POSTGRADUATE DEGREE

COURSE

M. Tech. I to IV Semester

CIVIL Engineering

(Structural Engineering)

University of Technology

Vatika Road, Jaipur Rajasthan 303903

UNIVERSITY OF TECHNOLOGY, JAIPUR

Program Outcomes (POs)

PO 1	Engineering Knowledge: Apply knowledge of mathematics, science, and Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering to solve numerical techniques problems.
PO 2	Problem Analysis: Identify, formulate, and solve Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.
PO 3	Design/Development of Solutions: Design and develop Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering systems, components, or processes.
PO 4	Conduct Investigations: Conduct experiments and simulations to analyse Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.
PO 5	Modern Tool Usage: Use modern tools and software to analyse and solve Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.
PO 6	The Engineer and Society: Apply Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering solutions to societal problems.
PO 7	Environment and Sustainability: Understand the impact of Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering solutions on the environment.
PO 8	Ethics: Apply ethical principles to civil engineering practice.
PO 9	Individual and Team Work: Work effectively as an individual and in teams to solve civil engineering problems.
PO 10	Communication: Communicate Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering ideas and solutions effectively.
PO 11	Project Management: Manage civil engineering projects and resources effectively.
PO 12	Lifelong Learning: Engage in lifelong learning to stay current with Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering developments.

Program Specific Outcomes (PSOs)

1. **PSO 1**: Graduates will be proficient in analysing, designing, and optimizing complex structural systems under various loading conditions using advanced tools and methodologies.
2. **PSO 2**: Graduates will possess the ability to perform structural assessments, propose innovative solutions, and design sustainable and resilient structures with a focus on safety and environmental concerns.
3. **PSO 3**: Graduates will be equipped to contribute to interdisciplinary research, development, and implementation of advanced materials, construction technologies, and smart structures in the field of structural engineering.

Program Educational Objectives (PEOs)

1. **PEO 1**: To equip graduates with a deep understanding of structural behavior, design principles, and material science to analyze and design innovative structures for civil engineering projects.
2. **PEO 2**: To prepare graduates to adopt state-of-the-art technology and engineering practices for solving complex structural problems, ensuring sustainability and resilience in construction.
3. **PEO 3**: To provide graduates with strong leadership, communication, and project management skills to collaborate effectively with multidisciplinary teams and stakeholders.
4. **PEO 4**: To inspire graduates to pursue lifelong learning, engage in research, and contribute to the advancement of the structural engineering field through innovative solutions and practices.

Course Overview and Objectives

The Structural Engineering is designed to provide advanced knowledge and skills in the analysis, design, and construction of structural systems. The program focuses on the principles and practices of structural mechanics, materials, design methodologies, and the integration of modern computational tools. It aims to prepare students for tackling challenges in designing robust, sustainable, and innovative structures, while considering safety, performance, and environmental impact. Graduates will gain expertise in topics such as reinforced concrete, steel structures, earthquake engineering, advanced structural analysis, and smart materials, empowering them to lead projects and contribute to research and development in the field of structural engineering.

UNIVERSITY OF TECHNOLOGY, JAIPUR

Scheme of

POSTGRADUATE DEGREE COURSE

M. Tech.

CIVIL Engineering

(Structural Engineering)

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M. Tech 1st Year, I Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Advanced Structural Analysis	5	0	0	3	25	100	125	5
2	Numerical Methods & Analysis	5	0	0	3	25	100	125	5
3	Advanced Design of Concrete Structures	5	0	0	3	25	100	125	5
4	Advanced Design of Steel Structures	5	0	0	3	25	100	125	5
5	Computer Aided Design Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
**: Not to be considered for award of division*

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, II Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Structural Dynamics	5	0	0	3	25	100	125	5
2	Advanced Strength of Materials	5	0	0	3	25	100	125	5
3	Advanced Concrete Technology	5	0	0	3	25	100	125	5
4	Earthquake Engineering	5	0	0	3	25	100	125	5
5	Material Testing, Experimental Methods & Quality Control	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits*
***ETE:** End Term Exam, **IA:** Internal Assessment*
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UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, III Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Finite Element Analysis	5	0	0	3	25	100	125	5
2	Repair and Rehabilitation of Structures	5	0	0	3	25	100	125	5
3	Seminar	0	0	0		90	60	150	6
4	Dissertation- I	0	0	0		100	0	100	4
	Total					**240**	**260**	**500**	**20**

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UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, IV Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Dissertation-II	0	0	0		500	0	500	16
	Total					**500**	**0**	**500**	**16**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
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Syllabus of

POSTGRADUATE DEGREE

COURSE

M. Tech.

CIVIL Engineering

(Structural Engineering)

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, I Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Advanced Structural Analysis	5	0	0	3	25	100	125	5
2	Numerical Methods & Analysis	5	0	0	3	25	100	125	5
3	Advanced Design of Concrete Structures	5	0	0	3	25	100	125	5
4	Advanced Design of Steel Structures	5	0	0	3	25	100	125	5
5	Computer Aided Design Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
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UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Structural Engineering)

Sub: Advanced Structural Analysis

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Matrix Methods of Structural Analysis**: Introduction to matrix methods, stiffness and flexibility matrices, structural analysis of beams and frames using matrix methods, influence lines, analysis of indeterminate structures, computer applications.	08
3.	**Analysis of Frames and Trusses**: Virtual work method, analysis of 2D and 3D frames, internal force calculations, methods for analyzing trusses (joint and section methods), analysis using displacement method.	07
4.	**Nonlinear Analysis of Structures**: Material and geometric nonlinearities, large displacement analysis, plastic hinge method, load-deflection curves, collapse mechanisms, computational models for nonlinear problems, and applications to real-world structures.	08
5.	**Finite Element Method (FEM)**: Basic principles of FEM, discretization, shape functions, element stiffness matrices, boundary conditions, static and dynamic analysis using FEM, applications to beams, frames, plates, and shells.	09
6.	**Structural Dynamics and Vibration**: Free and forced vibration analysis of structures, dynamic response, D'Alembert's principle, modal analysis, response spectrum method, time history analysis, earthquake analysis and response, modal superposition method.	08

Text/Reference Books:

1. Clarke, J.H. & Turner, M., *Structural Analysis: A Unified Classical and Matrix Approach*.
2. Weaver, W., and Johnston, E., *Matrix Methods of Structural Analysis*.
3. Cook, R.D., *Concepts and Applications of Finite Element Analysis*.
4. Timoshenko, S., and Young, D.H., *Vibration Problems in Engineering*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Apply matrix methods to analyze indeterminate structures and compute internal forces and displacements.
CO2	Understand and analyze the behavior of frames and trusses using various classical and modern methods.
CO3	Solve nonlinear structural problems by applying advanced analysis techniques and computational methods.
CO4	Implement and apply finite element analysis to solve complex structural problems involving beams, plates, and shells.
CO5	Analyze dynamic effects on structures, including vibrations, seismic loading, and time history response.

Course Description

The **Advanced Structural Analysis** course provides an in-depth exploration of modern techniques for analyzing complex structural systems. It builds on foundational knowledge in structural analysis and introduces advanced methods such as matrix analysis, finite element methods (FEM), and computational tools for solving indeterminate and nonlinear structures. The course emphasizes the analysis of frames, trusses, and continuous systems, with a focus on static and dynamic behavior. Students will also study the impact of vibrations, seismic forces, and time-history loading on structural integrity, preparing them to handle real-world engineering challenges and optimize structural design.

Course Objectives

1. To apply matrix methods for the analysis of indeterminate structures and the computation of internal forces and displacements.
2. To understand and analyze the behavior of frames and trusses using classical and modern methods.
3. To solve nonlinear structural problems by applying advanced analysis techniques and computational methods.
4. To implement finite element analysis in solving complex structural problems involving beams, plates, and shells.
5. To analyze dynamic effects on structures, including vibrations, seismic loading, and time-history response.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	3	1	-	1	-	-	-	-	2
CO2	3	2	2	3	3	-	-	-	-	2	-	1
CO3	3	3	2	3	3	-	-	-	-	-	-	3
CO4	2	3	3	3	3	2	3	-	-	-	-	2
CO5	3	3	3	3	2	3	2	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	3	2	1
CO3	-	-	-
CO4	-	2	3
CO5	3	2	1

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Structural Engineering)

Sub: Numerical Methods & Analysis

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Numerical Solution of Algebraic Equations**: Methods for solving nonlinear algebraic equations, bisection method, Newton-Raphson method, fixed-point iteration, convergence criteria, and error analysis.	06
3.	**Interpolation and Approximation**: Lagrange interpolation, Newton's divided difference interpolation, spline interpolation, least squares approximation, and application in curve fitting.	07
4.	**Numerical Integration and Differentiation**: Trapezoidal rule, Simpson's rule, Gaussian quadrature, numerical differentiation techniques, and applications to engineering problems.	07
5.	**Solution of Ordinary Differential Equations (ODEs)**: Euler's method, Runge-Kutta methods, multistep methods, stiff systems, stability analysis, boundary value problems, and application to structural dynamics.	10
6.	**Solution of Partial Differential Equations (PDEs)**: Finite difference method, finite element method for PDEs, stability and consistency of methods, solution of heat conduction, wave equations, and fluid dynamics problems.	10

Text/Reference Books:

1. Burden, R.L., and Faires, J.D., *Numerical Analysis*.
2. Chapra, S.C., and Canale, R.P., *Numerical Methods for Engineers*.
3. Atkinson, K.E., *An Introduction to Numerical Analysis*.
4. Sastry, S.S., *Introductory Methods of Numerical Analysis*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Solve nonlinear algebraic equations using appropriate numerical methods and error analysis.
CO2	Implement interpolation and approximation techniques for data fitting and curve modeling.
CO3	Apply numerical integration and differentiation techniques to solve engineering problems.
CO4	Solve ordinary differential equations (ODEs) using advanced methods and apply to real-world problems.
CO5	Apply finite difference and finite element methods to solve partial differential equations in engineering.

Course Description

The **Numerical Methods & Analysis** course focuses on computational techniques for solving mathematical problems that arise in engineering and science. The course covers methods for solving algebraic, differential, and integral equations, emphasizing error analysis, convergence, and stability of algorithms. Students will explore techniques such as interpolation, numerical integration, and iterative methods, providing the foundation to solve complex engineering problems using computers.

Course Objectives

- To introduce students to various numerical methods for solving mathematical problems in engineering.
- To develop skills in analyzing the accuracy, stability, and efficiency of numerical algorithms.
- To provide practical experience in implementing numerical techniques for solving algebraic, differential, and integral equations.
- To enable students to apply numerical methods to real-world engineering problems, enhancing their computational problem-solving skills.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	2	-	-	-	-	-	-	1
CO2	1	-	-	-	3	-	1	-	2	1	-	1
CO3	3	3	3	2	3	-	2	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	2	3	-	-
CO5	2	3	-	-	3	2	2	-	-	-	3	2

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	2
CO2	1	-	-
CO3	-	1	-
CO4	-	-	3
CO5	-	-	3

1st Year - I Semester: M. Tech. (Structural Engineering)

Sub: Advanced Design of Concrete Structures

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Introduction to modern concrete structures, role of concrete in structural design, design philosophies, and codes of practice.	01
2.	**Design of Reinforced Concrete Beams**: Bending and shear behavior of reinforced concrete beams, serviceability and ultimate strength design, torsion in beams, cracked section analysis, deflection control, bond and anchorage, design of cantilever and continuous beams, interaction of moment and shear.	08
3.	**Design of Slabs and Plates**: One-way and two-way slabs, design of slabs for various load cases (dead, live, wind, seismic), deflection control, use of slab-column junctions, flat slabs, analysis and design of floor systems, punching shear, design of plate structures (reinforced and prestressed), and applications of finite element analysis in slab and plate design.	09
4.	**Design of Columns and Walls**: Axial load, biaxial bending, and slenderness effects, design of short and slender columns, interaction curves for columns under axial load and bending, design of shear walls, wall-slab interaction, design of structural walls subjected to lateral loads, and use of nonlinear analysis for columns and walls under seismic loading.	08
5.	**Prestressed Concrete Design**: Basics of prestressing, methods of prestressing (pre-tensioning and post-tensioning), stress analysis in prestressed beams, loss of prestress, deflection control, analysis of serviceability and ultimate strength, design of prestressed beams and slabs, design of anchorage zones, and application to bridges and high-rise buildings.	09
6.	**Advanced Topics in Concrete Design**: Seismic design of concrete structures, advanced material properties such as high-strength concrete, fiber-reinforced concrete, self-compacting concrete, durability considerations, use of concrete in extreme environments, sustainability in concrete design, design for fire resistance, and application of computational tools (e.g., Finite Element Analysis) for complex concrete structures.	08

Text/Reference Books:

1. **Jain, A.K.**, *Design of Concrete Structures* (S. Chand & Company, 2018)
   A comprehensive text on the design of reinforced concrete structures with a focus on practical design aspects.
2. **Dayaratnam, P.**, *Design of Reinforced Concrete Structures* (A.H. Wheeler & Co, 2007)
   A classic book on reinforced concrete design with clear explanations of concepts and examples.
3. **MacGregor, J.G., and Wight, J.K.**, *Reinforced Concrete: Mechanics and Design* (Prentice Hall, 2015)
   A thorough text covering both the theory and practical aspects of reinforced concrete design.
4. **Tedesco, J.W., et al.**, *Design of Concrete Structures* (McGraw-Hill Education, 2015)
   A widely used textbook providing detailed coverage of concrete design concepts with updated codes and design methods.
5. **Varma, S.K., and Gupta, P.L.**, *Reinforced Concrete Structures* (New Age International, 2010)
   A well-regarded book for students and professionals focusing on the practical aspects of concrete structures.
6. **Park, R., and Paulay, T.**, *Reinforced Concrete Structures* (Wiley, 1975)
   A seminal work on reinforced concrete, particularly noted for its coverage of earthquake-resistant design.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Design reinforced concrete beams, slabs, and plates using advanced design methods.
CO2	Apply principles of concrete design to columns, walls, and complex structural elements under various loading conditions.
CO3	Design prestressed concrete members and understand the impact of prestressing on structural performance.
CO4	Implement advanced design considerations for seismic resistance, material properties, and sustainability in concrete structures.
CO5	Use computational tools for the analysis and design of concrete structures in real-world applications.

Course Description

The Advanced Design of Concrete Structures course focuses on the design principles, methodologies, and advanced techniques used in the analysis and design of reinforced concrete structures. The course covers complex topics such as prestressed concrete, seismic design, durability considerations, and the design of structures subjected to extreme loads. Students will also gain an understanding of modern codes and standards for concrete structure design.

Course Objectives

- To provide advanced knowledge of the design and analysis of reinforced concrete structures, including prestressed concrete.
- To equip students with the skills to design concrete structures under seismic loads and extreme conditions.
- To enhance understanding of durability and serviceability aspects in concrete design.
- To familiarize students with modern design codes and standards used in the concrete industry.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	1	2	1	1	-	-	-	-	2
CO2	2	3	-	-	-	-	1	-	2	-	-	-
CO3	2	3	3	2	3	-	-	-	2	-	2	-
CO4	3	-	-	3	-	2	1	-	1	-	-	-
CO5	3	-	-	-	3	2	3	-	2	2	2	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	1	2	2
CO2	2	-	2
CO3	2	-	-
CO4	3	-	-
CO5	3	3	-

1st Year - I Semester: M. Tech. (Structural Engineering)

Sub: Advanced Design of Steel Structures

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Design of Tension Members**: Behavior of steel tension members, design of angles, flats, and bars under axial tension, eccentric tension members, buckling of slender elements, and connection design.	07
3.	**Design of Compression Members**: Axial load and buckling analysis, design of short and long columns, slenderness effects, Euler's formula, design of built-up compression members, design for stability, and lateral-torsional buckling.	08
4.	**Design of Beams**: Bending analysis of beams, shear and torsion in beams, design of laterally supported and unsupported beams, deflection, and fatigue design. Use of web plates, stiffeners, and shear connectors.	08
5.	**Design of Frames and Bracing Systems**: Analysis of framed structures, second-order effects, bracing systems, stability analysis, design of moment-resisting frames, and rigid frames.	08
6.	**Advanced Topics in Steel Design**: Seismic design of steel structures, advanced material properties, and sustainability considerations. Design optimization, connection design, and computational methods for structural steel design.	09

Text/Reference Books:

1. Bhavikatti, S.S., *Design of Steel Structures*.
2. Duggal, S.K., *Design of Steel Structures*.
3. Salmon, C.G., and Johnson, J.E., *Steel Structures: Design and Analysis*.
4. Jain, S.P., and Arya, A.S., *Design of Steel Structures*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Design steel tension members and their connections under axial loading.
CO2	Apply principles of design for steel compression members considering buckling and stability.
CO3	Design beams and framing systems, incorporating bending, shear, and torsion.
CO4	Understand and apply seismic design principles for steel structures, including lateral forces and dynamic analysis.
CO5	Utilize advanced design techniques and computational tools for optimizing steel structures and connections.

Course Description

The **Advanced Design of Steel Structures** course explores the design and analysis of complex steel structures, including multi-story buildings, industrial frames, and bridges. It emphasizes advanced techniques in the design of components such as beams, columns, and connections, incorporating factors like stability, load distribution, and seismic considerations. The course also covers the application of modern design codes and standards for efficient, safe, and sustainable steel structures.

Course Objectives

- To equip students with advanced knowledge of steel structure design, including specialized components and systems.
- To introduce modern design codes and standards for steel structures and their application in real-world scenarios.
- To develop students' ability to analyze and design complex steel structures under various loading conditions, including seismic and dynamic loads.
- To enhance the students' skills in using advanced software tools for the analysis and design of steel structures.

Mapping Table

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2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	2	-	-	-	-	-	-	2
CO2	-	-	2	2	2	-	-	-	1	-	-	1
CO3	2	1	-	-	3	-	-	-	-	2	-	-
CO4	3	-	3	2	2	2	2	-	-	-	2	-
CO5	3	-	3	-	-	3	2	-	-	3	2	1

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	1	-
CO3	-	3	-
CO4	-	2	-
CO5	3	3	2

1st Year - I Semester: M. Tech. (Structural Engineering)

Lab: Computer Aided Design (CAD) Lab

Credit: 2 **Max. Marks**: 100 (IA:60, ETE:40)

0L+0T+4P

S.No.	Experiments
1	Familiarization with the CAD software interface and basic tools. Drawing simple shapes using basic CAD commands.
2	Creating 2D geometric shapes (lines, arcs, circles, polygons). Understanding and applying coordinate systems.
3	Designing basic assembly drawings by combining multiple 2D components. Applying dimensions and annotations.
4	Creating basic 3D shapes such as cubes, spheres, and pyramids. Modifying 3D objects using extrusion, rotation, and scaling commands.
5	Creating 3D models from basic shapes. Applying textures, lighting, and shadows for rendering realistic images.
6	Applying geometric and dimensional constraints to 2D sketches and 3D models. Ensuring design integrity using constraints.
7	Generating orthographic projections, isometric views, and sectional views. Dimensioning and annotating technical drawings.
8	Assembling components into a functional assembly. Simulating basic motions or stress on the assembly.
9	Exporting CAD models to various file formats (e.g., STL, STEP, IGES). Preparing models for CNC and other manufacturing processes.

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, II Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Structural Dynamics	5	0	0	3	25	100	125	5
2	Advanced Strength of Materials	5	0	0	3	25	100	125	5
3	Advanced Concrete Technology	5	0	0	3	25	100	125	5
4	Earthquake Engineering	5	0	0	3	25	100	125	5
5	Material Testing, Experimental Methods & Quality Control	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

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ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
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1st Year - II Semester: M. Tech. (Structural Engineering)

Sub: Structural Dynamics

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Introduction to structural dynamics, importance in civil engineering, types of vibrations, and dynamic loads.	01
2.	**Basic Concepts of Structural Dynamics**: Principles of dynamics, degrees of freedom, free and forced vibrations, harmonic oscillators, damping, resonance, transient response. Vibration isolation and vibration absorbers.	08
3.	**Single-Degree-of-Freedom (SDOF) Systems**: Free and forced vibrations of SDOF systems, response to impulse and harmonic loads, damping in SDOF systems, dynamic stiffness and effective damping. Nonlinear SDOF systems.	08
4.	**Multi-Degree-of-Freedom (MDOF) Systems**: Free vibration analysis, normal modes and natural frequencies, mode shapes, generalized coordinates, and solution techniques for MDOF systems (matrix methods, Lagrange's equation). Approximation methods for MDOF systems.	08
5.	**Continuous Systems and Vibration Analysis**: Beam vibrations, natural frequencies of beams, strings, and membranes, vibration of rods and plates, and modal analysis of continuous systems. Vibration analysis of structures using finite element methods (FEM).	08
6.	**Seismic Response of Structures**: Earthquake ground motion, seismic design philosophy, response spectrum analysis, time history analysis, damping in structures, evaluation of seismic loads, and dynamic analysis for irregular structures.	08

Text/Reference Books:

1. Chopra, A.K., *Dynamics of Structures*.
2. Timoshenko, S., and Young, D.H., *Vibration Problems in Engineering*.
3. Clough, R.W., and Penzien, J., *Dynamics of Structures*.
4. Funakubo, H., *Introduction to Structural Dynamics*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Analyze the behavior of structures subjected to dynamic loads, including free and forced vibrations.
CO2	Solve vibration problems for single-degree-of-freedom systems under various loading conditions.
CO3	Perform dynamic analysis of multi-degree-of-freedom systems and evaluate their response to dynamic loads.
CO4	Understand the principles of vibration in continuous systems such as beams and plates.
CO5	Analyze the seismic response of structures and evaluate the effects of earthquakes on building safety.

Course Description

The Structural Dynamics course focuses on the analysis of structures subjected to dynamic loading. Topics include the theory of vibrations, free and forced vibration analysis of structures, and response of multi-degree-of-freedom systems. The course also covers dynamic characteristics such as natural frequencies, mode shapes, and damping, with an emphasis on understanding the effects of dynamic loads like wind, seismic forces, and impacts on structural behavior.

Course Objectives

- To understand the fundamental principles of structural dynamics and vibration analysis.
- To analyze the dynamic response of structures to various loading conditions.
- To apply methods for determining natural frequencies, mode shapes, and damping characteristics of structures.
- To develop skills in the analysis and design of structures for dynamic loading, including earthquake and wind forces.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	1	2	-	-	-	-	2
CO2	3	2	1	3	3	-	-	-	-	-	-	-
CO3	2	3	2	2	2	-	2	-	-	2	-	-
CO4	3	1	1	-	-	2	2	-	-	-	-	-
CO5	1	3	-	-	3	-	-	-	-	3	2	1

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	1
CO2	-	-	3
CO3	-	1	2
CO4	2	-	2
CO5	3	-	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Structural Engineering)

Sub: Advanced Strength of Materials

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Overview of strength of materials and its importance in structural analysis.	01
2.	**Stress-Strain Relationship and Elasticity**: Advanced concepts of stress and strain, generalized Hooke's law, relationship between stress and strain, isotropic and anisotropic materials, theory of elasticity and plasticity. Stress-strain curves for different materials.	08
3.	**Analysis of Thin and Thick Walled Pressure Vessels**: Radial, tangential, and longitudinal stresses in thin and thick walled cylinders, pressure vessels under internal and external pressure, stress concentration, and failure analysis. Thermo-elastic analysis of pressure vessels.	08
4.	**Theory of Bending and Shear in Beams**: Advanced analysis of bending stresses in curved beams, shear stress distribution in beams of arbitrary cross-section, shear deformation theory, and shear correction factor. Bending of composite beams and non-homogeneous materials.	08
5.	**Torsion of Bars and Shafts**: Torsional stresses in solid and hollow shafts, shear stress distribution, strain energy due to torsion, analysis of shafts with varying cross-sections, and applications of torsion in mechanical design. Torsion in non-circular sections.	08
6.	**Buckling of Structural Elements**: Buckling of columns and beams, stability criteria, buckling under axial and lateral loads, combined loading conditions, and instability analysis using energy methods. Buckling in plates and shells.	08

Text/Reference Books:

1. Timoshenko, S., and Goodier, J.N., *Theory of Elasticity*.
2. Gere, J.M., and Timoshenko, S., *Mechanics of Materials*.
3. Beer, F.P., and Johnston, E.R., *Mechanics of Materials*.
4. Reddy, J.N., *Theory of Plates and Shells*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Derive and apply stress-strain relationships for advanced materials in various loading conditions.
CO2	Analyze thin and thick walled pressure vessels under internal and external pressures.
CO3	Perform advanced bending and shear analysis in beams with irregular cross-sections.
CO4	Analyze torsion in shafts and bars and apply the theory of torsion in mechanical structures.
CO5	Evaluate the buckling behavior of structural elements and understand the concept of stability in structural design.

Course Description

Advanced Strength of Materials explores the principles of stress and strain in materials, extending traditional strength of materials concepts to more complex problems. The course includes advanced topics such as elastic and plastic behavior, theory of plasticity, fracture mechanics, and fatigue analysis. Students will learn how materials behave under different loading conditions, focusing on failure criteria, stress concentration, and material performance in complex structural systems.

Course Objectives

- To develop a deep understanding of the strength and deformation behavior of materials under different loading conditions.
- To explore advanced topics such as plasticity, fracture mechanics, and fatigue in structural materials.
- To apply failure theories and stress concentration principles in the design and analysis of materials and structures.
- To prepare students to solve real-world engineering problems involving material strength and behavior.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	2	-
CO3	1	3	-	-	-	-	-	-	-	2	2	-
CO4	1	3	3	3	3	2	3	-	-	-	2	3
CO5	2	3	3	-	-	-	-	2	-	1	2	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	3
CO2	2	3	1
CO3	1	-	-
CO4	2	2	3
CO5	3	2	2

1st Year - II Semester: M. Tech. (Structural Engineering)

Sub: Advanced Concrete Technology

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Importance of concrete in civil engineering and overview of concrete technology.	01
2.	**Concrete Mix Design**: Principles of mix design, IS method, ACI method, and DOE method, water-cement ratio, workability, durability, and strength optimization in concrete mix. Concrete mix proportioning, and advancements in mix design techniques.	08
3.	**Properties of Hardened Concrete**: Strength, modulus of elasticity, shrinkage, creep, durability, impact, fracture toughness, and cracking. Nondestructive testing methods for assessing concrete properties, and test methods for evaluating concrete.	08
4.	**High-Performance Concrete**: Concept of high-performance concrete, materials for HPC, design and production of HPC, durability aspects, use of mineral and chemical admixtures in HPC. Ultra-high-performance concrete, self-compacting concrete (SCC).	08
5.	**Advanced Reinforced Concrete Design**: Behavior and design of RC elements under high temperature, dynamic loads, and seismic forces. Analysis and design of pre-stressed concrete members, detailing of reinforcement, and serviceability checks.	08
6.	**Sustainability and Green Concrete**: Eco-friendly concrete, recycled aggregates, industrial waste in concrete production, geopolymer concrete, carbon footprint in concrete construction, and life cycle assessment of concrete.	08

Text/Reference Books:

1. Neville, A.M., *Properties of Concrete*.
2. Mehta, P.K., and Monteiro, P.J.M., *Concrete: Microstructure, Properties, and Materials*.
3. IS 10262: *Concrete Mix Design*.
4. ACI 211.1: *Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Design concrete mixtures based on various mix design methods for optimal strength and workability.
CO2	Assess the properties of hardened concrete including strength, shrinkage, and durability.
CO3	Develop high-performance concrete with superior durability and strength characteristics.
CO4	Apply advanced techniques in the design of reinforced and pre-stressed concrete elements.
CO5	Investigate sustainability aspects of concrete materials and design eco-friendly concrete solutions.

Course Description

The **Advanced Concrete Technology** course delves into the latest developments in concrete materials, including mix design, durability, and special concretes. Topics include high-performance concrete, fiber-reinforced concrete, self-compacting concrete, and concrete for extreme environments. The course also explores modern techniques in testing, quality control, and the use of advanced additives and admixtures to enhance concrete properties.

Course Objectives

- To understand the composition and properties of advanced concrete materials.
- To study modern mix design techniques and methods for optimizing concrete performance.
- To examine the durability, sustainability, and behavior of concrete in various environments.
- To familiarize students with the latest technologies and innovations in concrete construction and testing methods.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	-	-	-	-	-	-	1
CO2	3	2	3	3	3	2	-	-	-	-	-	-
CO3	2	2	-	-	-	2	3	-	-	-	-	-
CO4	2	3	1	2	-	-	1	-	-	2	1	3
CO5	3	3	3	3	-	-	3	2	-	2	1	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	2	2	-
CO3	-	2	3
CO4	-	-	1
CO5	3	-	1

1st Year - II Semester: M. Tech. (Structural Engineering)

Sub: Earthquake Engineering

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Basics of earthquake engineering, importance of earthquake-resistant design.	01
2.	**Earthquake Sources and Ground Motion**: Causes and types of earthquakes, seismic waves, earthquake magnitude, intensity scales, and response spectra. Ground motion prediction, site-specific hazard analysis, and soil-structure interaction.	07
3.	**Seismic Hazard Analysis**: Deterministic and probabilistic seismic hazard analysis, ground motion prediction equations, site response analysis, and factors influencing ground motion. Seismic zoning and hazard maps.	08
4.	**Dynamic Response of Structures**: Free and forced vibration of structures, response spectrum analysis, time history analysis, damping, and base isolation techniques. Nonlinear seismic response analysis.	08
5.	**Design of Earthquake-Resistant Structures**: Design philosophy, seismic design codes (IS 1893, UBC), lateral load-resisting systems, detailing for ductility, energy dissipation devices, and retrofitting techniques for existing buildings.	09
6.	**Recent Advances in Earthquake Engineering**: Use of smart materials in earthquake-resistant design, advanced computational methods (FEM, nonlinear dynamic analysis), seismic performance-based design, and seismic resilience of structures.	08

Text/Reference Books:

1. Chopra, A.K., *Dynamics of Structures*.
2. Priestley, M.J.N., and Kowalsky, M., *Earthquake Engineering: From Engineering Seismology to Performance-Based Seismic Design*.
3. Paulay, T., and Priestley, M.J.N., *Seismic Design of Reinforced Concrete and Masonry Buildings*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the sources of earthquake hazards and interpret the characteristics of ground motion.
CO2	Perform seismic hazard analysis and evaluate site-specific seismic risks.
CO3	Analyze the dynamic response of buildings and structures under seismic excitation.
CO4	Design earthquake-resistant structures using modern seismic design codes and retrofitting techniques.
CO5	Apply recent advances in earthquake engineering to enhance structural resilience during seismic events.

Course Description

The Earthquake Engineering course focuses on the analysis, design, and construction of structures to withstand seismic forces. Topics include seismic hazard analysis, response of structures to earthquakes, earthquake-resistant design principles, and retrofitting techniques. The course also covers the use of dynamic analysis methods to predict the behavior of buildings, bridges, and other infrastructure during earthquakes.

Course Objectives

- To understand the principles of earthquake engineering and seismic risk assessment.
- To analyze the dynamic behavior of structures under seismic loads.
- To apply earthquake-resistant design techniques and retrofitting methods to improve the seismic performance of structures.
- To provide students with the skills to assess and mitigate earthquake-induced damage in civil engineering projects.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	1	1	-	-	2	2	2
CO2	2	2	1	3	1	2	1	-	-	3	2	3
CO3	1	3	-	-	3	2	2	-	-	3	3	3
CO4	2	-	-	3	2	2	2	2	-	3	2	3
CO5	2	3	3	2	2	3	3	2	1	3	3	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	2
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

1st Year - II Semester: M. Tech. (Structural Engineering)

Lab: Material Testing, Experimental Methods & Quality Control

Credit: 2 **Max. Marks**: 100 (IA:60, ETE:40)

0L+0T+4P

S.No	Experiment
1	Familiarization with Material Testing Equipment: Understanding the different tools and machines used for material testing.
2	Tensile Testing of Materials: Conducting tensile tests to determine the material's ultimate tensile strength, yield strength, and elongation properties.
3	Hardness Testing: Performing hardness tests using different methods such as Rockwell, Brinell, and Vickers to assess material resistance to indentation.
4	Impact Testing: Measuring the toughness of materials by performing Charpy or Izod impact tests to evaluate energy absorption under high-speed loading.
5	Fatigue Testing: Evaluating the durability of materials under repeated cyclic loading to determine the number of cycles before failure.
6	Bend Test: Investigating the ductility and bending strength of materials by subjecting them to bending forces and measuring deflection and failure modes.
7	Microscopic Analysis: Using optical or electron microscopes to examine material microstructure and correlate it with mechanical properties.
8	Quality Control Techniques: Implementing Statistical Process Control (SPC) to monitor manufacturing processes and maintain consistent quality through data analysis.

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, III Sem: Structural Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Finite Element Analysis	5	0	0	3	25	100	125	5
2	Repair and Rehabilitation of Structures	5	0	0	3	25	100	125	5
3	Seminar	0	0	0		90	60	150	6
4	Dissertation- I	0	0	0		100	0	100	4
	Total					**240**	**260**	**500**	**20**

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits*
***ETE:** End Term Exam, **IA:** Internal Assessment*
***: Not to be considered for award of division*

2^{nd} Year - III Semester: M. Tech. (Structural Engineering)

Sub: Finite Element Analysis

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Basics of Finite Element Analysis, its history, and applications in engineering. Discretization of a continuous system, concept of nodes and elements.	01
2.	**Basic Concepts of FEA**: Mathematical formulation of FEA, types of elements (1D, 2D, and 3D), node-based approach, interpolation functions, stiffness matrix, and global system equations. Basic steps of FEA procedure.	08
3.	**Finite Element Modeling**: Types of elements (linear and quadratic), element properties, assembling of global stiffness matrix, boundary conditions, and solution methods (direct and iterative methods).	08
4.	**Structural Analysis using FEA**: Analysis of trusses, beams, and frames using FEA. Applications of 2D and 3D elements in structural problems. Static and dynamic analysis of structures.	07
5.	**Thermal and Fluid Flow Analysis**: FEA for heat conduction and convection problems, transient heat transfer, steady-state heat analysis, fluid flow analysis using FEA. Application to thermal stresses.	09
6.	**Nonlinear Analysis and Advanced Topics**: Nonlinear material models, large deformation analysis, contact problems, buckling analysis, and introduction to dynamic FEA (modal analysis, transient analysis). Use of FEA in multi-disciplinary fields.	08

Text/Reference Books:

1. Zienkiewicz, O.C., and Taylor, R.L., *The Finite Element Method*.
2. Cook, R.D., *Concepts and Applications of Finite Element Analysis*.
3. Reddy, J.N., *An Introduction to the Finite Element Method*.
4. Bathe, K.J., *Finite Element Procedures*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the basic concepts and principles of the finite element method and its applications.
CO2	Perform finite element modeling of various structures and systems under static loading.
CO3	Solve structural problems using FEA and interpret the results of the analysis.
CO4	Apply FEA to thermal and fluid flow problems, and understand heat transfer simulations.
CO5	Analyze nonlinear behavior and perform dynamic analysis using FEA.

Course Description

The **Finite Element Analysis (FEA)** course provides an in-depth understanding of the finite element method as a powerful tool for solving complex engineering problems. It covers the formulation of the finite element method, mesh generation, and the application of FEA to structural, thermal, and fluid flow problems. Emphasis is placed on both the theory and practical aspects, enabling students to use commercial FEA software for real-world engineering simulations.

Course Objectives

- To introduce students to the fundamentals of the finite element method and its application to engineering problems.
- To develop skills in formulating and solving problems using FEA for structures, heat transfer, and fluid mechanics.
- To enable students to use FEA software tools for practical problem-solving and simulation.
- To explore error analysis, convergence, and optimization techniques in the context of finite element solutions.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	2	-	-	-	-	-	-	-	2
CO2	2	-	-	3	3	2	1	-	-	-	-	-
CO3	2	-	-	3	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	3	3	2	-	3	-	-
CO5	-	3	-	-	3	-	-	2	1	3	-	-

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	2
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

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2nd Year - III Semester: M. Tech. (Structural Engineering)

Sub: Repair and Rehabilitation of Structures

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course. Overview of the importance of repair and rehabilitation in civil engineering, common causes of deterioration in structures.	01
2.	**Deterioration of Materials and Structures**: Factors affecting the durability of concrete, steel, and other materials. Corrosion of reinforcement, alkali-silica reaction, fatigue in materials, and environmental effects.	07
3.	**Assessment and Diagnosis of Structural Damage**: Techniques for assessment, non-destructive testing methods (e.g., ultrasonic testing, radiography, and impact echo testing), visual inspection, load testing, and diagnosis of structural issues.	09
4.	**Repair Materials and Techniques**: Overview of repair materials (polymer-based, cement-based, and other specialized materials). Techniques for concrete repair, reinforcement, and strengthening, including epoxy injections, shotcrete, carbon fiber wraps.	08
5.	**Rehabilitation Techniques for Concrete and Steel Structures**: Strengthening of structural elements: beams, columns, slabs. Techniques such as external post-tensioning, jacketing, and bonded steel plates. Rehabilitation of steel structures, control of corrosion, and maintenance strategies.	09
6.	**Case Studies and Future Trends**: Case studies of successful repair and rehabilitation projects, including bridges, dams, and buildings. Emerging technologies in repair (e.g., self-healing concrete, nanomaterials). Sustainable practices in rehabilitation.	07

Text/Reference Books:

1. Shetty, M.S., *Concrete Technology: Theory and Practice*.
2. Rao, S., *Repair and Rehabilitation of Concrete Structures*.
3. Neville, A.M., *Properties of Concrete*.
4. Gupta, A., and Sharma, R., *Repair and Rehabilitation of Structures*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the fundamental causes of deterioration in materials and structures.
CO2	Apply non-destructive testing and diagnostic techniques to assess the condition of structures.
CO3	Select appropriate repair materials and techniques for different types of structural damage.
CO4	Develop and apply rehabilitation techniques to strengthen and extend the life of existing structures.
CO5	Study case studies of repair projects and understand emerging trends and sustainable practices in rehabilitation.

Course Description

The Repair and Rehabilitation of Structures course focuses on the assessment, repair, and strengthening of deteriorated or damaged structures. It covers various causes of structural damage, including environmental factors, material degradation, and design deficiencies, and introduces techniques for evaluating the condition of structures. Students will learn modern methods and materials used in repair and rehabilitation, emphasizing sustainability and safety.

Course Objectives

- To provide an understanding of the causes of structural deterioration and failure in buildings and infrastructure.
- To introduce various assessment techniques and strategies for diagnosing the condition of existing structures.
- To develop proficiency in selecting appropriate repair materials, methods, and technologies for rehabilitating structures.
- To emphasize sustainable and cost-effective solutions for the repair and strengthening of structures, ensuring long-term performance.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	3	-	-	-	-	-	1	-	1
CO2	3	1	1	2	1	-	1	-	-	-	-	-
CO3	2	2	3	2	-	-	2	-	-	-	-	2
CO4	3	2	3	2	2	-	-	-	-	-	-	1
CO5	3	1	-	2	3	-	-	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	1	3	2
CO3	-	1	-
CO4	2	2	1
CO5	3	2	3