO):

After completing this course, students will be able to:

1. Explain the need for precast elements in building construction.
2. Design precast reinforced and prestressed concrete beams for different conditions.
3. Design precast concrete columns and walls.
4. Analyse and design composite floors and beams.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

1. Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983.
2. David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989.
3. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011.4. IS 11447,IS6061 – I and III.
5. R.P. Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994.
6. IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.
7. INSDAG Teaching Resource Chapter 21 to 24: www.steel-insdag.org

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=fRqxXkxApSY
https://www.youtube.com/watch?v=d884hVclIjQ

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X								X	
CO2	X	X								X	
CO3	X	X								X	
CO4	X	X								X	

SEMESTER – II			
Subject	**STRUCTURAL STABILITY ANALYSIS**		
Subject Code	**22CCS242**	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

- Strength of Materials
- Theory of elasticity
- Finite Element Analysis

Course objectives:

This course will enable students to,

- Learn the concepts of stability of structures
- Analyse various structural elements for their stability.
- Compute buckling loads of columns; elastic buckling of frames and Plates.

Modules

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.

Teaching-Learning Process	**L1, L2**

Module -2

Buckling of frames and continuous beams. Elastic Energy method: Approximate calculation of critical loads for a cantilever, Exact critical load for hinged-hinged column using energy approach. Buckling 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. Columns subjected to pulsating forces.

Teaching-Learning Process	**L2, L3**

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). Algorithm to generate geometric stiffness matrix for four noded and eight noded isoparametric plate elements, Buckling of pin jointed frames (maximum of two active DOF)-symmetrical single bay Portal frame.

Teaching-Learning Process	**L2, L3, L4**

Module -4

Lateral buckling of beams: Differential equation –pure bending – cantilever beam with tip load – simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open cross section

Teaching-Learning Process	**L1, L2, L3**

Module -5

Expression for strain energy in plate bending with in plate forces (linear and non – linear): Buckling of simply supported rectangular plate– uniaxial load and biaxial load. Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge condition along the other two sides.

Teaching-Learning Process	**L1, L2, L3**

Course outcomes (CO):

On completion of this course, students will be able to:

1. Formulate differential equations for beam column elements with various combinations of loads and endconditions.
2. Analyse buckling of frames and continuous beams.
3. Carry out stability analysis of structures using Finite Element Method.
4. Analyse buckling of beams and torsion in beams.
5. Apply strain energy method for buckling of plates.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one fullquestion from each module.

Reference Books:

1. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, 2nd Ed., McGraw Hill Book Co., New York, 1961.
2. Simitses, G.J. and Hodges, D.H., Fundamentals of Structural Stability, Butterworth & Heinemann,2006.
3. Gambhir, M.L., Stability Analysis and Design of Structures, Springer, 2009.
4. Manicka Selvam, V.K., Elements of Matrix and Stability Analysis of Structures, 6ed., Khanna Publishers, New Delhi, 2004.
5. Srinath, L.S., Advanced Mechanics of Solids, 3ed., Tata McGraw-Hill Publishing Co. Ltd., New Delhi,2017.
6. Rajashekaran. S, Computational Structural Mechanic s, Prentice-Hall, India, 2001.
7. Ray W Clough and J Penzien, Dynamics of Structures, 2 nd Edition, McGraw-Hill, New Delhi, 1968.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=un_Fjz_dfXI&list=PLFEqFwyPC3WwDLI6jtt2xXVPw2ygj0Jxz

https://www.youtube.com/watch?v=KqhBV73pEwY

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**								**X**	
CO2	**X**	**X**								**X**	
CO3	**X**	**X**								**X**	
CO4	**X**	**X**								**X**	
CO5	**X**	**X**								**X**	

SEMESTER – II			
Subject:	**ACTION AND RESPONSE OF STRUCTURAL SYSTEMS**		
Subject Code	**22CCS 243**	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:

- Structural analysis 1 and 2

Course objectives:

This course will enable students to,

- Familiarize with procedures for calculating action effects for different types of structures frequently encountered in practice
- Understand the importance of appropriate code provisions.
- Assess the basic need, concepts and procedures of different types of analysis
- Characterize the response of different types of structural systems for Tall buildings.

Modules

Module -1

IS 875 PART 1, 2, 4, 5 : Sources, Nature and Magnitude, Probabilistic assessment, Characteristic and Design values. IS 875 PART 1 and 2 code provisions. Load combination rules for design. Load path for gravity loads- Tributary Area and Stiffness based approaches. Estimation of DL and LL on structural elements such as Slab, Beams, Columns, in different types of structural systems, Joint Loads on Trusses, Distributed load on Purlins- Numerical examples.

Teaching-Learning Process	**L1, L2,L3**

Module -2

Wind Load - IS 875 PART 3: Buildings : Nature and Magnitude, Factors influencing wind loads, Internal and External pressure distribution, Design Wind Speeds and Pressure, Numerical Examples to calculate external and internal pressure for different types of buildings and regions – Flat roof, Pitched Roof, Sign board, Structural glazing, Water tank on shaft staging, Multi-storey Frames - Load path for Lateral loads.

Teaching-Learning Process	**L1, L2,L3**

Module -3

Seismic Loads: IS 1893: Buildings : Nature and Magnitude, Centre of mass and rigidity, Calculation of Design Seismic Force by Static Analysis Method, Dynamic Analysis Method, Location of Centre of Mass, Location of Centre of Stiffness, and Lateral Force Distribution as per code provisions. - Load path for Lateral loads – Floor diaphragm action.

Teaching-Learning Process	**L1, L2,L3**

Module -4

Vehicles Loads as per IRC 6 - 2014 on Road Bridges – Class 70 R, Class AA, Class A ,Class B , Tracked Vehicle, Wheeled Vehicle, Load Combinations, Impact, Wind, Water Currents, Longitudinal Forces: acceleration, breaking and frictional resistance, Centrifugal forces, temperature, Seismic forces, Snow Load, Collision Loads. Load Combinations – Simple Numerical examples.

Teaching-Learning Process	**L1, L2,L3**

Module -5

Types of Analysis and Structural forms of Tall Buildings: Linear, Nonlinear behavior, Material nonlinearity, Geometric nonlinearity, Rigid and Elastic Supports, First Order Elastic Analysis, Second Order Elastic Analysis, First order Inelastic Analysis, Second order Inelastic Analysis – Concepts and Brief descriptions Structural forms in Tall buildings – Rigid frame, Braced Frames, Shear Walls, Core walls, Tubular, Belt truss, Outrigger.

Teaching-Learning Process	**L1, L2,L3**

Course outcomes(CO):

After studying this course, students will be able to:

1. Apply the load combination for design of structural elements.
2. Apply wind loads to different types of buildings and structures.
3. Design buildings for seismic loads
4. Compute appropriate vehicle loads on bridge structure.
5. Analyse structural elements of tall buildings

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

IS Codes

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

Reference Books:

1. L. S. Srinath, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co, 2010.
2. An explanatory Handbook on IS 875 (PART 3); Wind Load on Building and Structures, Document No: IITK-GSDMA Wind 07 V1.0 - IITK-GSDMA Project on Building Codes
3. Explanatory Examples on Indian Seismic Code IS 1893 (Part I): Document No. IITK-GSDMA-EQ21-V2.0 - IITK-GSDMA Project on Building Codes.
4. Aslam Kassimali, Matrix Analysis of Structures, Cengage Learning, 2012.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=xwlRlGO4e68
https://www.youtube.com/watch?v=UHV77TS9X1A

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – II			
Subject:	**STRUCTURAL HEALTH MONITORING**		
Subject Code	**22CCS244**	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:

- Structural Analysis.
- Basic knowledge of sensors and electronic.

Course objectives: This course will enable students to

- Study fundamentals of structural health monitoring.
- Study various vibration based techniques for structural health monitoring.
- Use fibre-optic methods for monitoring of structural health.
- Adopt electrical resistance and electromagnetic techniques for structural health monitoring.

Modules

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.

Teaching-Learning Process	**L2, L3**

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 localization 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 Multi- Layer 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.

Teaching-Learning Process	**L1, L2, L3**

Module -3

Fiber-Optic Sensors Classification of fiber-optic sensors, Intensity-based sensors, Phase modulated 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, Photo- elasticity 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 damage 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.

Teaching-Learning Process	**L1, L2, L3**

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.

Teaching-Learning Process	**L2, L3**

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 materials, Hybrid method, Signal processing, Time- frequency transforms, The continuous wavelet transform, The discrete wavelet transform, Multiresolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method,Hybrid method.

Teaching-Learning Process	**L3, L4**

Course outcomes (CO):

After completing this course, students will be able to:

- Co1: Emphasise the importance of structural health monitoring as part of system management.
- Co2: Adopt vibration based techniques for health monitoring of a few structural elements and components.
- Co3: Use fibre-optic and other types of sensors for estimating damage in a structural element.
- Co4: Characterise the defect or damage in a structural element using piezo-electric sensors or acoustic emission methods.
- Co5: Apply general principles of structural health monitoring using magnetic, electric and hybrid methods.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=Y_-OrF8lmio&list=PLyqSpQzTE6M8DM5yAH4VgLMkAXiQV7oDw

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X	X			X	X	X	X
CO2	X	X		X	X			X	X	X	X
CO3	X	X		X	X			X	X	X	X
CO4	X	X		X	X			X	X	X	X
CO5	X	X		X	X			X	X	X	X

Mini Project with Seminar			
Course Code	**22CCS25**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:4:2	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

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

- Choose, preferably through peer reviewed journals, are cent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic 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.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill,participationinthequestionandanswersessionandqualityofreport)bythecommitteeconstitutedforthepurposebythe HeadoftheDepartment.Thecommitteeshallconsistofthreefacultiesfromthe Department with the senior most acting as the Chairperson.

Marks distribution

Seminar Report: 30 marks Presentation skill:50 marks Question and Answer: 20marks

SEMESTER – II			
Subject:	**CAD LAB – FE ANALYSIS OF 2-D AND 3-D CONTINUUM**		
Subject Code	**22 CCS L26**	CIE Marks	**50**
Teaching Hours/Week (L:P:SDA)	**1:2:0**	SEE Marks	**50**
Total Number of Lecture Hours	**42**	Exam Hours	**03**
CREDITS – 02			

Prerequisites:

- Basics of Finite Element Analysis

Course objectives: This course will enable students to,

- Use industry standard software in a professional set up.
- Familiarise with the elements of finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design.

Practical Problems

1. FE Analysis of Plane Stress and Plane Strain Problems	
Teaching-Learning Process	**L1, L2, L3**
2. Flexural Behaviour of Slab Panels with different aspect ratio and boundaryconditions	
Teaching-Learning Process	**L1, L2, L3**
3. FE Analysis of Slab panel resting on column supports- Drop Panels, Capitals	
Teaching-Learning Process	**L1, L2, L3**
4. FE Analysis of Slab on Grade (Raft), Underpass, Bridge Structures	
Teaching-Learning Process	**L1, L2, L3**
5. FE Analysis of Framed structures due to Seismic forces using modal superpositionmethod	
Teaching-Learning Process	**L1, L2, L3**
6. Program Development for design of structural steel elements, using any programming (Tension member, Compression member and Bending)	
Teaching-Learning Process	**L1, L2, L3**

Exercises on Structural Analysis are aimed at using Finite element analysis based on Industry Standard Softwares.

Course Outcomes (CO):

After completing this course, students will be able to,

1. Carry out FE analysis of Plane Stress and Plane Strain Problems
2. Analyse and interpret Flexural Behaviour of Slab Panels.
3. Conduct FE analysis of structural elements like slab panels, drop panels and capitals.
4. Analyse Slab on Raft, Underpass and Bridge etc using FE method.
5. Carry out dynamic analysis using mode superposition method.
6. Develop programs for the analysis structural steel elements in tension, compression and bending.

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO2	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO3	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO4	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO5	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
CO6	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**

SEMESTER – III			
Subject:	**EARTHQUAKE RESISTANT DESIGN OF STRUCTURES**		
Subject Code	**22CCS31**	CIE Marks	**50**
Teaching Hours/Week (L:P:SDA)	**3:0:2**	SEE Marks	**50**
Total Number of Lecture Hours	**40**	Exam Hours	**03**
CREDITS – 04			

Prerequisites:

- Structural dynamics.

Course objectives:

This course will enable students to

- Familiarise with engineering seismology.
- Design buildings with earthquake resistance.
- Evaluate seismic response of structures.

Modules

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.

Teaching-Learning Process	**L1, L2**

Module -2

The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS-1893.

Teaching-Learning Process	**L2, L3, L4,L5**

Module -3

Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behaviour of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.

Teaching-Learning Process	**L2, L3, L4,L5**

Module -4

Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.

Teaching-Learning Process	**L2, L3, L4,L5**

Module -5

Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures

Teaching-Learning Process	**L2, L5, L6**

Course outcomes (CO):

After completing this course, students 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 question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Text Books:

1. Anil K. Chopra, Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed. –, 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.
5. IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993
6. Minoru Wakabayashi, Design of Earthquake Resistant Buildings, , McGraw Hill Pub 1985.
7. T Paulay and M J N Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons, 1992.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=kZFtZKzuo3I&list=PL6XkfCIV_u2Now2UXF1DCLrT06Zyg4UtS

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – III			
Subject :	**DESIGN OF TALL STRUCTURES**		
Subject Code	**22CCS321**	**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:

- Special Concrete
- Structural Dynamics

Course objectives:

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

Modules

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

Teaching-Learning Process	**L1,L2**

Module-2

Wind loading: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design.

Teaching-Learning Process	**L1, L3,L4,L5**

Module-3

Behavior of Various Structural Systems: Factors affecting growth, Height and structural form; High rise behavior, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger – braced and hybrid mega system.

Teaching-Learning Process	**L2,L3**

Module-4

Analysis and Design: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional analyses.

Teaching-Learning Process	**L2, L3,L4**

Module-5

Stability of Tall Buildings: Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first order and P-Delta analysis, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow; Design for differential movement, creep and shrinkage effects, temperature effects and fire	
Teaching-Learning Process	**L2, L3,L4,L5**

Course outcomes:

On completion of this course, students are able to:

- Co1: Achieve Knowledge of design and development of problem solving skills.
- Co2: Understand the principles of strength and stability
- Co3: Design and develop analytical skills.
- Co4: Summarize the behavior of various structural systems.
- Co5: Understand the concepts of P-Delta analysis

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=-syqppgcoVE
https://www.youtube.com/watch?v=7NEfZXFOvxU

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – III			
Subject	**ADVANCED MECHANICS OF MATERIALS**		
Subject Code	**22CCS322**	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:

- Structural analysis 1 and 2.

Course objectives:

This course will enable students to

- Analyse structures like curved beams.
- Carry out analysis of elements of structures for special cases of loading such as non-symmetrical bending. .
- Analyse structures for special cases of supports such as elastic foundation

Modules

Module -1

Torsion: Torsion of straight bars of Elliptic Cross section – St. Venants semi-inverse method and Prandtl's function Approach – Membrane analogy – Torsion of a bar of narrow rectangular cross section. Torsion of thin walled open cross sections – Torsion of thin walled tubes.

Teaching-Learning Process	**L1, L2, L3**

Module -2

Curved Beams: Introduction, Circumferential stress in a curved beam, Radial stresses incurved beams, Correction for circumferential stresses in curved beams having I, T, or similar cross sections, Deflections of curved beams, Statically indeterminate curved beams, Closed ring subjected to a concentrated load.

Teaching-Learning Process	**L1, L2, L3**

Module -3

Shear Center for Thin-Wall Beam Cross Sections: Definition of shear center in bending Approximations employed for shear in thin-wall beam cross sections, Shear flow in thin- walled beam cross sections, Shear center for singly symmetric and unsymmetrical sections. Non-symmetrical Bending of Straight Beams: Symmetrical and non-symmetrical bending, Bending stresses in beams subjected to non-symmetrical bending, Deflections of straight beams subjected to non-symmetrical bending.

Teaching-Learning Process	**L1, L2, L3**

Module -4

Beams on Elastic Foundations: General theory, Infinite beam subjected to concentrated load, Boundary conditions, Infinite beam subjected to a distributed load segment, Semi- infinite beam with different end conditions subjected to concentrated load and moment at its end - Short beams.

Teaching-Learning Process	**L1, L2, L3**

Module -5

Structures subjected to out of plane loading: Analysis of simple bents, frames, grids and beams circular in plan – Cantilever beams, semicircular continuous beams with three equally spaced supports, circular beams with different number of equally spaced supports.

Teaching-Learning Process	**L1, L2, L3**

Course outcomes(CO):

On completion of this course, students are able to:

1. Analyse torsion in elliptical, square bars and tubular cross sections.
2. Work out the stresses in curved beams and ring structure
3. Compute shear stress in thin walled sections and bending stresses in symmetrical and non-symmetrical beam sections.
4. Carry out analysis of beams on elastic foundations.
5. Analyse structural elements subjected to out of plane bending.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

Reference Books:

1. Arthur P. Boresi and Omar M. Sidebottom: Advanced Mechanics of Materials, Fourth Edition, John Wiley & Sons, 1985.
2. James M. Gere and S. P. Thimoshenko: Advanced Mechanics of Materials, Second Edition, CBS Publishers, New Delhi, 2000.
3. Ugural .A. C. and Fenster .S. K., Advanced Strength of material and Applied Elasticity, Arnold Publishers, 1981.
4. Shah H. J. and Junnarkar S. B., Mechanics of Structures, Volume – I and II, Charotar Publications, Anand, 2014.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=dFOoU2psFFg&list=PLx3rV8SZWEyij0jjlEVp9YuJnvSv6MV3z
https://www.youtube.com/watch?v=4meZNc2wB4s&list=PLKZlPALGW-7TK51CrfZRyWcY8h2gaxVCy

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – III			
Subject:	**RETROFITTING AND REHABILITATION OF STRUCTURES**		
Subject Code	**22CCS323**	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:

- Strength of materials.
- Structural analysis
- Design of RCC elements.

Course objectives:

This course will enable students to,

- Lay emphasis on the repair and maintenance of structural elements of a structure.
- Assess the distresses in the structures and enable the design of rehabilitating them.

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Modules

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,

Teaching-Learning Process	**L2, L3**

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.

Teaching-Learning Process	**L1, L2, L3**

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

Teaching-Learning Process	**L2, L3**

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.

Teaching-Learning Process	**L2, L3**

Course outcomes:

On completion of this course, students are able to:

- Co1: Achieve Knowledge of design and development of problem solving skills.
- Co2: Understand the cause of deterioration of concrete structures.
- Co3: Design and develop analytical skills.
- Co4: Summarize the principles of repair and rehabilitation of structures

Co5: Understands the concept of Serviceability and Durability.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) fromeachmodule.
- 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. Sidney, M. Johnson "Deterioration, Maintenance and Repair of Structures".

2. Denison Campbell, Allen & Harold Roper, "Concrete Structures – Materials, Maintenanceand Repair"- Longman Scientific and Technical

3. R.T.Allen and S.C. Edwards, "Repair of Concrete Structures"-Blakie and Sons Raiker R.N., "Learning for failure from Deficiencies in Design, Construction and Service"-R&D Center (SDCPL

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=taa4Fq-fERQ&list=PLq46p_ppqQemCi6i4SvZ1kCpFREHQkF_

https://www.youtube.com/watch?v=x9noZ4xEXyg&list=PLNRGMg8U7bLdPXyqgUHSzjL58kH3urQN1

https://www.youtube.com/watch?v=G7S_XocB9G8

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

SEMESTER – III			
Subject:	**GEOTECHNICAL EARTHQUAKE ENGINEERING**		
Subject Code	**22CCS324**	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:
Geotechnical Engineering at UG level

Course objectives: This course will enable students to,

- Plan a subsurface exploration
- Evaluate appropriate bearing capacity correction factors to use in design
- Select the appropriate deep foundation type for different soil profiles.

Compute earth pressure and implement the design procedure for earth retaining structures.

Modules

Module -1	
INTRODUCTION TO GEOTECHNICAL EARTHQUAKE ENGINEERING: Seismic hazards – Ground Shaking, Structural hazards, Liquefaction, Landslides, Retaining structure failures, Lifeline Hazards, Tsunami and Seiche Hazards; Mitigation of Seismic Hazards, Significant Historical Earthquakes. DYNAMIC SOIL PROPERTIES: Representation of Stress conditions by Mohr Circle – Principal stresses and stress path; measurement of dynamic soil properties: Field test, lab tests, interpretation of observed ground response.	
Teaching-Learning Process	**L1, L2, L3**
Module -2	
LIQUEFACTION: Liquefaction related phenomenon – flow liquefaction,Cyclic Mobility; Evaluation of liquefaction hazards; liquefaction Susceptibility historical criteria. Geologic criteria. Compositional criteria. State criteria: initiation of liquefaction- flow liquefaction surface, Influence of excess pore pressure. Evaluation of Initiation of liquefaction – effects of liquefaction.	
Teaching-Learning Process	**L1, L2, L3**
Module -3	
SOIL IMPROVEMENT FOR REMEDIATION OF SEISMIC HAZARDS: densification techniques - Vibro trechniques. Dynamic compaction, Blasting. Compaction grouting, Arial extent of Densification-;Reinforcement techniques – stone columns. Compaction piles. Drilled inclusions; grouting and mixing techniques-drainage techniques. Verification of soil improvement – lab testing techniques.; In-situ testing techniques, Geophysical testing techniques; Other considerations.	
Teaching-Learning Process	**L1, L2, L3**
Module -4	
GENERAL PRINCIPLE OF MACHINE FOUNDATION DESIGN: Types of machine and foundation,General requirements of machine foundations; permissible amplitude, Allowable soil pressure. Permissible stresses of concrete and steel.,Permissible stresses of timber. FOUNDATION OF RECIPROCATING MACHINE; Modes of vibration of a rigid foundation block. Methods of analysis, Linear elastic weight less spring method, Elastic half space method. Effect of footing shape on vibratory response, Dynamic response of embedded block foundation. Soil mass participating in vibrations, Design procedure for a block foundation.	
Teaching-Learning Process	**L1, L2, L3**
Module -5	

FOUNDATION OF IMPACT TYPE MACHINE: Dynamic analysis. Design procedure for a hammer foundation FOUNDATION OF ROTARY MACHINES: Special considerations. Design criteria. Loads on a T.G. Foundations,Method of analysis and design, Resonance method. Amplitude method, Combined method	
Teaching-Learning Process	**L1, L2, L3**

Course outcomes(CO):

On completion of this course, students are able to:

- Co1: Achieve Knowledge of design and development of problem solving skills.
- Co2: Understand the principles of engineering seismology
- Co3: Design and develop analytical skills.
- Co4: Summarize the Seismic evaluation and retrofitting of structures.
- Co5: Understand the concepts of earthquake resistance of reinforced concrete buildings.

Question paper pattern:

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from eachmodule.

Reference Books:

1Dynamics of Structures – Theory and Application to Earthquake Engineering-2nd ed. – Anil K. Chopra, Pearson Education.

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

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

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

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

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

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

8.Steven L Kramer – Geotechnical Earthquake Engineering , PHI series

9.Swami Saran – Soil Dynamics and Machine Foundations, Galgotia Publications Pvt. Ltd

Web links and Video Lectures (e-Resources):
https://www.youtube.com/watch?v=q-kHDw37XOM&list=PLbMVogVj5nJRNzx4KtSTVj7qr9OxwY3IF

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

ADVANCED STRUCTURAL ANALYSIS

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

SEMESTER – III

Subject Code	**22CCS331**	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: Strength of Materials and Structural Analysis

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

Modules

Module-1

Curved Beams: Curved beams, Introduction, assumptions, derivation of WINKLER BACH equation, Radius to the neutral surface of simple geometric figures, Limitation, Stress distribution in open curved members such as Hooks and chain links, Stress distribution in closed rings and chain links. Deformations of open and closed rings.

Teaching Learning Process	**L1,L2,L3,L4**

Module-2

Beams on Elastic Foundations: Governing differential equation for elastic line, Interpretation of constants, Infinite beam with point load, moment & UDL with problems. Semi-infinite beams with point load and moment UDL with problems over fixed and hinged support conditions.

Teaching Learning Process	**L1,L2,L3,L4**

Module -3

Shear Centre: Concept of shear center in torsion induced bending of beams, expression to the Shear Centre for Symmetrical and Unsymmetrical Sections, Derivation of shear centre for angles, channel, semicircular and built-up sections with numerical problems

Teaching Learning Process	**L1,L2,L3,L4**

Module -4

Unsymmetrical Bending (Asymmetrical Bending): Theory behind unsymmetrical bending, Assumptions, obtaining the stresses in beams, simply supported and cantilever unsymmetrical beams subjected to inclined loading, Deflections of unsymmetrical simply supported and cantilever beams with numerical problems.

Teaching Learning Process	**L1,L2,L3,L4**

Module -5

Buckling of Non Prismatic Columns and Beam-Column: Principle behind Euler's theory of buckling, Governing differential equation applied to buckling of columns and evaluation of constants for various boundary conditions, Obtaining the characteristic equation for the buckling load of non-prismatic compound columns, Analysis of Beam-column, conceptual theory of magnification stresses and deformations subjected to axial and different types of lateral loads with numerical problems.

Teaching Learning Process	**L1,L2,L3,L4**

Course Outcomes: Students will be able to

- Co1: Apply Winkler Bach and Strain Energy principles to obtain stresses and deformation in curved members
- Co2: Derive the expressions to Foundation pressure, Deflection, Slope, BM and SF of infinite and semi-infinite Beams resting on Elastic Foundation
- Co3: Obtain the equations for the shear centre for symmetrical and unsymmetrical from fundamental.
- Co4: Extrapolate the bending theory to calculate the stresses and deformations in unsymmetrical bending.
- Co5: Develop the characteristic equation for the buckling load of compound column and stresses and deformations in beam-column

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

Text Books

1) Krishna Raju N & Gururaj D R "Advanced mechanics of solids and structures", NAROSA Publishers Company Delhi.

2) Srinath L.S. "Advanced Mechanics of Solids", Tenth Print, Tata McGraw Hill publishing company. New Delhi, 1994.

Reference Books

1) Vazirani V N and Ratwani M M "Advanced theory of structures and Matrix Method".5th Edition, Khanna publishers, Delhi 1995.

2) HetenyiM. "Beams on elastic foundation" 3rd printing, University of Michigan, USA,1952.

3) Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, NewDelhi, 1974.

4) Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers

Web links and Video Lectures (e-Resources):
https://www.youtube.com/watch?v=s4CN6aVKhPo&list=PLEE5D02698EAAF2C0

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	
CO5	X	X		X						X	

Fracture Mechanics in Structural Engineering
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	**22CCS332**	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: 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

Module-1

Stress concentration in elastic materials
Theory of stress concentration in elastic materials, stress concentration factors around circular and elliptic holes. Influence of ratio of radii on stress concentration factor in elliptic hole.

Teaching Learning Process	**L1, L2**

Module-2

Linear Elastic Fracture mechanics
Modelling a crack as a flat elliptic hole by Inglis and the limitations of the model, Griffith theory of brittle fracture Theories of linear elastic fracture mechanics, stress intensity factors, Irwin's definition. Fracture toughness KIc, KIIc, KIIIc & corresponding values of GC.

Teaching Learning Process	**L2,L3**

Module-3

Elasto-plastic fracture mechanics
Crack-tip plasticity in metals. Irwin's modification for elasto-plastic material. J integral, CMOD, CTOD. Mixed mode problems and evaluation of critical fracture parameters.

Teaching Learning Process	**L2,L3,L4**

Module-4

Fracture of Concrete
Limitations of theories of linear elastic fracture mechanics in concrete, Review of concrete behaviour in tension and compression. Kaplan's experiments, concept of fracture energy, definition of a quasi-brittle material, concept of softening.

Teaching Learning Process	**L2,L3,L4**

Module-5

Advanced concepts in fracture behavior of concrete
Definition of fracture energy by RILEM, Influence of size on fracture behavior, Bazant's size effect law. Size dependent & independent fracture energies. Application of fracture mechanics in design of concrete structures.

Teaching Learning Process	**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; 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. Timoshenko & Goodier, “Theory of Elasticity”, McGrawHill
2. Valliappan S. "Continuum Mechanics Fundamentals" (1982), Oxford IBH, ND. New Delhi.
3. Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition, Martinus Nijhoff (1987).
4. T. L. Anderson, “Fracture Mechanics- Fundamentals and Applications”, CRC press
5. Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing company, New Delhi,1994
6. Bhushan L Karihaloo “Fracture mechanics and structural concrete “,John Wiley&Sons Inc,
7. Zdenek P. Bazant, Jaime Planas, “Fracture and Size Effect in Concrete and Other Quasibrittle Materials” CRC press

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=PTSFXu19OMg
https://www.youtube.com/watch?v=G5mcTw-PLEI

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

CO	PO										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	
CO3	X	X		X						X	
CO4	X	X		X						X	

COMPOSITE MATERIALS

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

SEMESTER – III

Subject Code	**22CCS333**	CIE Marks	50
Number of Lecture Hours/Week	03	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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

Course objectives: Students will be

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

Modules

Module-1

Introduction: Introduction to Composite materials, classifications (thermoset and thermoplastic) andcivil/structural engineering applications. Constituent materials of composites – Reinforcements and matrix. Rule ofmixture. Selection of materials. Manufacturing techniques – Hand layup method and compression moulding method. Basics of fiber reinforced composite (Synthetic and natural FR Polymer composites).Advantages and Limitations of composites.

Teaching Learning Process	**L1, L2,L4**

Module-2

Macro-mechanical Behaviour of a Lamina: Introduction, Stress-Strain Relations For Anisotropic Materials. Stiffness's, compliances, and engineering constants for orthotropic materials. Restrictions on engineering constants. Numerical problems.

Teaching Learning Process	**L3, L4,L5**

Module -3

Macro-mechanical Behaviour of a Lamina contd…

Stress-strain relations for plane stress in an orthotropic material. Stress-strain relations for a lamina of arbitrary orientation. Invariant properties of an orthotropic lamina. Strengths of an orthotropic lamina, thermal andmechanical stress analysis. Numerical problems.

Teaching Learning Process	**L3, L4,L5**

Module -4

Micro-mechanical behaviour of a lamina: introduction, mechanics of materials approach to stiffness.Determination of E_1. Determination of E_2. Determination of v_{12}. Determination of G_{12}. Numerical problems.

Teaching Learning Process	**L3, L4,L5**

Module -5

Classical composite lamination theory, cross and angle – play laminates, symmetric, anti-symmetric and general symmetric laminates. Mechanical coupling. Analysis of simple laminated structural elements ply-stress and strain, lamina failure theories concepts-Maximum Stress Failure Criterion, Maximum Strain Failure Criterion and Tsai-Hill Failure Criterion. Numerical Problems.

Teaching Learning Process	**L3, L4, L5**

Course outcomes:

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

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

Question paper pattern:

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

REFERENCE BOOKS:

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

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=0kB0G6WKhKE&list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities**
- **Group Discussion**

	PO										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	**X**	**X**		**X**						**X**	
CO2	**X**	**X**		**X**						**X**	
CO3	**X**	**X**		**X**						**X**	
CO4	**X**	**X**		**X**						**X**	

GREEN BUILDING TECHONOLOGY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	**22CCS334**	CIE Marks	50
Number of Lecture Hours/Week	03	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites: Concrete Technology and Basics of Ecology and Environment

Course objectives:

1. Exposure to the green building technologies and their significance.
2. Understand the judicial use of energy and its management.
3. Educate about the Sun-earth relationship and its effect on climate.
4. Enhance awareness of end-use energy requirements in the society.
5. Develop suitable technologies for energy management.

Modules

Module-1

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

Teaching Learning Process	**L2,L3**

Module-2

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception – Illumination requirement - Auditory requirement.

Teaching Learning Process	**L2,L3**

Module -3

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature – Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

Teaching Learning Process	**L3,L4**

Module -4

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

Teaching Learning Process	**L3,L4**

Module -5

Energy management options - Energy audit and energy targeting - Technological options for energy management.

Teaching Learning Process	L3,L4

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

- **CO1:** Select appropriate green building material and technique.
- CO2: Design sustainable and energy efficient civil engineering project.

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. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=nFBvLIfFFqI
https://www.youtube.com/watch?v=VE2tpwGCN0U
https://www.youtube.com/watch?v=VE2tpwGCN0U&list=RDCMUCY-ANi3wxkUSGhAel7T0TGw&start_radio=1&t=16s

Skill Development Activities Suggested

- **Conduction of technical seminars on recent research activities in Green Building Technology**
- **Group Discussion**

	PO										
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	X	X		X						X	
CO2	X	X		X						X	

PROJECT WORK PHASE – 1			
Course Code	**22CCS34**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	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			
Course Code	**22CCSI36**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	0:6:0	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.

*** END OF III SEMESTER***

PROJECT WORK PHASE – 2			
Course Code	**22CCS41**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:8:0	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 informationso 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 ifany.

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 thesenior 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.