COURSE STRUCTURE AND SYLLABI

M.Tech in Structural Engineering

2025-26 Batch

Centurion UNIVERSITY

Shaping Lives...
Empowering Communities...

SCHOOL OF ENGINEERING AND TECHNOLOGY
CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT
Odisha-761211, India

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CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT, ODISHA

CERTIFICATE

Centurion UNIVERSITY
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This is to certify that the syllabus of the Programme M.Tech in Structural Engineering of the School of Engineering and Technology is approved in the 15th Academic Council Meeting held on 22nd November 2025.

Dean
School of Engineering and Technology,
CUTM, Odisha

Pro-Vice Chancellor
CUTM, Odisha

Centurion University of Technology and Management, Odisha

Course Structure & Syllabus

M. Tech in Structural Engineering

2-Years Programme

School of Engineering & Technology

2025-2026

Index

Programme Objectives: At the end of the program, students will be able to;

PO	Outcomes
PO1	Engineering knowledge: Apply knowledge of mathematics, science, Engineering fundamentals, and civil engineering to the solution of engineering problems
PO2	Problem analysis: Identify, formulate, review literature and analyze civil engineering problems to design, conduct experiments, analyze data and interpret data
PO3	Design /development of solutions: Design solution for civil engineering problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in civil engineering
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and tools including prediction and modelling to civil engineering activities with an understanding of the limitations
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to civil engineering practice
PO7	Environment and sustainability: Understand the impact of the civil engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the civil engineering practice
PO9	Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in civil engineering
PO10	Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in civil engineering
PO11	Project Management and finance: Demonstrate knowledge & understanding of the civil engineering principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in civil engineering
PO12	Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in civil engineering

PEOs/PSOs

Programme Educational Objectives (PEOs):

PEO1: Provide an education that incorporates recent advancements in transportation engineering, including emerging mobility technologies, smart transportation systems, and sustainable infrastructure development.

PEO2: Develop transportation engineers with the analytical capability, flexibility, and technical understanding required to evaluate and manage transportation systems under varying traffic, geometric, environmental, and operational conditions**.**

PEO3: Provide comprehensive knowledge in modern transportation planning, traffic engineering, highway design, pavement materials, and intelligent transportation systems through advanced analytical tools, simulation techniques, and field-based learning**.**

Programme Specific Outcomes (PSOs):

PSO1: Gain technical expertise in the field of civil engineering as well as fundamental knowledge in science and engineering to solve complicated issues by conducting advanced research and development work in the field of civil engineering.

PSO2: To study practical engineering issues and create applications in the field of civil engineering, by using contemporary engineering software tools.

PSO3: Acquire proficiency in effective verbal as well as written communication to collaborating within a team, and cultivating a sense of accountability within specified timelines, all while upholding professional ethics and acknowledging the significance of ongoing learning.

Course Outcomes Attributes

Course Outcomes	**Attributes**
CO1	Knowledge
CO2	Analytical skill and Critical Thinking
CO3	Problem Solving and Decision taking ability
CO4	Use of Tool, Design and Development (Hands-on/Technical skill)
CO5	Research

Master of Technology(M.Tech in Structure)	
Programme Structure – Post-Graduate Study	
Type of Course	**2 Years**
Major (Core) Courses	**34**
Elective Core/ Domain	**6**
Skill + AEC	**4**
Internship	**2**
Research Project	**34**
TOTAL	**80**

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Course Structure

Structural Engineering

SEMESTER - I					
Sl No	**Code**	**Subject name**	**Credits**	**T+P+J**	**NcRF Level**
1	CUTM2383	Advanced Structural Analysis	3	3+0+0	6.5
2	CUTM2384	Structural Dynamics	3	3+0+0	6.5
3	CUTM2385	Theory of Elasticity & Plasticity	3	3+0+0	6.5
4	CUTM2386	Architectural Design	4	0+2+2	6.5
5	CUTM2387	Bridge Engineering	3	3+0+0	6.5
6	MTSE1106	Computer Graphics	2	0+2+0	6.5
7	CUTM2400	Term Paper	2	0+0+2	6.5
TOTAL			**21**		
SEMESTER - II					
1	CUTM2388	Finite Element Method	4	3+1+0	6.5
2		Elective-1	3		6.5
3	CUTM2378	Research Methodology & IPR	4	2+0+2	6.5
4		Elective-2	3		6.5
5	CUTM2389	Structural Engineering Lab	3	0+0+3	6.5
6	CUTM4441	3D Modelling using ANSYS and CATIA	4	0+2+2	6.5
7		SKILL	4	0+2+2	6.5
		TOTAL	**23**		
SEMESTER - III					
1	CUTM4442	Internship	2	0+0+2	7
2	CUTM4443	Dissertation Part-I	16	0+0+16	7
		TOTAL	**18**		
SEMESTER - IV					
1	CUTM444	Dissertation Part-I	18	0+0+18	7
		TOTAL	**18**		

Electives

Sl No.	**Code**	**Electives (1 & 2, choose any two)**	**Credits**	**T+P+J**	**NcRF Level**
1	CUTM2393	Design of Prefabricated Structures	3	2+1+0	6.5
2	CUTM2394	Renovation and retrofitting of green structures	3	2+1+0	6.5
3	CUTM2395	Advanced Construction Materials	3	2+1+0	6.5
4	CUTM2396	Soil Dynamics and Geotechnical Earthquake Engineering	3	2+1+0	6.5

Advanced Structural Analysis (45 Hours)

Course	Code	T-P-Pr	Credit
Advanced Structural Analysis	CUTM2383	3-0-0	3

Course Objectives:

- To develop an understanding of structural analysis theory necessary to be a judicious and effective user of computer analysis.
- To introduce students to advanced analytical techniques used in structural analysis.
- To develop students' abilities to analyse and design complex structural systems.

Course Outcome: At the end of the program, students will be able to**;**

- **CO1**: Understand advanced concepts in structural analysis including but not limited to statically indeterminate structures, matrix methods, and energy methods.
- **CO2**: Apply matrix analysis techniques to solve complex structural problems involving beams, frames, and trusses.
- **CO3:** Analyze statically indeterminate structures using force method, displacement method, and slope-deflection method
- **CO4**: Utilize energy methods such as the principle of virtual work and Castigliano's theorem to analyze structures subjected to various loading conditions.
- **CO5:** Develop proficiency in computer-based structural analysis tools such as finite element analysis (FEA) software

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3											3		
CO3			2												
CO4				3											
CO5					2										

***High-3, Medium-2, Low-1**

Course Outline

Module -1: Introduction (9 Hours)

Theory

Equilibrium condition, Compatibility condition, Static and Kinematic indeterminacy, Concepts of virtual work and minimum potential energy, Force method and displacement methods of analysis, Stiffness and Flexibility matrix method, Development of element flexibility and element stiffness matrices for truss, beam and grid elements.

Module -2 : Application of flexibility matrix method (9 Hours)

Theory

Force transformation matrix using Flexibility method, Analysis of continuous beams, plane trusses and rigid plane frames without and with support settlement by flexibility method (having not more than 3 coordinates – 3x3 flexibility matrix.

Module -3: Application of stiffness matrix method (9 Hours)

Theory

Displacement transformation matrix using Stiffness Method, Analysis of continuous beams, plane trusses and rigid plane frames without and with support settlement by stiffness method (having not more than 3 coordinates – 3x3 stiffness matrix).

Module -4: Computer implementation of stiffness method (9 Hours)

Theory

Basic concept, Solution techniques: Solution techniques including numerical problems for simultaneous equations, Gauss elimination and Cholesky method. Bandwidth considerations, Introduction to static condensation and sub-structuring.

Module -5: Plastic Analysis of Structures (9 Hours)

Theory

Plastic moment of resistance, Plastic Modulus, Shape factor, Load factor, Plastic Hinge and mechanism, Analysis of indeterminate beams and frames mechanism method, upper and lower bound theorems.

Text Books:

- Pandit, G. S., Gupta, S. P., “Structural Analysis, A Matrix Approach”, 2nd Edition, Tata McGraw-Hill Education, 2010.
- H. C. Martin," Introduction to Matrix Methods of Structural Analysis, McGraw-Hill
- M. B. Kanchi, "Matrix Methods of Structural Analysis", New Age International Publishers, New Delhi

Reference Books:

- Matrix Analysis of Frames & Structures, James M Gere & William Weaver, CBS Publisher.

Structural Dynamics (45 Hours)

Course	Code	T-P-Pr	Credit
Structural Dynamics	CUTM2384	3-0-0	3

Course Objectives:

- To introduce students to the fundamental concepts and principles of structural dynamics.
- To enable the students to identify, formulate and solve engineering problems related to single degree, multi-degree and continuous systems subjected to dynamic loads
- To familiarize students with various techniques for dynamic analysis of structures.

Course Outcomes: At the end of the program, students will be able to;

- **CO1** Understand the fundamental principles of structural dynamics, including the concepts of mass, stiffness, and damping.
- **CO2** Analyse single-degree-of-freedom (SDOF) systems subjected to various types of dynamic loading, including harmonic, transient, and random excitations.
- **CO3** Proficiency in using software and tools, such as finite element analysis software as well as skill to design as per needs and specifications when subjected to dynamic loads
- **CO4** Apply numerical methods such as finite element analysis (FEA) and numerical integration techniques for solving dynamic structural problems on Random vibration.
- **CO5** Understand the effects of damping, frequency, and mode shapes on the dynamic response of structures.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	3												
CO3					2									3	
CO4				3											
CO5	2														

***High-3, Medium-2, Low-1**

Course Syllabus

Module -1: Fundamentals (9 Hours)

Theory

Oscillatory motion; Harmonic motion; Periodic motion; Vibration terminologies; Equation of motion; Damped and undamped free vibration; Response to harmonic and periodic loads.

Module-2: Single degree and multi-degrees of freedom system (9 Hours)

Theory

Response to impulse load using Duhamel's integral for single degree of freedom system. Numerical Solution to Response using Newmark Method and Wilson Method, vibrating measuring instruments. Equation of motion, Free vibration analysis, Dynamic response and modal analysis

Module 3: Free and Forced vibration of distributed mass system (9 Hours)

Theory

Vibration of strings; Longitudinal and torsional vibration of rods; Flexural vibration of beams; Evaluation of natural frequencies and mode shapes of uniform beams for different end conditions; Raleigh's principle

Module 4: Concepts related to Random vibrations (9 Hours)

Theory

Dynamic Effects of Wind Load, Moving Loads and Vibrations caused by Traffic. Random phenomena; Time averaging and expected value; Frequency response function.

Module 5: Analysis of structural response to Earthquake (9 Hours)

Seismological background, Deterministic analysis of earthquake.

Text Books:

- Dynamics of Structures: Theory and Applications to Earthquake Engineering, A K Chopra, Prentice Hall of India
- Structural Dynamics, M Mukhopadhyay: Ane Books Pvt Ltd, New Delhi

Reference Books:

- Structural Dynamics - Theory and Computation, M. Paz, Van Nostrand,1985.
- Dynamics of structures, W. Clough and J Penzien, McGraw-Hill, Inc,
- Theory of Vibration with application, W. T. Thomson.

Theory of Elasticity & Plasticity (45 Hours)

Course	Code	T-P-Pr	Credit
Theory of Elasticity & Plasticity	CUTM2385	3-0-0	3

Course Objectives:

- To introduce students to the fundamental concepts and principles of elasticity.
- To provide the students with basic knowledge of Elasticity, Plasticity and application of the concepts of stress and strain in Cartesian Coordinates.
- To analyse and calculate stress and strain in structures subjected to various loading conditions.

Course Outcomes: At the end of the program, students will be able to;

- **CO1** Understand the concepts of stress, strain, and deformation in elastic and plastic materials.
- **CO2** Analyze the behavior of materials under various loading conditions using the principles of linear elasticity.
- **CO3** Apply mathematical techniques such as tensor analysis and variational methods to solve elasticity problems.
- **CO4** Understand the concepts of yield criteria and plastic deformation in materials.
- **CO5** Analyze the plastic behavior of materials using theories such as von Mises criterion and Tresca criterion.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3					2										
CO4	3												2		
CO5		2													

*High-3, Medium-2, Low-1

Course Syllabus

Module-1: Stress and strain (9 Hours)

Theory

Concept of stress at a point; stress tensor; stress on inclined plane; stress components on a three-dimensional rectangular parallelepiped in Cartesian coordinate system; derivation of stress equilibrium equations; transformation of stresses; stress invariants. The state of strain at a point, strain displacement relations, strain compatibility condition and stress compatibility conditions.

Module-2: Stress-Strain Relationship (9 Hours)

Theory

Generalized Hooke's law for Isotropic, Orthotropic, Transversely Isotropic materials, plane stress and plane strain problems; Problems in 2D Cartesian coordinate system, Airy's stress function, Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams.

Module-3: Polar Coordinate System (9 Hours)

Theory

Relationship between Cartesian and Polar coordinate system, Equilibrium equations, Strain displacement relations, Stress-strain relationship, Strain-displacement relationship for plane stress and plane strain conditions, Bending of curved bar.

Module 1: Elementary problems of elasticity in three dimensions (9 Hours)

Theory

Stretching of a prismatic bar by its own weight, torsion of circular and non-circular sections.

Module-5: Plastic behaviour and Failure theories (9 Hours)

Theory

Stress – strain diagram in simple tension, perfectly elastic, Rigid – Perfectly plastic, Elastic Perfectly plastic materials. Failure theories, yield conditions, stress – space representation of yield criteria through Westergaard stress space, Tresca and Von-Mises criteria of yielding.

Text Books:

1. "Theory of Elasticity" by S.P. Timoshenko & J. N. Goodier, 3rd Edition, McGrawHill
2. "Advanced Mechanics of Solids" by L.S. Srinath, 2nd Edition, Tata McGraw Hill, 2008,
3. "Theory of Elasticity" by Sadhu Singh, 4th Edition, Khanna Publishers, 2007,
4. "Plasticity for Engineers" by C.R. Calladine, Ellis Horwood, Chichester, U.K., 1985

Reference Books:

1. M. Kachanov, "Theory of Plasticity", MIR Publication
2. Computational Elasticity – M Ameen, Narosa Publishing House.
3. Theory of Plasticity – J Chakrabarty, Elsevier Butterworth-Heinemann

Architectural Design (0-2-2) (60 Hours)

Course	Code	T-P-Pr	Credit
Architectural Design	CUTM2386	0-2-2	4

Course Objectives:

- Prepare students for successful engineering or management careers in the architecture, engineering, and construction (AEC) industry or related fields.
- To deepen students' understanding of the architectural design process, including concept development, design exploration, and problem-solving methodologies.
- Exposed to different design strategies and approaches, such as contextual design, sustainable design.

Course Outcomes: At the end of the program, students will be able to;

- **CO1** Understand the principles of architectural design, including spatial organization, form, function, and aesthetics.
- **CO2** Develop proficiency in architectural drawing techniques, including hand sketching, drafting, and computer-aided design (CAD).
- **CO3** Analyze architectural precedents and case studies to understand design principles and concepts.
- **CO4** Apply sustainable design principles in architectural projects, considering environmental impact and energy efficiency.
- **CO5** Communicate design ideas effectively through visual presentations, models, and verbal explanations

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2					3										
CO3		2		3											
CO4			2				3								
CO5										2					2

***High-3, Medium-2, Low-1**

Course Syllabus

Module-1: Fundamentals (10 Hrs)

Theory

Understanding the integration of different types of structures and construction systems in design of Built Spaces.

Parameters:

Structure and construction as disciplines that evolve making of a space. Structural systems as choices based on program, space and form character. Structure as a space maker and structure as order.

Module-2: Desired skills: (10 Hrs)

Practice

Study and analyse the natural and man-made structural systems, co-relation between function, structure, space and form. Different structural models in building systems. Models as analytical tools of decision making. Understanding of Gravity loads transfer, structural grid and Framing systems. Co-relation between Structural Grid, Design Grid and Parking Grid.

Module-3: Outlining the architectural design steps (Through an example)(10 Hrs)

Practice:

Integration of structure and construction in the design of a multi-functional simple programmatic Building Project in Urban or Rural context, ideally on a Building Site for a built-up area of 501-1000 sq. m. The Course may be integrated with Structures, Building materials & construction and Interior Design.

Module-4: (10 Hrs)

Project:

Small projects such as small house, canteen, clinic, study Centre, Guest house, etc. may be given to the students as a design project. The requirements and their areas are to be stipulated by the design teacher.

Case study: (20 Hrs)

The students accompanied by the design teacher should visit at least two existing buildings. Notes should be made on these in reference to its flow of operation. Climatic angles should be observed, particularly in case of a house design. Materials used must also be observed

Text Book/Reference Book:

1. Richard Weston; Materials Form and Architecture; Laurence king Publishing, Singapore, 2003.
2. Gunter Pfeifer, Antje M. Liebers, Per Brauneck; Exposed Concrete Technology &Design; BirkHauser, Switzerland, 2005.
3. Catherine Croft; Concrete Architecture; McGraw Hill, New Delhi, 2004.
4. Donald Watson & Michael J. Crosbie; Time Saver Standards for Architectural Design, McGraw Hill, 2004.
5. Francis D.K. Ching, Building Construction Illustrated, John Wiley & Sons, 2001.

Bridge Engineering (3-0-0) (45 Hours)

Course	Code	T-P-Pr	Credit
Bridge Engineering	CUTM2387	3-0-0	3

Course Objectives:

- To develop an understanding of and appreciation for basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.
- To develop a clear understanding of conceptual design, and to carry out a design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements.
- To model and analyze bridge structures subjected to different types of loads.

Course Outcomes: At the end of the program, students will be able to;

- **CO1**: Understand the principles of bridge engineering, including structural behavior, loading conditions, and materials selection.
- **CO2**: Analyze different types of bridge structures, including beam bridges, truss bridges, arch bridges, and suspension bridges.
- **CO3**: Apply structural analysis techniques to assess the performance of bridges under various loading conditions, including dead loads, live loads, and environmental loads
- **CO4**: Design bridge components such as superstructures, substructures, foundations, and bearings according to industry standards and codes.
- **CO5**: Understand the principles of bridge construction, including construction materials, methods, and techniques.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3				2		2									
CO4			3												
CO5	2												2		

*High-3, Medium-2, Low-1

Module-1: **Fundamentals (11 Hrs)**

Theory

Classification and different components of a standard bridge, Engineering and aesthetic requirements of a standard bridge, Standard specifications of bridges (Bridge codes).

Investigation for bridge: Site selection, data drawing, design discharge linear water way, economical span, location of piers and abutments, vertical clearance above HFL, scour depth and choice of bridge type.

Standard Loadings for Road Bridges: Dead load, Live loads, Impact effect, Wind load, Longitudinal forces, Centrifugal forces, Horizontal forces due to water current, Buoyancy effect, Earth pressure, Deformation stresses, Erection stresses, Temperature effects, and Seismic force.

Module 2: **Bridge Foundation (11 Hrs)**

Theory

Types of foundation i.e., open foundation, pile foundation and well foundation; design of piers, abutments, wing wall and bed blocks.

Bridge sub-structures design: Design of Culverts i.e., design of pipe culvert (hydraulics and structural), design of slab culvert; design of rectangular box culvert.

Module 3: **Bridge girder design: (11 Hrs)**

Theory

Design and detailing T-beam bridge (without footpath), load distribution, design and orthographic plate analysis of bridge deck. Bearings: Bearings for slab bridges and girder bridges, design of elastomeric bearing. Joints: Design and construction of expansion joints.

Module 4: **Long span bridges**: **(11 Hrs)**

Theory

Arch bridges, Cable stayed bridges, suspension bridges, pre-stressed concrete bridges (pre-tensioned and post-tensioned) and steel bridges.

Inspection and Maintenance of Bridges:

Types of inspection (routine inspection, principal inspection and special inspection), Types of maintenance (Ordinary maintenance and specialized maintenance).

Text Books:

1. N.K. Raju, " Design of bridges", Oxford & IBH Publishing Co. pvt. ltd.
2. D.J. Victor, " Essentials of bridge engineering", Oxford & IBH Publishing Co. pvt. ltd.

Reference Books:

1. V. K. Raina, Concrete Bridges Practice – Analysis, Design and Economics, Shroff Publications, New Delh12nd Ed.2005.
2. Principles and Practice of Bridge Engineering, SP Bindra, Dhanpat Ra1Publications
3. Design of Bridge Structures, by T. R. Jagadeesh, PHI.
4. IRC MANUAL.

Computer Graphics (0-2-0) (30 Hours)

Course	Code	T-P-Pr	Credit
Computer graphics	MTSE 1106	0-2-0	2

Course Objectives:

- Overview of Computer Graphics & practical introduction to graphics programming
- To provide an introduction to the theory and practice of computer graphics to get a comprehensive knowledge of computer graphics.
- Leading to the ability to understand contemporary terminology, progress, issues, and trends.

Course Outcomes: At the end of the program, students will be able to;

- **CO1** Understand the fundamental principles of computer graphics and its applications in civil engineering.
- **CO2** Develop proficiency in using computer-aided design (CAD) software for creating and editing engineering drawings.
- **CO3** Apply 3D modeling techniques to represent civil engineering structures and infrastructure projects.
- **CO4** Analyze and visualize civil engineering data using graphical methods and visualization tools.
- **CO5** Understand the importance of graphical communication in civil engineering design and documentation.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2					3										3
CO3			2												
CO4		3													
CO5	2											2			

***High-3, Medium-2, Low-1**

Module 1: Preparation of following drawings manually (6 Hrs)

Practice:

1. Single room building plan section elevation
2. Two bed room house building plan section elevation
3. Duplex house with stair case details building plan section elevation
4. Development of line diagram of two storied building plan section elevation
5. Work shop with sloped roof truss (fink or howe) plan section elevation
6. Multi-storied building with framed structure plan section elevation

Module 2: 2D drafting: Introduction (6 Hrs)

Practice:

1. Explore CAD interface and basic 2D drawing tools (line, circle, rectangle, arc, etc.).
2. Practice creating and modifying objects using commands like Move, Copy, Trim, Extend, and Offset.
3. Set up drawing units (metric/imperial), define limits, and apply appropriate drawing scales.
4. Add and format dimensions (linear, aligned, angular) and text annotations using suitable styles.
5. Use hatch patterns and fill commands; modify object properties (color, line type, thickness).
6. Create complete 2D drawings (e.g., floor plan, elevation) with proper text, dimensioning, and layout setup.

Module 3: Advance computer aided 2D Drafting Advance command programming (6 Hrs)

Practice:

1. Apply transparent overlays and hatching patterns to differentiate materials and structural elements.
2. Assign specific colours and line types to different layers for organized and readable drawings.
3. Create and modify multiline styles to represent compound architectural elements like walls and partitions.
4. Develop and insert blocks for repeated objects such as doors, windows, and furniture elements.
5. Utilize symbol libraries and predefined styles to maintain consistency in architectural drafting.
6. Draft and visualize a complete building layout (plan, elevation, section) in AutoCAD incorporating all the above utilities.

Module 4:Introduction to 3d modelling: (6 Hrs)

Practice:

1. Create basic 3D sculptures using primitive objects like cubes, spheres, cylinders, and cones.
2. Explore and apply slide facilities, script attributes, and V-port controls during a 3D editing session.
3. Understand and utilize construction planes for accurate placement of 3D objects in different views.
4. Draw and manipulate 3D surfaces by setting elevation, thickness, and using dynamic projections.
5. Practice solid modeling techniques using primitive commands and apply Boolean operations (union, subtract, intersect).
6. Develop a complete 3D model integrating all techniques, simulating a real-world architectural or structural form.

Module 5: 3d rendering and setting:(6 Hrs)

Practice:

1. Visualize a complete building model using 3D modeling software like SketchUp, AutoCAD, or Revit.
2. Explore the use of lights and cameras by placing them strategically within the model for realistic visualization.
3. Apply rendering tools and scene settings to generate photo-realistic images of the building model.
4. Use material mapping techniques to assign textures and finishes to different building surfaces.
5. Set up environmental effects such as background, shadows, and reflections to enhance the realism of the scene.
6. Finalize the model by combining all elements—lighting, materials, environment—and generate rendered images for submission.

Term Paper (0-0-2) (30 Hours)

Subject Name	Code	L-T-P	(Credit)
Term Paper	CUTM2400	0-0-2	2

Interpret the literature to link the earlier research with the contemporary technologies as well as communicate effectively as an individual to present ideas clearly and coherently. This may enhance the quality of review the research findings and its correlation to the latest applications. After review, prepare the documents and present the concepts clearly and coherently in front of panel member which inculcate the spirit of enquiry for self-learning. For this subject, two stage of evaluation process will be. In first stage two times presentation of the review and at the end of presentation one report need to be submit (second stage).

Finite Element Method (3-1-0) (60 Hours)

Course	Code	T-P-Pr	Credit
Finite Element Method	CUTM2388	3-1-0	4

Course objective:

- To provide basic knowledge of mathematics, science and engineering in the areas of element analysis applied to structural systems.
- To discretize complex geometries, apply boundary conditions, and select appropriate element types and mesh densities.
- To perform static analysis for structural problems, including determination of displacements, stresses, and reaction forces.

Course outcomes: At the end of the program, students will be able to;

- CO1 Understand the fundamental principles of the Finite Element Method (FEM) and its applications in civil engineering
- CO2 Develop proficiency in discretizing structural systems into finite elements and formulating element stiffness matrices.
- CO3 Apply FEM techniques to analyze various types of civil engineering structures under static and dynamic loading conditions
- CO4 Interpret and evaluate FEM results to assess the structural behavior and performance of engineering systems.
- CO5 Utilize commercial FEM software packages for solving complex structural analysis problems.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													2
CO3			3												
CO4				3											
CO5					3										

*High-3, Medium-2, Low-1

Module-1: Background of variational calculus:**(15 Hrs)**

Theory:
Galerkin methods, Collocation methods, least squares methods. Variational methods of approximation- Rayleigh-Ritz method.
Variational theorem: Principle of minimum potential energy, Use of polynomial displacement function. Variational approach for formulation of element stiffness matrix for truss and beam elements.
Practice:

1. Simulation: Crack Analysis of Thin-walled Pressure Vessels.
2. Simulation: Static and Dynamic Analysis of Shaft.

Module-2: Basics of finite element method (FEM) (15 Hrs)
Theory:
The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods., different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method.
Practice:

1. 3D Experience Simulia – Modelling and Finite Element Analysis of Framed Structure subjected Earthquake Loads.
2. Introduction to 3D Experience Platform: About the Apps and their Applications from Engineering Point of View.

Module-3: One Dimensional Problems: (15 Hrs)
Theory:
Detail formulation including shape functions, stress strain relations; strain displacement relations and derivation of stiffness matrices using energy approach; assembling of element matrices, application of displacement boundary conditions; Numerical solution of one-dimensional problems using bar, truss and beam elements.
Practice:

1. Analysis of Steel Bridge – Simulation using 3D Experience Tool.

Module-4: Two Dimensional Problems: (15Hrs)
Theory:
Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria; Finite Element modelling of two-dimensional problems using Constant strain Triangle (CST) elements, Stress strain relations for isotropic and orthotropic materials; Four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading;
Isoparametric Elements: Natural coordinates, isoparametric elements, four node, eight node elements; Numerical integration, order of integration.
Practice:

1. Tensile Test using Simulation 3D Experience Tool.

Text books:

1. C.S. Desa1and J.F. Abel, Introduction to the Finite Element Method: CBS Publishers
2. R. D. Cook., Concepts and Applications of Finite Element Analysis, Wiley.

3. C.S. Krishnamoorthy, “Finite element analysis, theory and programming", Tata McGrawHill

Reference books:

1. S.S. Bhavikatt1- Finite Element Analysis – New Age International Publishers, Delhi
2. Logan, D. L., A First Course in the Finite Element Method, PWS Publishing, Boston,
3. O. C Zienkiewicz .and R. L. Taylor, Finite Element Method, Mc Graw Hill

RESEARCH METHODOLOGY & IPR (2-0-2) (60 Hours)

Subject Name	Code	T-P-Pr (Credit)	Credit
Research Methodology and IPR	CUTM2378	2-0-2	4

Course Objective

- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.

Course outcome At the end of the program, students will be able to;

- **CO1** Understand the principles of research design and data collection methods as well as the legal framework of intellectual property rights**.**
- **CO2** Develop research proposals and formulate research questions**.**
- **CO3** Identify different types of intellectual property such as patents, trademarks, copyrights, and trade secrets.
- **CO4** Develop the ability to critically evaluate research studies with appropriate techniques, resources which will lead to evaluate the strengths and limitations of different types of intellectual property protection.
- **CO5** Develop the ability to critically evaluate research studies with appropriate techniques, resources which will lead to evaluate the strengths and limitations of different types of intellectual property protection.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3												
CO2				3		2									
CO3		2		3											
CO4					2										
CO5							2	3							

*High-3, Medium-2, Low-1

Module 1: Elementary Research Methodology (12 Hrs)

Theory

Research Concept, Objective, characteristics, Steps and Significance of Research, Arbitrary and Scientific Research, Research approaches. Types of research: Historical, Descriptive, Analytical, Case Study, Quantitative vs. qualitative, Conceptual, Empirical Action Research, Research Methods vs Methodology. Research Problems: Selection and definition of the research problems, formulating a research problem, identifying variables and Constructing hypothesis; Choosing a mentor, lab and research question; maintaining a lab notebook; Selection of problems - stages in the execution of research

Module 2: Academic Writing and Presentation (12 Hrs)

Theory

Technical writing skills - types of reports; layout of a formal report; standard of Journal (Impact Factor, Citation Index), Scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Module 3: Scientific communication skills (12 Hrs)

Theory

Concept of effective communication- setting clear goals for communication; determining outcomes and results; barriers to effective communication; non-verbal communication-importance of body language, power of effective listening; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search.

Module 4: Introduction to IPR (12 Hrs)

Theory

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; plant variety protection and farmers rights.

Module 5: Types of Patents (12 Hrs)

Theory

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; filing of a patent application; role of a Country Patent Office; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications.

PROJECTS

1. Write a review article and submit to a journal
2. Write a book chapter/ book for publishing
3. Write an original article for a journal

Books:

1. Geoffrey Marczyk, David DeMatteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.
2. Carol Ellison (2010) ***McGraw-Hill's ConcisevGuide to WritingvResearch Papers***, McGraw-Hill
3. Kothar1CR (2016) ***Research Methodology: Methods and Techniques***, New Age Pvt Ltd
4. Ganbawale RM, (2017) ***Bioststistics and Research Methodology***, New Central Book Agency
5. Sinha, S.C. and Dhiman, A.K., (2002). ***Research Methodology***, Ess Ess Publications. 2 volumes.
6. Trochim, W.M.K., (2005). ***Research Methods: the concise knowledge base***, Atomic Dog Publishing. 270p.
7. Wadehra, B.L. (2000). ***Law relating to patents, trademarks, copyright designs and geographical indications***. Universal Law Publishing.
8. Neuman, W.L. (2008). ***Social research methods: Qualitative and quantitative approaches,*** Pearson Education

Structural Engineering Laboratory (0-2-0) (30 Hours)

Course	Code	T-P-Pr	Credit
Structural Engineering Laboratory	CUTM2389	0-2-0	2

Course Objectives:

- To provide the basic knowledge of science and engineering of concrete properties related to civil engineering problems.
- To familiarize students with various experimental techniques used in structural engineering.
- To perform experimental tests on structural components and systems to evaluate their behavior and performance

Course outcome At the end of the program, students will be able to;

- **CO1** Demonstrate mastery in the use of experimental equipment, instruments, and techniques commonly used in structural engineering laboratories.
- **CO2** Gain an understanding of the behaviour of structural elements and systems through hands-on experimentation and analysis of structural responses under various loading conditions.
- **CO3** analyze and interpret experimental data obtained from laboratory tests, identifying trends, drawing conclusions, and correlating findings with theoretical principles.
- **CO4** apply theoretical knowledge of structural mechanics and principles to design, plan, and conduct laboratory experiments, and to interpret experimental results within the context of structural engineering theory.
- **CO5** adhere the safety protocols and ethical standards while conducting laboratory experiments, ensuring the safety of themselves and others, and maintaining integrity in data collection and reporting.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				3											
CO2	3														
CO3		3													
CO4			3												
CO5							3								

*High-3, Medium-2, Low-1

Module-1:Mix design (08 Hrs)

Practice

1. Design mix proportions for high strength concrete using OPC, fly ash, slag, and fibre reinforcement as per IS 10262:2019.
2. Prepare concrete mixes for each type (OPC-based, fly ash-based, slag-based, and fibre-reinforced) using the designed proportions.
3. Conduct standard tests to evaluate the fresh properties (workability, slump, compaction factor) of all concrete types.
4. Perform compressive strength tests at different curing ages for comparison among all concrete variants.
5. Evaluate tensile strength, flexural strength, and bond strength of the prepared concrete mixes in the laboratory.
6. Analyze and compare the results to assess the performance differences among OPC, fly ash, slag, and fibre-reinforced concrete.

Module-2: Evaluation and comparison of physical properties (08 Hrs)

Practice

1. Determine the density of OPC-based, fly ash-based, slag-based, and fibre-reinforced concrete through standard laboratory methods.
2. Evaluate water absorption and volume of voids for each type of concrete to assess their physical characteristics.
3. Conduct acid resistance tests on different concrete mixes and compare mass loss and surface degradation.
4. Perform sulphate attack tests to evaluate expansion, cracking, and strength reduction in each concrete type.
5. Test chloride penetration resistance and carbonation depth to assess durability under aggressive environmental conditions.
6. Measure permeability characteristics of all concrete types and compare the results to determine long-term durability performance.

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Module-3: Non-destructive performances (08 Hrs)

Practice

1. Conduct rebound hammer tests on OPC-based, fly ash-based, slag-based, and fibre-reinforced concrete to evaluate surface hardness and estimate compressive strength.
2. Perform ultrasonic pulse velocity (UPV) tests to assess the quality and uniformity of different concrete mixes non-destructively.
3. Analyze and compare the non-destructive test results to classify concrete quality and detect internal flaws or inconsistencies.
4. Study the micro-structural properties of concrete samples using X-ray diffraction (XRD) to identify crystalline phases and hydration products.

5. Use Scanning Electron Microscopy (SEM), Field Emission SEM (FESEM), and Electron Probe Micro-Analysis (EPMA) to examine surface morphology, pore structure, and elemental distribution.
6. Perform optical microscopy to visually observe the concrete matrix and compare microstructural features across different concrete types

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Module-4: Tensile Properties (08 Hrs)

Practice

1. Determine the tensile properties such as yield stress and proof stress of mild steel (Fe 250) and HYSD steel bars (Fe 415, Fe 500, Fe 550) using a Universal Testing Machine (UTM).
2. Measure the percentage elongation of mild and HYSD steel bars after tensile testing to assess ductility.
3. Plot and analyze the stress-strain curves for mild steel and HYSD bars to study their mechanical behavior.
4. Cast reinforced concrete (RC) specimens (beams, columns, and slabs) using OPC-based, fly ash-based, slag-based, and fibre-reinforced concrete mixes.
5. Perform load testing on RC beams, columns, and slabs to evaluate their structural performance in terms of load-carrying capacity and failure patterns.
6. Compare and analyze the structural behavior of RC elements with different concrete types based on experimental results.

Text books:

1. A.M. Neville, J.J. Brooks, Concrete Technology, Low Priced Edition, Pearson Education, 2004.

Reference books:

1. M. S. Shetty, Concrete technology- Theory & Practice, S. Chand & Company, New Delhi, 2000.

3D Modelling through Ansys and Catia (0-2-2) (60 Hours)

Course	Code	T-P-Pr	Credit
3D Modeling through Ansys and Catia	CUTM4441	0-2-2	4

Course objective:

- To learn the technique of 3D modelling of different structural elements using the software like Ansys and Catia.
- To create 3D models in Ansys, import geometry, define material properties, apply loads and boundary conditions, and perform analysis and simulations.
- To use Catia for creating complex 3D models, designing parts and assemblies, and generating detailed engineering drawings.

Course outcome At the end of the program, students will be able to;

CO1	Understanding of the basic principles and concepts of 3D modeling, including the use of parametric design and solid modeling
CO2	Ability to use Ansys and Catia to create 3D models of parts and assemblies also familiarity with the user interface, commands, and tools in problem solving
CO3	Create detailed drawings and technical documentation of models with help of tools and gain the knowledge of the best practices and industry standards related to 3D modeling and simulation
CO4	Interpret simulation results obtained from Ansys and Catia, analyzing structural responses, identifying critical areas of stress, deformation, and failure, and making informed design decisions based on the analysis.
CO5	Apply 3D modeling skills and simulation techniques learned in the course to real-world civil engineering projects, demonstrating the practical application of Ansys and Catia in engineering practice.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	3												
CO3					3									2	
CO4															
CO5						2									

***High-3, Medium-2, Low-1**

Module-1: Introduction (08 Hrs)

Theory

Introduction to Engineering Design, Different types of Numerical Methods & Applications, History/need/advantages/limitations of FEM/FEA, Introduction to FEM, Basics of FEM, Different types of software for structural modelling and analysis.

Module-2: General Steps of the Finite Element Method (08 Hrs)

Practice

1. General Steps of the Finite Element Method
2. Explanation of 1D, 2D and 3D Elements with examples
3. Introduction to Ansys interface (Coordinate system and Basic geometrical entities creation in solid modelling like key points, lines, areas etc.)

Module-3: Material Properties and Boundary Conditions (08 Hrs)

Practice

1. Understand the basics of meshing and identify different types of finite elements used in FEA (1D, 2D, 3D elements).
2. Learn and apply various meshing techniques to generate quality meshes suitable for structural analysis.
3. Assign appropriate material properties to the finite element model based on the design intent.
4. Apply and modify different boundary conditions to simulate real-world constraints in structural models.
5. Perform different types of analyses (static, dynamic, coupled field) and interpret the results effectively.
6. Solve example problems including 1D element analysis, 2D plane stress/strain analysis, and 3D structural analysis using FEA software.

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Module-4: 3D solid models and edit parts (08 Hrs)

Practice

1. Explore the CATIA user interface and practice creating and editing 2D sketches.
2. Create sketch-based features and apply transformation features such as move, rotate, and scale.
3. Use dress-up features and advanced replication tools to modify and duplicate model components.
4. Generate 3D solid models and edit parts within assemblies for building and structural components.
5. Create surface features and produce detailed drawing views with appropriate annotations for buildings and structures.
6. Finalize drawings with dress-up on 2D views, perform real-time rendering, apply GD&T principles, and prepare drawings for plotting/printing.

Module 5: Project-Based Learning and Evaluation (16 Hrs)

To apply the concepts learned in Modules 1–4 through comprehensive modeling, simulation, and design projects using CATIA and ANSYS. This module emphasizes independent learning, real-world problem-solving, and report preparation**.**

PROJECTS:

1. Truss Analysis using ANSYS (1D Element Application)
2. Beam Deflection under Load (Static Analysis)
3. 2D Plane Stress Analysis of a Rectangular Plate with a Hole
4. Thermal Stress Analysis of a Plate (Coupled Field Analysis)
5. Modal Analysis of a Multistorey Frame
6. Design and Assembly of a Steel Roof Truss in CATIA
7. Surface Modelling of a Footbridge Deck using CATIA
8. Meshing Optimization Study for a Concrete Slab
9. Finite Element Analysis of a Water Tank Dome
10. Structural Analysis of a Building Frame Under Seismic Load

Text book/reference book:

1. “Finite Element Simulations with ANSYS Workbench 2020” by Huei-Huang Lee
2. “CATIA V5R20 for Designers” by Prof. Sham Ticko

Electives

Design of Prefabricated Structure (2-1-0) (45 Hours)

Course	Code	T-P-Pr	Credit
Design of prefabricated Structure	CUTM2393	2-1-0	3

Course Objectives:

- To introduce students to the concept of prefabricated structures and their advantages in terms of construction time, quality control, cost-efficiency,
- To focuses on the principles and techniques involved in designing and constructing prefabricated structural elements
- To analyze the structural behavior of prefabricated elements and systems

Course outcome At the end of the program, students will be able to;

- **CO1** Understand the prefabricated construction methods, materials, and techniques, including their advantages, limitations, and applications in civil engineering projects.
- **CO2** Learn the design principles and considerations specific to prefabricated structures, including modular design, connections, transportation, and erection requirements.
- **CO3** Conduct structural analysis and evaluation of prefabricated structures using appropriate analytical and computational methods, ensuring structural integrity, stability, and performance under various loading conditions.
- **CO4** Apply relevant codes, standards, and regulations governing the design and construction of prefabricated structures, ensuring compliance with safety, quality, and durability requirements.
- **CO5** Evaluate the environmental impact of prefabricated construction methods and materials, incorporating sustainable design principles to minimize resource consumption, waste generation, and carbon footprint.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			3												2
CO4								2							
CO5						3									

*High-3, Medium-2, Low-1

Module 1: Principles of prefabrication (12 Hrs)

Theory

Need for prefabrication, Materials for prefabrication, Modular coordination of prefabricated components, Bases and aim of modular co-ordination, Standardization of Systems production, transportation and erection of prefabricated components.

Module 2: Behaviour of structural components (12 Hrs)

Theory

Large panel constructions, Construction of roof and floor slabs, Case study low cost housing solution, Types and concepts of precast system, Wall panels, Columns, Architectural aspects of Shear walls.

Module 3: DESIGN PRINCIPLES: (12 Hrs)

Theory

Design philosophy- Design of cross section based on efficiency of material used – Problems in design because of joint flexibility – Allowance for joint deformation - Demountable precast concrete systems.

Module 4: JOINTS AND CONNECTIONS IN STRUCTURAL MEMBERS: (10 Hrs)

Theory

Types of Joints – based on action of forces - compression joints - shear joints - tension joints - based on function - construction, contraction, expansion. Design of expansion joints - Dimensions and detailing - Types of sealants - Types of structural connections - Beam to Column - Column to Column - Beam to Beam - Column to foundation.

Progressive collapse – Codal provisions – Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., - Importance of avoidance of progressive collapse.

Practices:

1. Analyze the design of different types of prefabricated structures
2. Design and detail the components and connections of a simple prefabricated structure
3. Study real-world case studies and evaluate their design and construction
4. Discuss the economic and environmental benefits of prefabrication in comparison to traditional construction methods.

TEXT BOOKS

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge based process planning for construction and manufacturing, Academic Press Inc., 1994

REFERENCE BOOKS

1. Koncz T., Manual of precast concrete construction, Vols. I, 2 and 3, Bauverlag, GMBH, 1971.
2. Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 1978.

Renovation & Retrofitting of Green Structures (2-1-0) (45Hours)

Course	Code	T-P-Pr	Credit
Renovation & Retrofitting of Green Structures	CUTM2394	2-1-0	3

Course objectives:

- To learn various distress and damages to concrete and masonry structures
- To understand the importance of maintenance of structures
- To study the various types and properties of repair materials

Course outcome At the end of the program, students will be able to;

- **CO1** Gain a comprehensive understanding of green building concepts, principles, and practices, including energy efficiency, sustainability, and environmental impact reduction
- **CO2** learn techniques for assessing the condition and performance of existing structures, identifying deficiencies, and evaluating the feasibility of renovation and retrofitting options.
- **CO3** Explore retrofitting strategies and methodologies for improving the energy efficiency, indoor environmental quality, and sustainability of existing structures.
- **CO4** Apply green building standards, certifications, and rating systems (e.g., LEED, BREEAM) to evaluate and benchmark the environmental performance of renovated and retrofitted structures, ensuring compliance with industry best practices.
- **CO5** Conduct life cycle assessments (LCAs) of renovation and retrofitting projects to quantify their environmental impacts.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3					2									2	
CO4								2							
CO5						3									

*High-3, Medium-2, Low-1

Module 1: Durability of Concrete (12 Hrs)

Theory

Requirement of Durability, Concrete Mix Proportions - Mix Constituents Concrete in Aggressive Soils and Water - Concrete degradation due to chemical attack, Freeze-thaw damage. Structural damage-Identification of defects, damage and decay mechanisms.

Module 2: Sustainable building Materials (12 Hrs)

Theory

waste utilization in buildings materials, Resource saving by means lightweight materials, Carbon points in building materials, Green Building Concepts, green building materials, zero and negative energy buildings, certification norms and certification body, green building planning, renewable energy design incorporation.

Module-3: Measures for Prevention of Cracks in Structures (12 Hrs)

Theory

Monitoring and Measuring Movement of Cracks - Broad Considerations for Crack Diagnosis. Concrete Restoration Systems – Crack Repairing Techniques, Concretes Containing Polymers - A New Range of Repair Materials Measures for Prevention of Cracks in Structures. Measures for Prevention of Cracks in Structures.

Bonding Coat and Repair Application. Repair Methods - Repairs using Mortars General - Repair Options, Performance Requirements of Repair Systems - Factors to be considered for selection of repair methods. Repair Stages – Concrete Removal and Surface Preparation, Form Work, Bonding Coat and Repair Applications

Module 4: Repair Methods (10 Hrs)

Theory

Repairs using Mortars - Portland Cement Mortars, Polymer Modified Cement Mortars, Epoxy Mortars. Dry Pack and Epoxy Bonded Dry Pack, Silica Fume Concrete, Polymer Concrete System, Strengthening Concrete by Surface impregnation using Vacuum Methods – Thin {Polymer Overlays, Thin Epoxy Overlays, Resin / Polymer modified Cement Slurry injection, Protective Seal Coats on the Entire Surface, Ferro-cement, Plate Bonding, RCC Jacketing, Propping and Supporting, Fibre Wrap Technique. Foundation Rehabilitation Methods - Chemical and Electro-chemical Methods of Repair.

Practices

1. Conduct a retrofit assessment of an existing building or structure and identify opportunities for improvement in terms of sustainability.
2. Develop a retrofitting plan for a real-world structure, taking into account the budget, schedule, and environmental impact.
3. Conduct a cost-benefit analysis of different green retrofitting options, considering the financial and environmental benefits.

References:

1. CPWD Handbook on Repair and Rehabilitation of RCC Buildings. Cracks in Structures – Published by Director General (Works) CPWD, Govt. of India, New Delhi
2. Renovation of Buildings and Maintenance Management, Conmat Technologies Private Limited, CF 318, Sector – I, Salt Lake, Kolkata – 700064

Advanced Construction Materials (2-1-0) (45 Hours)

Course	Code	T-P-Pr	Credit
Advanced Construction Materials	CUTM2395	2-1-0	3

Course objective:

- To introduce students to the characteristics, properties, and applications of advanced construction materials.
- To learn about self-compacting concrete, high-strength concrete, fiber-reinforced concrete, high-performance concrete, and other innovative concrete mixes.
- To introduce students to emerging and innovative construction materials.

Course outcome At the end of the program, students will be able to;

- **CO1** Gain a comprehensive understanding of advanced construction materials, including their properties, characteristics, manufacturing processes, and applications in civil engineering projects.
- **CO2** Learn the criteria for selecting advanced construction materials based on project requirements and conduct material testing to evaluate their properties and behavior.
- **CO3** Apply advanced construction materials in the design and construction of civil engineering structures, incorporating innovative solutions to enhance performance, durability, and sustainability.
- **CO4** Compliance with relevant codes, standards, and regulations governing the use of advanced construction materials, ensuring structural integrity, safety, and quality of construction.
- **CO5** Evaluate the environmental impact of advanced construction materials throughout their lifecycle, incorporating sustainable design principles.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3												3	
CO3			2												
CO4								2							
CO5						2									

*High-3, Medium-2, Low-1

Module-1: Cement: (12 Hrs)

Theory

Chemical composition of OPC, Modified Portland Cements. Pozzolanic Materials: Natural pozzolans, Artificial pozzolans – Fly ash, Silica fume, GGBS.

Module-2: Aggregates: (12 Hrs)

Theory

Classification, source, size, shape, Texture, Strength, Bulk density, Specific gravity, Bulking of aggregate, Alkali-aggregate reaction, Thermal properties, grading of aggregates, crushed sand, gap grading

Module 3: Admixtures: (12 Hrs)

Theory

Plasticizers, Super plasticizers, Retarders, Accelerators, Air-entraining admixtures, Water-repellent admixtures, Bonding admixtures lightweight materials**.**

Module 4: Reinforcement, Asphalt Binders, Smart and Intelligent Materials (10 Hrs)

Theory

Natural and artificial fibres and Composites**:** Fibres: Types of fibres, Aspect ratio, mechanical and physical properties of FRC, Polymers-Polymer concrete- types and properties

Smart and Intelligent Materials: Smart and Intelligent Materials for intelligent buildings – ceramics, hybrid, chitosan-based gel, adhesives, polymers, oxides, nano tubes and censors.

Asphalt Binders: Types, use, Temperature susceptibility, chemical properties, super pave and performance grade binder, characterization of asphalt cement, classification of asphalt cement, Asphalt concrete.

Practices:

1. Conduct laboratory experiments to evaluate the physical and mechanical properties of different construction materials, such as concrete, steel, wood, and composites.
2. Research and analyze the sustainability and environmental impact of various construction materials, including their production, use, and disposal.
3. Participate in design projects and develop innovative solutions using advanced construction materials, such as smart materials, nanomaterials, and biobased materials.
4. Conduct case studies of real-world structures, and evaluate the materials used, their performance, and their impact on the environment.

Text Books:

Concrete Technology – Theory and Practice- M.S. Shetty, S Chand and Co. Ltd.

Smart Materials - Mel Schwartz, Talyor and Francis

Reference Books:

Concrete Technology- A.M. Neville & J.J Brooks, Low Priced Edition, Pearson Education,2004.

Materials for civil and construction engineers -Michels. Mamlouk & John P. Zaniewski, Prentice Hall.

Soil Dynamics & Geotechnical Earthquake Engineering (2-1-0) (45 Hours)

Course	Code	T-P-Pr	Credit
Soil Dynamics & Geotechnical Earthquake Engineering	CUTM2396	2-1-0	3

Course objectives:

- Understand the fundamental concepts of Theory of vibration and the various terminology encompassed to study the behavior of soils due to the effects of dynamic loads.
- To gain an understanding of seismic hazards and the generation of ground motions.
- To gain knowledge and skills in analyzing and designing structures considering soil-structure interaction effects during earthquakes

Course outcome At the end of the program, students will be able to;

- **CO1** Gain a thorough understanding of soil dynamics, including soil behavior under dynamic loading.
- **CO2** Analyze seismic hazards and their effects on geotechnical structures, including ground motion characteristics, seismicity analysis, and probabilistic seismic hazard assessment.
- **CO3** Design geotechnical structures to resist seismic forces, incorporating seismic design principles, and mitigation measures against liquefaction and soil amplification.
- **CO4** Assess the performance of geotechnical structures under seismic loading, including dynamic analysis, response spectrum analysis, and evaluation of ground displacements and deformations.
- **CO5** Implement relevant codes, standards, and guidelines for seismic design and analysis of geotechnical structures, ensuring compliance with safety, quality, and resilience requirements.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			3												
CO4				3											
CO5								2						2	

***High-3, Medium-2, Low-1**

Module 1: **Theory of Vibrations: (12 Hrs)**

Theory

Engineering problems involving soil dynamics; Role of inertia; Theory of Vibrations: Single and two-degree freedom systems, vibration-measuring instruments, vibration isolation

Practices;

1. Conduct laboratory experiments to study the behavior of soils under various loading conditions, such as compression, shear, and torsion.

Module 2: **General nature of soil behaviour: (12 Hrs)**

Theory

Wave propagation in elastic media. General nature of soil behaviour under cyclic/dynamic loading; Field and Laboratory tests for measurement of small strained and large strain, dynamic properties of soils.

Practices:

2. Analyze real-world case studies of earthquakes, and evaluate the impact of ground motion on structures and the environment.

Module 3: Foundations (12 Hrs)

Theory

Design criteria for machine foundations, elastic homogeneous half space solutions, lumped parameter solutions. Codal provisions.

Strong Ground Motion: Measurement, characterization and estimation. Dynamic soil properties; Ground response analysis; Effect of local site conditions on ground motion.

Practices:

3. Participate in design projects, where you apply the principles of soil dynamics and geotechnical earthquake engineering to design and analyze retaining walls, foundations, and slopes.

Module 4: Ground response analysis (10 Hrs)

Theory

Amplification theory and ground response analysis. Densification and liquefaction of granular soils, Liquefaction: evaluation of liquefaction hazards, effects of liquefaction; Case studies. Seismic slope stability analysis, Seismic bearing capacity and earth pressures. Codal provisions. Elastic theories of soil dynamics; Wave propagation; Dynamic soil properties; Vibration isolation; Pile dynamics.

Practices:

4. Conduct fieldwork, where you collect and analyze soil samples and measure in-situ soil properties, such as shear strength and compressibility.

Text Books:

1. S.L. Kramer, Geotechnical Earthquake Engineering, Pentice Hall, international series, Pearson Education (Singapore) Pvt. Ltd.,2004.
2. S. Saran, Soil Dynamics and Machine Foundations, Galgotia Publications PrivateLtd.1999

Reference Books:

1. N. S. V. Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wiley New Delhi, 1998