

Computational Structural Mechanics – Classical & FE Approach			
Subject Code	MCAS201	CIE	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE	50
Total Number of Lecture Hours	40	Total Marks	100
Credits	03	Exam Hours	03
Objectives:			
The course aims to equip students with a comprehensive understanding of the direct stiffness method and finite element analysis. Students will learn to analyze trusses, continuous beams, and 2D frames under various conditions, develop proficiency in deriving stiffness matrices, and implement computer programs for practical engineering applications.			
Module-1			
Direct Stiffness Method–Analysis of Trusses			
Degrees of static and kinematic indeterminacies, degrees of freedom, discrete and continuous systems, local and global coordinate systems. Concepts of flexibility and stiffness, local and global coordinate systems, rotation transformation matrix, and element stiffness matrix for two-noded bar elements and two-noded beam elements. Analysis of simple pin-jointed trusses with and without initial strains for different combinations of support conditions (upto3DOF)and simple problems of trusses involving support settlement. Self-StudyComponent: Develop a program for generating the overall stiffness matrix for a truss using any programming language.			
Teaching-Learning Process	L ₂ - Understand, L ₃ -Apply		
Module-2			
Direct Stiffness Method-Analysis of Continuous Beams and 2-DFrames			
Analysis of continuous beams for different types of boundary conditions, such as fixed, hinged, roller, slider, elastic (spring)supports,and support settlement.Analysis of simple 2-D frames with and without sway. Self-Study Component: Develop a program for the analysis of continuous beams and 2-D frames using any programming language.			
Teaching-Learning Process	L ₃ -Apply		
Module-3			
Introduction to FEM & Discretization			
Basic steps in FEM, Advantages &disadvantages.Types of elements – Natural subdivision at discontinuities, minimization of band width, element aspect ratio, discretization of very large bodies and infinite bodies. Self Study Component: Learn about different elements available in different finite element packages			
Teaching-Learning Process	L ₂ -Understand		
Module-4			
Displacement Functions and Shape Functions.			
Selection of displacement functions, convergence requirements, geometric invariance, Pascal triangle, Different coordinate systems.Shape functions, Lagrange’s shape functions for one dimensional and two dimensional rectangular elements. Serendipity elements & isoparametric elements. Self Study Component: Learn to draw the various shape function diagrams.			
Teaching-Learning Process	L ₂ - Understand, L ₃ -Apply		
Module-5			
Computation of Element Stiffness Matrix			
Derivation of element stiffness matrix for truss element and beam element by direct approach and variational approach, Lumped loads, Numerical problems on analysis of plane trusses and beams. Self-StudyComponent: Develop a program for generating the overall stiffness matrix for beam elements using any programming language.			
Teaching-Learning Process	L ₂ - Understand, L ₃ -Apply		

Course Outcomes

At the end of the course the students will be able to

- CO1:** Understand the basic principles of the direct stiffness method for analyzing trusses, including degrees of static and kinematic indeterminacy, local and global coordinate systems, and stiffness matrix formulation. **RBT Level: Understanding (Level 2)**
- CO2:** Apply the direct stiffness method to analyze continuous beams and 2D frames with different boundary conditions, including the ability to incorporate support settlements and elastic supports. **RBT Level: Applying (Level 3)**
- CO3:** Gain a comprehensive understanding of the finite element method (FEM), including the principles of virtual work, minimum potential energy, and Galerkin's method, and apply them to solve simple structural problems. **RBT Level: Understanding (Level 2) and Applying (Level 3)**
- CO4:** Develop proficiency in deriving shape functions and stiffness matrices for axial force elements and beam elements, including those with linear, higher-order, and Hermitian interpolation, and apply them to real-world engineering problems. **RBT Level: Analyzing (Level 4)**
- CO5:** Demonstrate the ability to develop and implement computer programs to generate stiffness matrices and analyze trusses, continuous beams, and 2D frames using programming languages, applying this knowledge to practical engineering scenarios. **RBT Level: Creating (Level 6)**

Question paper pattern:

The question paper will have ten questions; each question carries equal marks. There will be two full questions or a maximum of four sub-questions from each module. Students will have to attend five full questions from each module.

Text Books:

1. Rajasekaran.S, "Computational Structural Mechanics", PHI, New Delhi 2001.
2. Reddy.C.S, "Basic Structural Analysis", TMH, New Delhi 2001
3. Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3rd Edition, Jo Wiley and Sons, New York, 2007

Reference Books:

- Beaufait, F. W. et al.**, *Computer Methods of Structural Analysis*, Prentice Hall, 1970.
- Weaver, W. and Gere, J. H.**, *Matrix Analysis of Framed Structures*, Van Nostrand, 1980.
- Rubinstein, M. F.**, *Matrix Computer Methods of Structural Analysis*, Prentice Hall, 1966.
- Bathe, K. J.**, *Finite Element Procedures in Engineering Analysis*, PHI, New Delhi, 2006

Skill Development Activities

- Develop computer programs for analyzing trusses and continuous beams using the direct stiffness method.
- Create simulations to visualize the behavior of structures under different loading conditions.
- Conduct hands-on workshops on finite element modeling using software tools.
- Analyze real-world case studies of structural failures to understand design considerations.
- Participate in group projects to design and present earthquake-resistant structures using learned principles.

Web links

- <https://archive.nptel.ac.in/courses/105/107/105107209/>
- https://onlinecourses.nptel.ac.in/noc23_ce87/preview

CO-PO Mapping Table

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	2	1	1	1	-	-	2
CO2	3	3	2	2	3	1	1	1	-	-	3
CO3	3	3	3	3	3	2	2	2	-	2	3
CO4	3	3	3	3	3	2	2	2	2	2	3
CO5	3	2	2	3	3	2	3	3	2	2	3

Explanation of Scale:

- **3:** Strongly aligned
- **2:** Moderately aligned
- **1:** Slightly aligned
- **-:** Not aligned

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**

2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Structural Dynamics and Earthquake Resistant Design of Structures			
Subject Code	MCAS202	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:2	SEE Marks	50
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS–04			
<p>Course objectives: The objective of this syllabus is to provide students with a comprehensive understanding of dynamic analysis in civil engineering, including single and multi-degree-of-freedom systems, seismic forces, and earthquake-resistant design. It aims to equip students with practical skills in modeling, numerical methods, and structural design, using modern engineering tools and adhering to national standards, such as IS 1893, for real-world applications. Evaluate the dynamic characteristics of the structures.</p>			
Modules			
Module-1			
<p>Introduction: Introduction to dynamic problems in civil engineering, concept of degrees of freedom, D'Alembert's principle, principle of virtual displacement, and energy principles.</p> <p>Dynamics of Single-Degree-of-Freedom Systems: Mathematical models of single-degree-of-freedom systems, free vibration response of damped and undamped systems, including methods for evaluation of damping.</p>			
Teaching Learning Process			L2
Module-2			
<p>Response of Single-Degree-of-Freedom Systems to Harmonic Loading: Including support motion, vibration isolation, and transmissibility. Numerical methods applied to single-degree-of-freedom systems.</p> <p>Dynamics of Multi-Degree-of-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.</p>			
Teaching Learning Process			L3
Module-3			
<p>Approximate Methods in Dynamic Analysis: Rayleigh's method, Dunkerley's method, Stodola's method. Introduction to engineering seismology, geological and tectonic features of India, origin and propagation of seismic waves, characteristics of earthquakes and their quantification—magnitude and intensity scales, seismic instruments. The response history and strong motion characteristics. Response Spectrum—elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, and the use of response spectrum in earthquake-resistant design.</p>			
Teaching Learning Process			L3,L2
Module-4			
<p>Computation of seismic forces in multi-storied buildings: Using procedures (Equivalent Lateral Force and Dynamic Analysis) as per IS-1893. Introduction to masonry structures and design provisions for these in IS-1893. Effect of infill masonry walls on frames and modeling concepts of infill masonry walls. Concepts for earthquake-resistant masonry buildings—codal provisions.</p>			
Teaching Learning Process			L3,L4
Module-5			
<p>Design of Reinforced Concrete Buildings for Earthquake Resistance: Load Combinations. Confinement of concrete for ductility, design of columns and beams for ductility, and ductile detailing provisions as per IS 1893. Structural behavior, design, and ductile detailing of shear walls. Overview of linear and nonlinear procedures of seismic analysis. Seismic evaluation and retrofitting of structures.</p>			
Teaching Learning Process			L4, L5
<p>Course out comes: CO1: Understand the basic principles of dynamic problems in civil engineering, including degrees of freedom, D'Alembert's principle, and energy methods, and apply these to single-degree-of-freedom systems.</p>			

(Bloom's Level: Understanding - L2)

CO2: Analyze the response of single-degree-of-freedom systems to harmonic loading, including support motion, vibration isolation, and transmissibility, and apply numerical methods to solve these problems.

(Bloom's Level: Applying - L3)

CO3: Apply approximate methods such as Rayleigh's, Dunkerley's, and Stodola's methods in dynamic analysis, and understand seismic concepts, including the propagation of seismic waves, earthquake quantification, and response spectrum.

(Bloom's Level: Applying - L3, Understanding - L2)

CO4: Evaluate seismic forces in multi-storied buildings using IS 1893 standards, understand the impact of masonry infill walls on structural performance, and apply earthquake-resistant design provisions for masonry structures.

(Bloom's Level: Evaluating - L4, Applying - L3)

CO5: Design reinforced concrete buildings for earthquake resistance, incorporating load combinations, ductile detailing of beams and columns, and applying IS 1893 provisions to shear walls and retrofitting techniques.

(Bloom's Level: Creating - L5, Analyzing - L4)

Question paper pattern:

The question paper will have ten questions; each question carries equal marks. There will be two full questions and a maximum of four sub-questions from each module. Students will have to attend five full questions from each module.

Reference Books:

1. **Dynamics of Structures** – “Theory and Application to Earthquake Engineering,” 2nd ed., Anil K. Chopra, Pearson Education.
2. **Earthquake Resistant Design of Building Structures**, Vinod Hosur, WILEY (India).
3. **Vibrations, Structural Dynamics** – M. Mukhopadhaya, Oxford IBH.
4. **Structural Dynamics** – Mario Paz, CBS Publishers.
5. **Structural Dynamics** – Clough & Penzien, TMH.
6. **Vibration Problems in Engineering** – S. Timoshenko, Van Nostrand Co.
7. **Earthquake Resistant Design of Structures** – Pankaj Agarwal, Manish Shrikande, PHI India.

Web links and Video Lectures (e-Resources):

<https://www.youtube.com/watch?v=0KiYC8000iM&list=PLvVhmihvTvDbqByamCNEYw2zDBOscOHRb>https://www.youtube.com/watch?v=,Ilzo8OzoZ_c&list=RD0MjbIvZOwDdoM&start_radio=1

https://www.youtube.com/watch?v=kZFtZKzuo3I&list=PL6XkfCIV_u2Now2UXE1DCLrT06Zvg4UtS

Skill Development Activity

Modeling and Simulation:

Use MATLAB/ANSYS/SAP2000 to simulate SDOF and MDOF systems under dynamic loading.

Vibration Isolation Experiments:

Conduct lab experiments to analyze vibration isolation and transmissibility.

Numerical Methods:

Implement numerical methods (e.g., Newmark-beta) for dynamic problems using Python or MATLAB.

Seismic Analysis Case Studies:

Analyze earthquake data and structural responses using seismic response spectra.

Structural Health Monitoring and Retrofitting:

Learn NDT techniques and retrofitting methods for seismic evaluation.

Seismic Design with Software:

Use ETABS/STAAD Pro to design earthquake-resistant structures as per IS 1893.

Collaborative Project:

Work in teams to design a multi-story building with seismic considerations, integrating various skills.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	2	-	1	-	-	-	2
CO2	3	3	2	2	3	-	2	1	-	-	3
CO3	3	3	2	2	3	1	2	1	1	-	3
CO4	3	3	3	3	3	2	3	2	1	2	3
CO5	3	3	3	3	3	3	3	2	1	2	3

Explanation of Scale:

- **3:** Strongly aligned
- **2:** Moderately aligned
- **1:** Slightly aligned
- **-:** Not aligned

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Two Unit Tests each of **25 Marks**
4. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Design of Plates and shells			
Subject Code	MCAS203	CIE Marks	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS–03			
Prerequisites: Students should have fundamental knowledge of strength of materials, structural analysis, and mathematics (differential equations, calculus). Familiarity with plate and shell structures, and basic understanding of elasticity theory are also essential.			
Course objectives: This course aims to equip students with the knowledge and skills to analyze and design plate and shell structures. Students will learn various methods of analysis, including classical thin plate theory, Navier’s solution, Levy’s approach, and membrane analysis. The course will enable students to apply these concepts to real-world problems.			
Modules			
Module-1			
Bending of Plates Classification of plates and methods of analysis. Slope and curvature of slightly bent plates – curvature and twist in any arbitrary direction. Principal curvatures. Classical thin plate theory. Relation between bending moments and curvatures, principal bending moments. Differential equation for laterally loaded rectangular plates. Boundary conditions. Kirchhoff modification of boundary conditions at a free edge. Differential equation for the bending of orthotropic plates. Rectangular plates subjected to edge moments. Cylindrical bending of long rectangular plates. Structural effects due to bending of plates.			
Teaching Learning Process			L1, L2, L3
Module-2			
Simply Supported Rectangular Plates Subjected to harmonic loading, Navier’s solution for simply supported plates subjected to uniformly distributed load (UDL), hydrostatic pressure, patch load, partial UDL, and concentrated load, etc. Bending of rectangular plates subjected to UDL by Levy’s approach: (i) all edges simply supported, (ii) two opposite edges simply supported and the other two edges clamped. Bending of rectangular plates subjected to uniformly varying load (UVL): (i) all edges simply supported, (ii) two opposite edges simply supported and the other two edges clamped. Method of superposition for the analysis of rectangular plates with complex boundary conditions.			
Teaching Learning Process			L3, L4, L5
Module-3			
Symmetrical Bending of Circular Plates Differential equation for symmetrical bending of laterally loaded circular plates. A round simply supported plate subjected to uniformly distributed load (UDL) over the entire surface, a central concentrated load, and constant edge moment. A round clamped plate subjected to UDL over the entire surface and a central concentrated load. Method of superposition. Annular plate subjected to edge moments and UDL over the entire surface.			
Teaching Learning Process			L3, L4, L6
Module-4			

Analysis of Shells Shapes and forms of shells, geometry of quadric surfaces; general form, standard equation, ellipsoid, hyperboloid, elliptic cone, elliptic paraboloid, hyperbolic paraboloid, quadric cylinder, etc.; classifications of shells, membrane action, and bending action. Membrane analysis of shells of revolution: domes and conical shells.	
Teaching Learning Process	L1, L2, L3
Module-5	
Analysis of Shells (Contd...) Membrane analysis of hyperbolic paraboloid shells and membrane analysis of cylindrical shells. Lundgren's Beam theory for bending analysis of cylindrical shells.	
Teaching Learning Process	L4, L5, L6
<p>Course outcomes: On completion of this course, students are able to:</p> <p>CO1: Analyze and classify different types of plates and shells, applying appropriate theoretical frameworks and methods for their bending and structural analysis.</p> <p>CO2: Derive and solve differential equations governing the behavior of both rectangular and circular plates under various loading conditions, including uniform and concentrated loads.</p> <p>CO3: Implement advanced analytical methods, such as Navier's solution and Levy's approach, to effectively analyze simply supported plates with complex boundary conditions.</p> <p>CO4: Apply principles of membrane and bending action in the analysis of shell structures, understanding their geometric properties and structural behavior.</p> <p>CO5: Conduct comprehensive analyses of advanced shell forms, including hyperbolic paraboloids and cylindrical shells, integrating practical applications and theoretical knowledge.</p>	
<p>QP pattern: The question paper will consist of ten questions, with two full questions (each containing a maximum of four sub-questions) from each module. Each full question will address various topics covered within the respective module. Students will be required to answer five full questions, selecting one full question from each module.</p>	
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Timoshenko, S. and Woinowsky-Krieger, W., "Theory of Plates and Shells," 2nd Edition, McGraw-Hill Co., New York, 1959. 2. Ramaswamy, G. S., "Design and Construction of Concrete Shell Roofs," CBS Publishers and Distributors, New Delhi, 1986. 3. Ugural, A. C., "Stresses in Plates and Shells," 2nd Edition, McGraw-Hill, 1999. 4. Szilard, R., "Theory and Analysis of Plates: Classical and Numerical Methods," Prentice Hall, 1994. 5. Chatterjee, B. K., "Theory and Design of Concrete Shells," Chapman & Hall, New York, 3rd Edition, 1988. 	
<p>Web links and Video Lectures (e-Resources) :https://www.youtube.com/watch?v=tA_LgwTvre4&list=PLwdnzIV3ogoXOR59EK4dNDzxb5I65Jiu uhttps://www.youtube.com/watch?v=CkolEAtY6jY</p>	
<p>Skill Development Activities Suggested</p> <ol style="list-style-type: none"> 1. Plate Classification Exercise: Create a presentation or poster categorizing different types of plates based on geometrical and material properties, including applications for each type. Skills Developed: Research, classification, presentation, and visualization. 2. Differential Equation Derivation: Work in groups to derive the differential equations governing the bending of rectangular plates under various loading conditions and present findings to the class. Skills Developed: Collaborative problem-solving, critical thinking, and mathematical derivation. 3. Navier's Solution Application: 	

Solve problems related to Navier’s solution for simply supported rectangular plates under different loads (e.g., UDL, concentrated loads) and use software to visualize results.

Skills Developed: Analytical thinking, software proficiency (e.g., MATLAB, ANSYS), and problem-solving.

4. **Membrane Analysis Case Study:**

Conduct a case study on a real-world structure (like a dome or shell roof) using membrane analysis principles, analyzing its design and load-bearing capacity.

Skills Developed: Research, analytical thinking, and application of theoretical concepts to real scenarios.

5. **Hands-On Model Creation:**

Create physical or digital models of shell shapes (e.g., hyperbolic paraboloids, cylindrical shells) using materials like cardboard or 3D modeling software, assessing structural stability.

Skills Developed: Creativity, practical application of theory, spatial awareness, and engineering design.

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

5. Two Unit Tests each of **25 Marks**
6. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom’s taxonomy as per the outcome defined for the course.

Semester-End Examination:

11. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
12. The question paper will have ten full questions carrying equal marks.
13. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
14. Each full question will have a sub-question covering all the topics under a module.
15. The students will have to answer five full questions, selecting one full question from each module

Continuum Mechanics			
Subject Code	MCAS204	CIE	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites: Students should have a basic understanding of mechanics of materials, particularly stress and strain relationships, as well as an introductory knowledge of elasticity and material properties. Familiarity with fundamental concepts of equilibrium equations, boundary conditions, and basic calculus is essential. Prior exposure to structural analysis will aid in comprehending complex stress distribution, torsion, and elasticity problems.

Objectives: This course aims to provide students with a thorough understanding of stress and strain analysis in two- and three-dimensional systems. Students will learn about constitutive relations, compatibility equations, and various approaches to solving elasticity problems using Cartesian and polar coordinates. The course also covers principal stresses, torsion of different cross-sectional bars, and advanced topics such as anisotropy, failure theories, and stress functions, preparing students for complex engineering challenges.

Course Outcomes

At the end of the course the students will be able to

CO1	Comprehend the basic concepts of stress and strain at a point, compatibility equations for 2D and 3D plane stress and plane strain problems
CO2	Write stress functions for a given continuum problem using Airy's stress functions and stress polynomials, solving for stresses and displacement
CO3	Solve continuum problems in polar coordinates for stresses and displacement
CO4	Solve 3D problems in continuum for principle stresses and principle strains
CO5	Comprehend the solution of problems of torsion of non circular sections

Modules	RBT Level
Module -1	
Basic Concepts Definition of stress and strain at a point, components of stress and strain at a point, strain displacement relations in Cartesian co-ordinates, constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases, plane stress, plane strain. <i>Self-study component:</i> Students should develop the constitutive relations for anisotropic materials and for different cases of orthotropy.	L2, L3, L4, L6
Module - 2	
Two-dimensional problems in Rectangular Coordinates Airy's stress function approach to 2-D problems of elasticity. Solution by Polynomials – End Effects, Saint – Venant's Principle – solution of some simple beam problems, including working out of displacement components. <i>Self-study component:</i> Students should learn the analysis of stresses for a simply supported beam subjected to concentrated load and beams subjected to hydrostatic loads, Fourier series and forms of stress functions.	L2, L3, L4, L6
Module -3	

<p>Two - dimensional problems in Polar coordinates General equation in Polar coordinates –Strain and displacement relations, equilibrium equations - Stress distribution symmetrical about an axis – Pure bending of curved bars – Displacements for symmetrical stress distributions – The effect of a small circular hole on stress distribution in a large plate subjected to uni- axial tension and pure shear. <i>Self-study component:</i> Students shall study the concept of analysis of non-axis-symmetric problems. Boussinesq’s problem and related wedge and groove problems.</p>	L2, L3, L4, L6
Module -4	
<p>Analysis of Stress and Strain in Three Dimensions: Introduction. Stress at a point in any arbitrary direction– Principal stresses and corresponding directions – Determination of the principal stresses and principal planes. – Stress invariants – Determination of the maximum shearing stress- Octahedral stress components. Strain at a point in any arbitrary section, Principal strains and corresponding directions – strain invariants. <i>Self-study component:</i> Students should study the failure theories in a general state of stress for ductile and brittle materials.</p>	L3, L4, L5, L6
Module -5	
<p>TORSION: St. Venant’s semi-inverse method and Prandtl’s stress function Approach – Torsion of straight prismatic bars of Elliptic Cross section. Membrane analogy – Torsion of a bar of narrow rectangular cross section. Torsion of thin-walled open cross sections – Torsion of thin-walled tubes. <i>Self-study component:</i> Students should study about Torsion of multicell problems as in the case of multicell girders used in bridges and flyovers.</p>	L2, L3, L4, L6
<p>Question paper pattern: The question paper will have ten questions; each question carries equal marks. There will be two full questions and a maximum of four sub-questions from each module. Students will have to attend five full questions from each module.</p>	
<p>Text Books: 1. Timoshenko and Goodier, Theory of elasticity, McGraw Hill Book Company, III Edition,1983. 2. Valliappan. S, Continuum Mechanics fundamentals, Balkema academic and technical publications,1981</p>	
<p>Reference Books: 1. T G Sitharam& L Govindaraju, Elasticity for Engineers, IK International Publisher, New Delhi. Year2017 2. Sadhu Singh, Theory of Elasticity, Fourth Edition,KhannaPublishers,1979 3. P D S Verma, Theory of Elasticity, Sangam Books Limited,1997.</p>	
<p>Skill Development Activities Suggested: 1 Beam Deflection Analysis: Students can conduct a hands-on project analyzing the deflection of a simply supported beam under various load conditions. They can use theoretical calculations alongside physical models or simulations to compare results, enhancing their understanding of beam behavior. 2 Airy’s Stress Function Application: Organize a workshop where students apply Airy’s stress function to solve 2-D elasticity problems. They can work in groups to derive solutions using polynomial approaches and analyze stress distributions in practical scenarios. 3 Polar Coordinates Stress Distribution: Students can perform a case study on stress</p>	

distribution around a circular hole in a large plate subjected to uniaxial tension. They can utilize software tools to visualize and analyze stress fields, reinforcing their comprehension of polar coordinate problems.

4 Torsion Analysis Simulation: Develop a simulation exercise where students analyze the torsion of various cross-sectional shapes (e.g., elliptical, rectangular) using numerical methods. They can present their findings on stress distribution and the effectiveness of different geometries in resisting torsion.

5 Failure Theory Research Presentation: Students can research different failure theories applicable to ductile and brittle materials under complex stress states. They can present their findings in class, discussing real-world applications and implications for material selection in engineering design.

Web

Links:

- <https://nptel.ac.in/courses/112103167>
- <https://archive.nptel.ac.in/courses/112/103/112103296/>
- <https://archive.nptel.ac.in/courses/103/106/103106159/>
- <https://nptel.ac.in/courses/112103296>

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1:	3	2	1	1	2	1	2	1	1	1	1
CO2:	3	2	1	2	1	2	1	1	1	1	1
CO3:	2	3	1	1	1	2	1	1	1	1	1
CO4:	3	2	2	2	2	1	2	1	1	1	1
CO5:	2	2	1	1	2	1	1	1	1	1	1

Legend:

- 1 = Low
- 2 = Medium
- 3 = High

This table illustrates how each Course Outcome aligns with the Program Outcomes, showcasing the expected contributions of the COs to the overall educational objectives of the program. Let me know if you need any adjustments or additional information!

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

7. Two Unit Tests each of **25 Marks**
8. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom’s taxonomy as per the outcome defined for the course.

Semester-End Examination:

16. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
17. The question paper will have ten full questions carrying equal marks.

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

Design of Structural Systems for Bridges and Flyovers			
Subject Code	MCAS215A	CIE	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites: Students should have a foundational understanding of structural engineering principles, including the mechanics of materials, basic structural analysis techniques, and knowledge of relevant Indian Standards for construction. Familiarity with design concepts for various structural forms and the use of CAD software for analysis is also recommended.

Objectives: The course aims to provide students with a comprehensive understanding of bridge engineering, encompassing the historical context, design principles, and various structural forms of bridges. Students will learn to assess the loads acting on bridges and apply these concepts in the design of elevated bridges, underpasses, and box culverts. Additionally, the course will cover advanced topics such as finite element concepts and soil-structure interaction to prepare students for practical applications in bridge design.

Course Outcomes	
At the end of the course the students will be able to	
CO1	Comprehend and use the basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.
CO2	Develop an intuitive feeling about the sizing of bridge elements and the conceptual design part
CO3	Assess the load flow mechanism and loads on bridges.
CO4	Design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements
CO5	Design elevated bridges for given specifications. Conduct finite element analysis of bridge decks

Modules	RBT Level
Module -1	
Introduction to bridge engineering Historical background of bridges and types. Bridge aesthetics and proportioning. Bridge geometry. Conceptual design of various structural forms. Foundations with or without piles; abutments, retaining walls and wing walls; columns and cap beams; bearings. <i>Self-study component: Prepare a report on Components of bridges- A case study</i>	L1,L2
Module -2	
Loads on bridges (IRC6-2010) Class 70 R, Class AA, Class A , Class B , Tracked Vehicle, Wheeled Vehicle, Load Combinations, Impact, Wind, Water Currents, Longitudinal Forces: acceleration, braking and frictional resistance, Centrifugal forces, temperature, Seismic forces, Snow Load, Collision Loads. Load Combinations <i>Self-study component: Prepare a report on types of load referring to IS 873</i>	L2
Module -3	
Design of Elevated Bridges and flyovers Solid slab, RCC - T beam and slab, Simple and box girder, PSC Girder systems for bridges and flyovers <i>Self-study component: Collect the working drawings of any one from Solid slab, RCC - T beam and slab, box girder, PSC Girder systems for bridges and flyovers and study the same</i>	L2, L3,L4

Module -4	
<p>Design of Underpass and Box culverts Analysis and Design of Underpass and Box culverts as per the specifications of relevant Indian Standards <i>Self-study component: Collect the working drawings of Box culverts and study the same</i></p>	L3,L4
Module -5	
<p>FE Concepts: Discrete and Continuum models of Bridge Deck – Spine, Grillage, Surface models, Bridge Piers, Support and Loading conditions, Soil-Structure Interaction <i>Self-study component: Analyze the structure using CAD software</i></p>	L4, L5
<p>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.</p>	
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Krishna Raju N “Design of Bridges,” Oxford, IBH Publications New Delhi, 2006. 2. Johnson Victor, “Essential of Bridge Engineering,” Oxford, IBH Publications, New Delhi, 2000. 3. Ponnu swamy, S., “Bridge Engineering”, Tata McGraw Hill, 2008. 	
<p>Reference Books</p> <ol style="list-style-type: none"> 1. Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw - Hill Publishing Co Ltd., New Delhi, 2010. 2. IRC112 - 2011 Code of Practice for Concrete Road Bridges and Railway Board Codes 3. Jagadeesh. T.R. and Jayaram. M.A., “Design of Bridge Structures”, Prentice Hall of India, 2004. 4. Raina V.K.” Concrete Bridge Practice” Tata McGraw Hill Publishing Company, New Delhi, 1991. 5. ITK-RDSO GUIDELINES ON SEISMIC DESIGN OF RAILWAY BRIDGES- Provisions with Commentary and Explanatory Examples ,2010 	
<p>Skill Development Activities (SDA)</p> <ol style="list-style-type: none"> 1. Report Preparation: Prepare a detailed report on the components of bridges, highlighting the historical background and various structural forms. 2. Load Types Analysis: Create a report analyzing different types of loads on bridges as per IS 873, emphasizing load combinations. 3. Working Drawings Review: Collect and study working drawings of various bridge types, focusing on understanding their structural components. 4. Design Application: Analyze an underpass or box culvert by applying the relevant Indian Standards and preparing design calculations. 5. CAD Software Analysis: Use CAD software to model and analyze the structure of a bridge deck, applying finite element concepts and exploring soil-structure interactions. 	
<p>Web Links: https://archive.nptel.ac.in/courses/105/105/105105216/ https://onlinecourses.nptel.ac.in/noc22_ce63/preview https://archive.nptel.ac.in/courses/105/105/105105165/ https://archive.nptel.ac.in/courses/124/105/124105015/ https://onlinecourses.nptel.ac.in/noc22_ce73/preview</p>	

Here's the CO-PO table for the provided course outcomes (COs) and program outcomes (POs):

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	1	1	1	1	1	1	1	1	1
CO2	2	2	1	1	1	1	1	1	1	1	1
CO3	2	2	1	1	1	1	1	1	1	1	1
CO4	3	3	2	2	2	1	1	1	1	1	1
CO5	3	3	2	2	2	1	1	1	1	1	1

Key:

- **1:** Low correlation
- **2:** Moderate correlation
- **3:** High correlation

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

9. Two Unit Tests each of **25 Marks**
10. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

21. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
22. The question paper will have ten full questions carrying equal marks.
23. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
24. Each full question will have a sub-question covering all the topics under a module.
25. The students will have to answer five full questions, selecting one full question from each module

PYTHON AND ITS APPLICATION IN CIVIL ENGINEERING			
Course Code	MCAS215B	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			
Introduction Python Basics, Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program, Flow control, Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit(), Functions, def Statements with Parameters, Return Values and return Statements, The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling, A Short Program: Guess the Number.			
Teaching-Learning Process	<i>L</i> ₁ – Remembering, <i>L</i> ₂ – Understanding.		
Module-2			
The Lists, The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Example Program: Magic 8 Ball with a List, List-like Types: Strings and Tuples, References, Dictionaries and Structuring Data, The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things, Manipulating Strings, Working with Strings, Useful String Methods, Project: Password Locker, Project: Adding Bullets to Wiki Markup.			
Teaching-Learning Process	<i>L</i> ₂ – Understanding, <i>L</i> ₃ – Apply, <i>L</i> ₄ – Analyse., <i>L</i> ₅ – Evaluate		
Module-3			
Structural Pattern Matching with Regular Expressions, Finding Patterns of Text Without Regular Expressions, Finding Patterns of Text with Regular Expressions, More Pattern Matching with Regular Expressions, Greedy and Nongreedy Matching, The findall() Method, Character Classes, Making Your Own Character Classes, The Caret and Dollar Sign Characters, The Wildcard Character, Review of Regex Symbols, Case-Insensitive Matching, Substituting Strings with the sub() Method, Managing Complex Regexes, Combining re .IGNORECASE, re.DOTALL, and re.VERBOSE, Project: Phone Number and Email Address Extractor			
Teaching-Learning Process	<i>L</i> ₂ – Understanding, <i>L</i> ₃ – Apply, <i>L</i> ₄ – Analyse., <i>L</i> ₅ – Evaluate		
Module-4			
Classes and objects, Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying, Classes and functions, Time, Pure functions, Modifiers, Prototyping versus planning, Classes and methods, Object-oriented features, Printing objects, Another example, A more complicated example, The init method, The __str__ method, Operator overloading, Type-based dispatch, Polymorphism, Interface and implementation, Inheritance, Card objects, Class attributes, Comparing cards, Decks, Printing the deck, Add, remove, shuffle and sort, Inheritance, Class diagrams, Data encapsulation.			
Teaching-Learning Process	<i>L</i> ₂ – Understanding, <i>L</i> ₃ – Apply, <i>L</i> ₄ – Analyse., <i>L</i> ₅ – Evaluate		
Module-5			
Implementation of python in analysis of s/s beam, cantilever beam, fixed, pin and rigid jointed frames; RCC design; design of beams, design of slabs; one way slab and two way slab, design of continuous beams; to find out shear strength of concrete for given grade of concrete using python (Theory and numerical problems)			
Teaching-Learning Process	<i>L</i> ₂ – Understanding, <i>L</i> ₅ – Evaluate, <i>L</i> ₆ - Create		

Course outcomes:

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

Question paper pattern:

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

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

Textbook/ Textbooks

- (1) Al Sweigart, "Automate the Boring Stuff with Python", 1st Edition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at <https://automatetheboringstuff.com/>)
- (2) Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at <http://greenteapress.com/thinkpython2/thinkpython2.pdf>) (Chapters 13, 15, 16, 17, 18) (Download pdf/html files from the above links).

Reference Books

- (1) Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372
- (2) Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, O'Reilly Media, 2016. ISBN-13: 978-1491912058
- (3) Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015. ISBN-13: 978-8126556014
- (4) Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
- (5) Dr.B.C.Punmia, Ashok kumarjain,arunkumarJain,"limit state design of reinforced concrete (As per IS 456:200), 1st Edition,Laxmi Publications (P) LtD, NEW Delhi-110002

Web links and Video Lectures (e-Resources):

<https://www.youtube.com/watch?v=OmljuvEkCj0&list=PLHZy9r10iTUda2KcyDBVHdVkoMwaNjxB->

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	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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and

earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

11. Two Unit Tests each of **25 Marks**
12. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

26. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
27. The question paper will have ten full questions carrying equal marks.
28. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
29. Each full question will have a sub-question covering all the topics under a module.
30. The students will have to answer five full questions, selecting one full question from each module

Structural Stability Analysis			
Subject Code	MCAS215C	CIE	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites:

Bachelor's degree in Civil Engineering or related field, courses in Structural Analysis, Mechanics of Materials, and Mathematics (calculus, statistics), familiarity with design software.

Course Objectives:

Upon completion, students will be able to analyze beam-column structures subjected to various loads, determine critical loads for buckling of frames, beams, and plates, apply finite element approach for stability analysis, evaluate buckling behavior of rectangular plates under combined loads, and develop problem-solving skills using trigonometric series and energy methods.

Course Outcomes

At the end of the course the students will be able to

CO1	Derive the differential equations of beam column subject to different types of loads and different end conditions
CO2	Comprehend approximate calculation of critical loads for frames and continuous beams by elastic energy methods
CO3	Apply finite element method to stability analysis of structural elements
CO4	Analyze buckling of rectangular plates with various edge conditions
CO5	Comprehend to analyze buckling of rectangular plates with combined loads

Modules	RBT Level
Module -1	
<p>Beam column Differential equation of 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. <i>Self-study: Students shall develop a programme for differential equation for different loading and end conditions</i></p>	L2, L3, L4
Module -2	
<p>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 inelastic 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 non-conservative, follower and pulsating forces. <i>Self-study: Students shall prepare a report on the concept of buckling of RC structures</i></p>	L3, L4, L5
Module -3	

<p>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. <i>Self-study: Students shall refer the reference material and obtain solution for the column with different boundary conditions</i></p>	<p>L4, L5, L6</p>
<p>Module -4</p>	
<p>Buckling of simply supported rectangular plate Buckling of uniformly compressed rectangular plate simply supported along two opposite edges perpendicular to the direction of compression and having various edge condition along the other two edges- Buckling of a Rectangular Plate Simply Supported along Two opposite sides and uniformly compressed in the Direction Parallel to those sides. <i>Self-study: Students shall prepare a report on Buckling of simply supported rectangular plate</i></p>	<p>L3, L4, L5</p>
<p>Module -5</p>	
<p>Buckling of simply supported rectangular plate – Combined effects Buckling of a Simply Supported Rectangular Plate under Combined Bending and Compression – Buckling of Rectangular Plates under the Action of Shearing Stresses – Other Cases of Buckling of Rectangular Plates. <i>Self-study: Students shall refer the reference material and obtain solution for the Cases of Buckling of Rectangular Plates</i></p>	<p>L5, L6</p>
<p>Question paper pattern:</p> <ul style="list-style-type: none"> The question paper will have ten questions; each question carries equal marks. There will be two full questions and a maximum of four sub-questions from each module. Students will have to attend five full questions from each module. 	
<p>Text Books:</p> <ol style="list-style-type: none"> Stephen P. Timoshenko, James M. Gere, “Theory of Elastic Stability”, 2nd Edition, McGraw-Hill, New Delhi,1998 Zeiglar.H,” Principles of Structural Stability”, Blaisdall Publication, Waltham, Mass.(1968) Robert D Cook et al, “Concepts and Applications of Finite Element Analysis”, 3rd Edition, John Wiley and Sons, New York, 4th edition (31 October2001) 	
<p>Reference Books:</p> <ol style="list-style-type: none"> Rajashekar. S, “Computational Structural Mechanics”, Prentice-Hall, India, 1 January2001. Ray W Clough and J Penzien, “Dynamics of Structures”, 2nd Edition, McGraw-Hill, New Delhi, 2 edition (30 September1993) 	
<p>Skill Development activities Suggested:</p> <ol style="list-style-type: none"> Module 1: Beam-Column Analysis SDA: Design and analyze a simply supported beam-column structure using Euler's formulation. Module 2: Buckling of Frames and Beams SDA: Calculate critical loads for a cantilever beam using the elastic energy method. Module 3: Stability Analysis by Finite Element Approach SDA: Develop a finite element model for a pinned-pinned column and evaluate its stability. 	

4. Module 4: Buckling of Simply Supported Rectangular Plates

SDA: Analyze the buckling behavior of a rectangular plate under uniform compression.

5. Module 5: Buckling of Simply Supported Rectangular Plates - Combined Effects

SDA: Investigate the effect of combined loading on the buckling behavior of a rectangular plate.

Web Links:

<https://archive.nptel.ac.in/courses/105/105/105105217/>

https://onlinecourses.nptel.ac.in/noc22_ce91/preview

https://archive.nptel.ac.in/content/syllabus_pdf/105105217.pdf

Here's the CO-PO mapping table with Course Outcomes (COs) as rows and Program Outcomes (POs) as columns:

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1	1	1		1	1						
CO2	1		1	1	1						
CO3	1	2	2			2					
CO4	1				2		2				
CO5	1	2			2			2			

1: Low Contribution – The Course Outcome has a basic or minimal impact on the Program Outcome.

2: Moderate Contribution – The Course Outcome contributes to the Program Outcome in a meaningful way but is not central to it.

3: High Contribution – The Course Outcome is crucial and significantly supports the Program Outcome.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

13. Two Unit Tests each of **25 Marks**

14. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

31. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

32. The question paper will have ten full questions carrying equal marks.

33. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

34. Each full question will have a sub-question covering all the topics under a module.

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

GEOTECHNICAL EARTHQUAKE ENGINEERING			
Subject Code	MCAS215D	CIE	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE	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, <ul style="list-style-type: none"> • 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 techniques. 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 each module.

Reference Books:

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

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

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

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

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

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

7. Seismic Design of Reinforced Concrete and Masonry Buildings, T Paulay and M 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=PLbMVogVj5nJRNzx4KtSTVj7qr90xwY31F>

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	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

15. Two Unit Tests each of **25 Marks**

16. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

36. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

37. The question paper will have ten full questions carrying equal marks.

38. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

39. Each full question will have a sub-question covering all the topics under a module.

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

Advanced Mechanics of Materials			
Subject Code	MCAS216A	CIE	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE	50
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites: Students should have a foundational understanding of mechanics of materials, including concepts of stress, strain, and basic beam theory. Familiarity with structural analysis and material properties is essential. Previous exposure to topics such as bending moments, shear forces, and basic structural behavior will help in comprehending the complexities of non-symmetrical bending and curved beams.

Objectives: The objectives of this syllabus are to equip students with a comprehensive understanding of various structural mechanics concepts, including non-symmetrical bending in straight beams and shear center analysis for thin-walled sections. Students will learn to apply the method of tension coefficients for three-dimensional structures, analyze curved beams and their stresses, and investigate the behavior of beams on elastic foundations. Additionally, the syllabus aims to provide insight into structures subjected to out-of-plane loading, enhancing problem-solving skills in real-world applications.

Course Outcomes At the end of the course the students will be able to	
CO1	Locate the shear center for thin-walled beam cross sections in bending, shear flow in thin-walled beams for singly symmetric and unsymmetrical sections. Learn the non-symmetrical bending of straight beams and determine its deflection
CO2	Learn the method of tension coefficients for the analysis of space frames
CO3	Comprehend the behaviour of a curved beam of different types subject to different loadings
CO4	Analyse beams on elastic foundation subject to different loadings with different boundary conditions
CO5	Analyse structures subjected to out of plane loading

Modules	RBT Level
Module -1	
<p>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.</p> <p>Shear Center for Thin-Walled Beam Cross Sections: Definition of shear center in bending. Approximations employed for shear in thin-walled beam cross sections, Shear flow in thin-walled beam cross sections, Shear center for singly symmetric and unsymmetrical sections.</p> <p><i>Self-study component:</i> Students should observe different structural sections and visualize the position of shear centre in each case and planning to transfer loads through the shear centre. They should go around the campus and observe steel and RC structures to identify situations of non-symmetric bending.</p>	L2, L3, L4, L6
Module -2	
<p>Method of Tension Coefficients for analysis of 3D Structures General principles, Analysis of three-dimensional trusses and frames.</p> <p><i>Self-study component:</i> Students should visualize different constraint possibilities at the supports. Also identify how internal instability is balanced by additional constraints.</p>	L2, L3, L4
Module -3	

<p>Curved Beams: Introduction, Circumferential stress in a curved beam, Radial stresses in curved 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 concentrated loads. <i>Self-study component: Students should study the analysis of statically indeterminate curved beams such as closed rings or links of chains used in heavy machinery.</i></p>	L2, L3, L4, L5
Module -4	
<p>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. <i>Self-study component: Analysis of finite beams on elastic foundation subjected to different loads, Identify beams on elastic foundation in the field.</i></p>	L2, L3, L4, L5
Module -5	
<p>Structures subjected to out of plane loading: Analysis of simple bents, frames, grids. Beams circular in plan – Cantilever circular beams, semicircular continuous beams with three equally spaced supports, Semicircular fixed beam, ring beams with different number of equally spaced supports. <i>Self-study component: Analysis of rectilinear brackets of non-rectangular and circular plan form, Analysis of non-semicircular curved beams.</i></p>	L2, L3, L4, L5
<p>Question paper pattern: The question paper will have ten questions; each question carries equal marks. There will be two full questions and a maximum of four sub-questions from each module. Students will have to attend five full questions from each module.</p>	
<p>Text Books:</p> <ol style="list-style-type: none"> 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. Timoshenko: "Advanced Mechanics of Materials", Second Edition, CBS Publishers, New Delhi, 2000. 	
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw - Hill Publishing Co Ltd., New Delhi, 2010. 2. Ugural. A.C. and Fenster. S. K "Advanced Strength of material and Applied Elasticity", Arnold Publishers, 1981. 3. Junnarkar. S.B., "Mechanics of Structures", Volume - III, Charotar Publications, Anand, 2015. 4. R.T. Fenner, Engineering elasticity – R.T. Fenner, 1986. 	

Skill Development Activities Suggested:

- **Bending Analysis Project:** Students can create physical models of beams subjected to non-symmetrical bending and measure deflections to compare with theoretical calculations.
- **Shear Center Visualization:** Organize a workshop where students use CAD software to visualize shear centers in various thin-walled beam cross-sections and analyze their effects on structural integrity.
- **3D Structural Analysis:** Conduct a group activity where students analyze a real-world three-dimensional truss system using the method of tension coefficients, identifying constraints and internal stability.
- **Curved Beam Study:** Students can research and present case studies on the applications of curved beams in engineering structures, including load distribution and stress analysis.
- **Field Analysis of Elastic Foundations:** Organize field visits to observe and analyze structures built on elastic foundations, where students will collect data on real-world loading conditions and perform theoretical analyses.

Web Links

<https://archive.nptel.ac.in/courses/112/101/112101095/>

https://onlinecourses.nptel.ac.in/noc22_ce54/preview

<https://archive.nptel.ac.in/courses/105/106/105106049/>

<https://archive.nptel.ac.in/content/storage2/courses/105106049/lecnotes/main.html>

Here's the updated CO-PO mapping table with priority levels indicated for each Course Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	1	1	1	1	1	2	2	2	2
CO2	1	1	1	1	1	1	1	2	2	2	2
CO3	1	1	1	1	1	1	1	2	2	2	2
CO4	1	1	1	1	1	1	1	2	2	2	2
CO5	1	1	1	1	1	1	1	2	2	2	2

Priority Levels:

- **1:** High priority
- **2:** Medium priority
- **3:** Low priority

This indicates that all Course Outcomes are of high priority with respect to the Program Outcomes, while the overall alignment with PO8, PO9, PO10, and PO11 is of medium priority.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

17. Two Unit Tests each of **25 Marks**

@#\$ 18. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

41. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
42. The question paper will have ten full questions carrying equal marks.
43. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
44. Each full question will have a sub-question covering all the topics under a module.
45. The students will have to answer five full questions, selecting one full question from each module

GEOTECHNICAL ASPECTS OF FOUNDATIONS AND EARTH RETAINING STRUCTURES			
Subject Code	MCAS216B	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, <ul style="list-style-type: none"> • 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 soil 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 each module.

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=lsYFtwwlHlw&list=PLbRMhDVUMngeiZjKPTPEF11CByXmYX3Kv>

<https://www.youtube.com/watch?v=LIAAhaeeA8Q>

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	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

19. Two Unit Tests each of **25 Marks**
20. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the

outcome defined for the course.

Semester-End Examination:

46. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
47. The question paper will have ten full questions carrying equal marks.
48. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
49. Each full question will have a sub-question covering all the topics under a module.
50. The students will have to answer five full questions, selecting one full question from each module

APPLICATIONS OF IOT IN CIVIL ENGINEERING			
Course Code	MCAS216C	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			
Internet of Things, promises, definition, scope, sensors for IoT applications, structure of IoT, IoT Map device Industry Sensors: Definitions and Characteristics of first-generation sensors, advanced generation sensors, Integrated IoT sensors, Polytronics systems, Sensor Swarm, Printed Electronics and IoT generation Road Map			
Teaching-Learning Process	<i>L₁ – Remembering, L₂ – Understanding. L₃ – Apply, L₄ – Analyse.,</i>		
Module-2			
Basics of Networking, Communication Protocols, Sensor Networks, Machine to Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.			
Teaching-Learning Process	<i>L₁ – Remembering, L₂ – Understanding. L₃ – Apply, L₄ – Analyse.,</i>		
Module-3			
Internet of Things devices and sensors for collecting job site data, construction crew management, construction equipment management, IoT adoption to enhance productivity, maintenance, safety and security in construction industry.			
Teaching-Learning Process	<i>L₁ – Remembering, L₂ – Understanding. L₃ – Apply, L₄ – Analyse.,</i>		
Module-4			
Structural health monitoring using Internet of Things and Microelectromechanical systems (MEMS) – introduction to MEMS, wireless sensor networks, smart sensors.			
Teaching-Learning Process	<i>L₁ – Remembering, L₂ – Understanding. L₃ – Apply</i>		
Module-5			
Piezo sensors, Piezo generators & IoT, case studies of IoT & MEMS application in civil infrastructure projects.			
Teaching-Learning Process	<i>L₁ – Remembering, L₂ – Understanding. L₃ – Apply</i>		
Course outcomes:			
At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. Understand the basics of IoT, types of sensors & devices used. 2. Understand the basics of networking for M2M communications & programming 3. Interpret the adoption of IoT in various civil engineering activities 			
Question paper pattern:			
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.			
<ul style="list-style-type: none"> • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. 			

Reference Books

- (1) AshwinPajankar, Internet of Things with Arduino and Bolt, BPB Publications (2018)
- (2) Krishnan Saravanan, Implementation and Deployment of IoT Projects in Smart Cities, IGI Global Publications (2020)
- (3) Qusay F Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-IEEE Press (2018)
- (4) ICCCB E 2020, Proceedings of the 18th International Conference on Computing in Civil and Building Engineering, Springer (2020)

Web links and Video Lectures (e-Resources):

<https://www.youtube.com/watch?v=se9Shdi1ij0>

<https://www.youtube.com/watch?v=6TvOu5uGVdc>

<https://www.youtube.com/watch?v=4zgeit61Ozs>

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	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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

21. Two Unit Tests each of **25 Marks**
22. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

51. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
52. The question paper will have ten full questions carrying equal marks.
53. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
54. Each full question will have a sub-question covering all the topics under a module.
55. The students will have to answer five full questions, selecting one full question from each module

Reliability Analysis and Reliability Based Design of Structures			
Subject Code	MCAS216D	CIE Marks	50
Number of Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40	Total Marks	100
Credits	03	ExamHours	03
<p>Pre requisite: To effectively engage with the course on Reliability Analysis and its Based Design of Structures, students should possess a foundational understanding of structural engineering principles and concepts. It is essential for students to have prior knowledge in basic statistics, including probability distributions and statistical parameters, as well as experience in structural analysis methods. Familiarity with concepts such as load types, structural materials, and the fundamental principles of design will also facilitate a deeper comprehension of the advanced topics covered in this course. Additionally, skills in using engineering software for simulations and analyses will be beneficial for practical applications.</p>			
<p>Objectives: The primary objective of this course is to equip students with the necessary knowledge and skills to analyze and design structures with a focus on reliability and safety. By the end of the course, students will be able to apply statistical techniques to assess variability in structural elements, determine appropriate safety formats for failure surfaces, and utilize regression and correlation methods to analyze relationships between variables. Furthermore, students will gain proficiency in reliability-based design principles, including the calculation of partial safety factors and the use of simulation techniques to derive statistics for design variables. Overall, the course aims to prepare students to make informed decisions in structural engineering that prioritize safety, efficiency, and integrity.</p>			
Course Outcomes			
<p>CO1: Comprehend the concepts and techniques of reliability and probability distributions. CO2: Define the safety format for failure surfaces for given actions and responses, along with their statistics. CO3: Learn the statistical regression and correlation of two variables. CO4: Determine the partial safety factors for a target reliability index. CO5: Use simulation techniques to derive the statistics of design variables.</p>			
Module			
Module-1			
Concept of Variability			
<ul style="list-style-type: none"> • Applications of statistical principles to deal with randomness in basic variables. • Statistical parameters and their significance. • Description of various probability distributions: Binomial, Poisson, Normal, Log-Normal, Beta, and Gamma distributions. <p>Testing the goodness of fit of distributions to actual data using the Chi-Square method and the Kolmogorov-Smirnov (K.S.) method.</p>			
Teaching-Learning Process		L ₂ - Understanding, L ₃ -Apply, L ₄ -Analyse	
Module-2			
Statistical Regression and Correlation			
<ul style="list-style-type: none"> • Least squares and Chi-Square methods. • Operations on one random variable, expectation, and multiple random variables. • Reliability distributions and basic formulations. 			
Teaching-Learning Process		L ₂ - Understanding, L ₃ -Apply	
Module-3			
Statistical Quality Control in Civil Engineering			
<ul style="list-style-type: none"> • Sampling for quality control: Characteristic strength and characteristic load. • Probability modeling of strength, geometrical dimensions, material properties, and loading. • Statistical inference problems: Comparison of various acceptance and rejection testing. 			
Teaching-Learning Process		L ₃ -Apply L ₅ - Evaluate	
Module-4			
Safety Assessment of Structures			
<ul style="list-style-type: none"> • Reliability analysis using I, II, and III order reliability formats. • Mean value method and its applications in structural designs. 			
Teaching-Learning Process		L ₃ -Apply L ₅ - Evaluate	
Module-5			

Reliability of Structural Elements	
<ul style="list-style-type: none"> Simulation techniques: Monte Carlo method and its applications. Reliability index and reliability formulation in various limit states. Reliability-based design: Application to the design of reinforced concrete (RC), prestressed concrete (PSC), and steel structural elements under the Load and Resistance Factor Design (LRFD) concept. 	
Teaching-Learning Process	L ₂ - Understanding, L ₃ -Apply
Question paper pattern:	
<ul style="list-style-type: none"> The examination will consist of 10 questions, with 2 full questions (each having up to 4 sub-questions) drawn from each of the 5 modules, ensuring comprehensive coverage of all topics. Students are required to answer 5 full questions, selecting one from each module, demonstrating their understanding of the subject matter across all areas of study. 	
Textbooks:	
<ol style="list-style-type: none"> Ang, A.H.S., and Tang, W.H. <i>Probability Concepts in Engineering Planning and Design</i>, John Wiley & Sons, New York, Vol. I and II, First Edition (January 1, 1984). Ranganathan, R. <i>Reliability Analysis and Design of Structures</i>, Tata McGraw-Hill Publishing Co. Ltd., New Delhi (2008). 	
Reference Books:	
<ol style="list-style-type: none"> Sancheti, D.C., and Kapoor, V.K. <i>Statistics: Theory, Methods & Applications</i> (1996). Devaraj, V., and Ravindra, R. <i>Reliability-Based Analysis and Design for Civil Engineers</i>, IK International Publishing House Pvt. Ltd. (December 30, 2017). 	
Web Link: https://archive.nptel.ac.in/courses/105/103/105103140/ https://archive.nptel.ac.in/courses/105/105/105105209/ https://onlinecourses.nptel.ac.in/noc21_ce58/preview	
Skill Development Activities Suggested	
<ol style="list-style-type: none"> Workshops on Software Tools: Conduct hands-on workshops using reliability analysis software (e.g., MATLAB, R) to perform simulations and analyses. Case Studies and Group Projects: Analyze real-life structural failures in groups, focusing on reliability assessments and safety factor calculations. Guest Lectures and Seminars: Invite industry experts for lectures on reliability-based design and host student seminars to present findings. Statistical Data Analysis Exercises: Practice statistical methods (e.g., regression, correlation) with civil engineering data sets to enhance data interpretation skills. Field Visits and Research Projects: Arrange site visits to observe practical applications of reliability analysis and initiate research projects on innovative techniques. 	

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				
CO5	X	X									X

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

23. Two Unit Tests each of **25 Marks**

24. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

56. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
57. The question paper will have ten full questions carrying equal marks.
58. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
59. Each full question will have a sub-question covering all the topics under a module.
60. The students will have to answer five full questions, selecting one full question from each module

COMPUTATION LABORATORY –II			
Course Code	MCASL207	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	1:2:0	SEE Marks	50
Total Teaching Hours	10 to 12 lab sessions	Total Marks	100
Credits	02	Exam Hours	03
Note: Students are suggested to execute any 8 below mentioned programs.			
Sl.NO	Programs	RBT levels	
1	Analysis and Design of RCC beam and column elements using MATLAB/Python	L4, L5	
2	Analysis of Simple Multi storey RCC Structure using FEA Package	L4, L5	
3	Analysis and Design of RCC slabs for different end conditions using MATLAB/Python	L4, L5	
4	Structural Analysis of 2D beams with different loading and support conditions by using MATLAB/Python	L4, L5	
5	Analysis of STEEL beam elements using MATLAB/Python	L4, L5	
6	Analysis of STEEL column elements using MATLAB/Python	L4, L5	
7	Analysis of cold formed STEEL sections for different load conditions using MATLAB/Python	L4, L5	
8	Analysis of unidirectional fiber reinforced composite materials by using MATLAB/Python to compute parameters of rule of mixture and engineering constants.	L4, L5	
9	Analysis of unidirectional fiber reinforced composite materials by using MATLAB/Python to compute compliance matrix, stiffness matrix and other related parameters.	L4, L5	
10	Analysis of unidirectional fiber reinforced composite materials by using MATLAB/Python to compute A-B-D matrix.	L4, L5	
Course outcomes:			
At the end of the course the student will be able to:			
<ol style="list-style-type: none"> 1. Carry out structural analysis of RC elements 2. Analysis of beams for different loading and support conditions. 			

Web links and Video Lectures (e-Resources):
Skill Development Activities Suggested
<ul style="list-style-type: none"> • 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	X
CO2	X	X	X	X	X			X	X	X	X

Skill and Ability enhancement courses for PG Level Civil Engineering courses

Course Code	MCAS258	CIE Marks	50
Credits	01	SEE Marks	50

Preamble

The Ability Enhancement and Skill Development Course at the postgraduate level is designed to strengthen students' core competencies and equip them with essential skills for academic and professional advancement. This course focuses on developing critical thinking, academic writing, research methodology, digital literacy, communication, and ethical reasoning to support advanced learning and scholarly engagement. It also emphasizes skill development in areas such as problem-solving, data analysis, entrepreneurship, project management, and the use of discipline-specific tools and technologies. Aligned with the objectives of the National Education Policy (NEP) 2020, the course aims to enhance employability, innovation capacity, and leadership qualities among postgraduate students.

Procedure to take up Skill and Ability enhancement courses for PG Level Civil Engineering courses

Students may opt the subjects from NPTEL (National Programme on Technology Enhanced Learning) online course list and VTU online courses offered during the current semester, subject to the approval of the Department and as per university regulations. The selected course must be relevant to the student's postgraduate program, contribute to academic or professional development, and not duplicate content already covered in the core curriculum. A NPTEL or VTU online course in the semester may be permitted for credit transfer or academic enrichment, provided the course includes assessments such as assignments and proctored examinations. Students must submit their course selection for departmental approval within the first two weeks of the semester. Successful completion of the course, including passing the final certification exam (online) will be required for academic credit or consideration under skill enhancement components.

Some of the Generalized Subjects but not limited for Skill Development Courses (SDC) and Ability Enhancement Courses (AEC)

- Environmental Data Analysis and Simulation Tools
- Disaster Risk Reduction and Management in Infrastructure
- Smart Infrastructure and IoT Applications in Civil Engineering
- Legal Aspects, Contracts, and Arbitration in Construction
- Technical Communication and Scientific Writing for Engineers
- Entrepreneurship and Innovation in Civil Engineering
- Project Formulation and Proposal Writing
- Digital Literacy and Software Tools for Engineering Research
- Intellectual Property Rights and Patent Drafting
- Leadership and Team Management in Engineering Contexts
- Other skill enhancement courses suggested by the respective programs

PROGRAM OUTCOMES

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

PO1	Graduates of the program will be able to demonstrate in-depth knowledge of Structural Engineering discipline and build capability to apply that knowledge to real problems.
PO2	Program graduates will gain knowledge and skill in integrating Structural engineering concepts across multiple disciplines.
PO3	Graduates will have the ability to employ technical knowledge and leadership skills to Structural Engineering research and consultancy problems.
PO4	Graduates of the Structural Engineering program will demonstrate the ability to carry out original and useful research in key areas of Structural Engineering.
PO5	Program graduates will be able to identify and analyze the impact of Structural Engineering in development project and find a suitable solution from number of alternatives.
PO6	Graduates of the program will develop skills to communicate technical values of Structural Engineering research with the public, learners, practitioners and other community members of concern.
PO7	Program graduates will develop confidence in Structural analysis and management with high ethical value towards social, environmental and economic issues.
PO8	Graduates will develop enthusiasm and confidence to pursue lifelong learning for professional advancement.
PO9	Program graduates will develop the spirit of working in team for common objectives.
PO10	Graduates of the program will develop interest to pursue higher studies and research.
PO11	Graduates of the program will develop interest to use Modern Engineering and IT tools for further studies and problem solving.