TECHNO INDIA UNIVERSITY

WEST BENGAL

Syllabus for

M.Tech in Civil Engineering

AY 2024-2025

TECHNO INDIA UNIVERSITY
WEST BENGAL

1st Semester

Department of Civil Engineering

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Advanced Numerical Analysis	**Subject Code:** TIU-PMA-T115
Contact Hours/Week: 4–0–0 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE:

Learning the Numerical techniques to obtain approximate solutions of various mathematical problems which cannot be solved analytically.

COURSE OUTCOME :

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

CO1	To solve a system of linear equations through direct methods.	K3
CO2	To deduce a system of linear equations through indirect methods.	K4
CO3	To calculate eigen value problem.	K4
CO4	To apply numerical methods to approximate a function.	K3
CO5	To deduce least square curve fitting.	K4
CO6	To examine numerical solution of initial value problems.	K4

COURSE CONTENT:

MODULE 1:		8 Hours
Solution of Simultaneous Linear Equations - Direct Methods – Gauss Elimination, Gauss Jordan, LU Decomposition, Matrix Inversion.		
MODULE 2:		8 Hours
Iterative Methods – Gauss - Jacobi, Gauss – Seidel		
MODULE 3:		4 Hours
Relaxation method. Necessary and sufficient conditions for convergence. Speed of convergence. (Proofs not required) S.O.R. and S.U.R. methods. Gerschgorin's circle theorem. (Statement only).		
MODULE 4:		5 Hours
Eigen value problem – Numerical largest value, Determination of eigen value by iterative methods.		
MODULE 5:		5 Hours
Quadratic Approximation, Cubic Spline Interpolation.		
MODULE 6:		7 Hours

Least Square Curve Fitting, nonlinear regression		
MODULE 7:		8 Hours
Numerical solution of initial value problems by Euler, Modified Euler, Runge-Kutta and Predictor-Corrector method.		
TOTAL LECTURES		45 Hours

Text Books:

1. Dr. B. S. Grewal – Numerical Methods in Engineering and Science

2. K Das – Numerical Methods

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3		2	2						1			
CO2	3		3	2						2			
CO3	3		2	2						1			
CO4	3	2	2	3						2			
CO5	3	2	3	2						2			
CO6	3	2	3	3						3			
	3	2	2.5	2.33						1.83			

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WEST BENGAL

rogram: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Structural Dynamics	**Subject Code:** TIU-PCE-T103
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE:

Enable the student to:

1- Understand the fundamental concepts of structural dynamics, including single-degree and multi-degree freedom systems, and analyze their response to various types of excitations.
2- Apply analytical and numerical methods, such as modal analysis and approximate techniques, to evaluate dynamic responses in structures subjected to external forces, including earthquake excitations.
3- Develop proficiency in random vibration theory, including response analysis using Fourier transform methods, and understand the significance of power spectral density functions in structural dynamics.

COURSE OUTCOME :

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

CO1	**Explain** the fundamental principles of structural dynamics, including free and forced vibrations of single-degree-of-freedom (SDOF) systems.	K2
CO2	**Analyze** and**compute**the response of multi-degree-of-freedom (MDOF) systems using modal analysis techniques.	K3
CO3	**Differentiate** and **classify** the behavior of structures subjected to various dynamic loads, including wind, blast, and seismic forces.	K4
CO4	**Examine** and **interpret** earthquake-induced structural responses and appraise seismic design provisions from relevant codes.	K4
CO5	**Utilize** and **demonstrate** the use of modern computational tools and software for structural dynamics analysis and earthquake-resistant design.	K3
CO6	Critically **evaluate** anddevelop seismic mitigation strategies for structures by integrating advanced engineering solutions and sustainability considerations.	K4

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO STRUCTURAL DYNAMICS AND FREE VIBRATION ANALYSIS**	**5 HOURS**
Fundamentals of structural dynamics, concepts of mass, stiffness, and damping. Free vibration in single-degree-of-freedom (SDOF) systems, including natural frequency, period, and amplitude. Damping effects and types, practical applications of free vibration analysis for assessing structural behavior under minor disturbances.		
MODULE 2	**FORCED VIBRATION OF SINGLE-DEGREE-OF-FREEDOM SYSTEMS**	**6 HOURS**
Response of SDOF systems to various types of forced vibrations (harmonic, periodic, transient).		

Resonance, phase angle, and dynamic magnification. Solutions for undamped and damped forced vibrations, response under arbitrary and impulse loading. Introduction to vibration control using smart materials (e.g., piezoelectric, shape memory alloys), Use of Tuned Mass Dampers (TMDs) in skyscrapers and bridges		
MODULE 3	**MULTI-DEGREE-OF-FREEDOM (MDOF) SYSTEMS**	**7 HOURS**
Modeling MDOF structures, equations of motion, natural modes of vibration. Introduction to modal analysis, solving dynamic response of structures with multiple degrees of freedom, including buildings and bridges.		
MODULE 4	**NUMERICAL METHODS IN STRUCTURAL DYNAMICS**	**7 HOURS**
Numerical approaches such as Newmark-Beta method, Wilson-Theta method, and other time-integration techniques. Application of numerical methods to analyze time-history responses in earthquake engineering and wind loading scenarios.		
MODULE 5	**RESPONSE SPECTRUM ANALYSIS**	**7 HOURS**
Importance of response spectrum analysis in earthquake-resistant design. Construction and interpretation of response spectra, role of damping and period in response determination. Practical applications in seismic design and structural analysis under earthquake loads.		
MODULE 6	**STRUCTURAL DYNAMICS IN SEISMIC DESIGN APPLICATIONS**	**7 HOURS**
Application of structural dynamics principles to seismic design. Seismic design criteria, base isolation techniques, importance of damping in seismic response mitigation. Case studies of real-world seismic designs, performance-based design for dynamic loading conditions.		
MODULE 7	**SPECIAL TOPICS IN STRUCTURAL DYNAMICS**	**6 HOURS**
Advanced topics in structural dynamics: soil-structure interaction, dynamic behavior of high-rise buildings, effects of blast and impact loads. Exploration of current research trends, complex dynamic phenomena in specialized applications, advancements in dynamic analysis tools and techniques.		
TOTAL		**45 HOURS**

Books:

1. Chopra,A.K.,Dynamics of Structures:Theory and Applications to Earthquake Engineering,Prentice Hall/Pearson Education
2. Clough,R.W.andPenzien,J.,Dynamics of structures,McGrawHill,Inc.,NewYork
3. Craig,R.R.,StructuralDynamics:An Introduction to ComputerMethods,WileyNewYork
4. Rao,S.S.,MechanicalVibrations,Pearson
5. Thomson,W.T.,Theory of Vibration with Application,CRC Press
6. Newland,D.E.,An Introduction to Random Vibrations ,Spectral and Wavelet Analysis,Courier Dover Publications

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	2	2	1	2	1	0	1	2			
CO2	3	3	3	2	1	2	1	0	1	3			
CO3	3	3	3	3	2	3	2	1	2	3			
CO4	3	3	3	3	3	3	2	1	2	3			
CO5	2	3	3	3	2	3	2	1	2	3			
CO6	2	3	3	3	3	3	3	1	2	3			
	2.67	2.83	2.83	2.67	2.0	2.67	1.83	0.67	1.67	2.83			

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Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Matrix Computer Method of Structural Analysis	**Subject Code:** TIU-PCE-T105
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:

1- With a comprehensive understanding of matrix methods for structural analysis.
2- Develop proficiency in computational techniques for analyzing complex structural systems.
3- Emphasize the formulation and application of stiffness and flexibility methods in structural ```
4- Enhance skills in coding and utilizing structural analysis software for efficient problem-solving.
5- Apply matrix methods to real-world engineering challenges effectively.

COURSE OUTCOME :

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

CO1	Recall the fundamental concepts of matrix methods in structural analysis, including stiffness and flexibility methods..	K1
CO2	Identify different types of structural systems (trusses, beams, frames) and their representation in matrix form..	K1
CO3	Explain the formulation of element and global stiffness matrices for various structural elements..	K2
CO4	Illustrate the direct stiffness method and its application to solve structural problems.	K2
CO5	Develop and solve equilibrium equations for complex structures using matrix methods.	K3
CO6	Implement numerical techniques and computer algorithms for structural analysis using programming or finite element software..	K3

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO MATRIX METHODS IN STRUCTURAL ANALYSIS**	**6 HOURS**
Overview of structural analysis and the role of matrix methods. Introduction to basic concepts such as degrees of freedom, nodal displacements, and boundary conditions. Fundamentals of matrix algebra and its application in structural analysis. Importance of coordinate systems and vector transformations. Comparison between classical and matrix methods, highlighting their respective advantages and applications.		
MODULE 2	**STIFFNESS METHOD FOR STRUCTURAL ANALYSIS**	**7 HOURS**
Formulation of stiffness matrices for 1D, 2D, and 3D structural elements. Development of member stiffness matrices for beams, trusses, and frames. Process of assembling the global stiffness matrix for multi-node systems, with considerations for numerical stability. Application of boundary conditions and solving equilibrium equations using the stiffness method. Practical applications of the stiffness method in real-world structural systems.		

MODULE 3	**FLEXIBILITY (FORCE) METHOD OF STRUCTURAL ANALYSIS**	**6 HOURS**
Fundamentals of the flexibility method and its significance in structural analysis. Development of flexibility matrices for statically indeterminate structures. Formulation of compatibility conditions for multi-member structures. Methods for determining member forces and displacements using the flexibility method. Comparison between flexibility and stiffness methods to understand their relative advantages in different scenarios.		
MODULE 4	**DIRECT STIFFNESS METHOD**	**7 HOURS**
Formulation of direct stiffness matrices for different types of structures. Step-by-step solution process for trusses, beams, and frames using the direct stiffness method. Use of displacement boundary conditions in direct stiffness applications. Techniques for simplifying and optimizing matrix operations for large-scale structural systems. Case studies demonstrating practical applications of the direct stiffness method.		
MODULE 5	**COMPUTER IMPLEMENTATION OF MATRIX METHODS**	**5 HOURS**
Fundamentals of coding for matrix operations in structural analysis, using tools such as MATLAB and Python. Development of algorithms for stiffness and flexibility analysis. Creation of scripts for automated matrix assembly and solution procedures. Methods for validating computational models with theoretical examples. Applications of coding for analyzing large and complex structures.		
MODULE 6	**NONLINEAR ANALYSIS IN MATRIX METHODS**	**7 HOURS**
Introduction to nonlinear analysis and its relevance in structural engineering. Different types of nonlinearities, including material, geometric, and boundary conditions. Iterative methods for solving nonlinear equilibrium equations. Nonlinear matrix formulations in the stiffness method. Practical examples of nonlinear behavior in reinforced concrete and steel structures.		
MODULE 7	**APPLICATIONS AND ADVANCED TOPICS**	**7 HOURS**
Eigenvalue and modal analysis for evaluating the dynamic response of structures. Stability analysis using matrix methods, including buckling analysis of columns and frames. Introduction to finite element methods (FEM) as an extension of matrix methods. Use of structural analysis software such as SAP2000, ETABS, and ANSYS for solving complex engineering problems. Future trends and research applications in matrix computer methods.		
TOTAL		**45 hours**

Books:

1. W. Weaver Jr. and J. M. Gere, *Matrix Analysis of Framed Structures*, 3rd Edition, Springer, 2012.
2. C. S. Reddy, *Basic Structural Analysis*, 3rd Edition, McGraw Hill Education, 2010.
3. J. L. Meek, *Matrix Structural Analysis*, McGraw Hill Education, 2001.
4. W. McGuire, R. H. Gallagher, and R. D. Ziemian, *Matrix Structural Analysis*, 2nd Edition, John Wiley & Sons, 2000.
5. S. Rajasekaran and G. Sankarasubramanian, *Computational Structural Mechanics*, PHI Learning, 2001.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	1	2	2					2			
CO2	3	3	2	3	2					2			
CO3	3	3	3	3	2				2	3			
CO4	3	3	3	3	2	2			2	3			
CO5	3	3	3	3	2	3			3	3			
CO6	3	3	3	3	3	3	2	2	3	3			
	3	2.8	2.5	2.8	2.16	2.6	2	2	2.5	2.6			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Prestressed Concrete	**Subject Code:** TIU-PCE-E101A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:

1- Understand the fundamental concepts, advantages, and construction principles of precast and prestressed concrete systems.
2- Analyze and design prestressed concrete members considering strength, serviceability, and various prestressing methods.
3- Evaluate the behavior of prestressed structural elements, including anchorage zones, composite construction, and indeterminate structures.

COURSE OUTCOME :

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

CO1	**Explain** the fundamental concepts, advantages, and limitations of precast and prestressed concrete.	K1
CO2	**Analyze** the different methods of prestressing and their effects on structural members.	K2
CO3	**Evaluate** the losses in prestress and their influence on member behavior.	K3
CO4	**Design** prestressed concrete members for flexure and shear as per codal provisions.	K3
CO5	**Assess** the stresses in anchorage zones of prestressed members and design end blocks using standard guidelines.	**K3**
CO6	**Apply** the concepts of partial prestressing, composite construction, and prestressing of indeterminate structures in practical applications.	**K3**

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO PRE-STRESSED CONCRETE**	**6 HOURS**
Fundamental concepts of pre-stressed concrete, including the need for pre-stressing and its advantages over conventional reinforced concrete. Different methods of pre-stressing, including pre-tensioning and post-tensioning. Materials used in pre-stressed concrete, such as high-strength concrete and steel, and their significance in enhancing structural performance.		
MODULE 2	**ANALYSIS OF PRE-STRESSED CONCRETE BEAMS**	**7 HOURS**
Analysis of pre-stressed concrete beams under different loading conditions. Basic concepts of stress distribution in pre-stressed members, load balancing, and linear and non-linear stress calculations. Examination of rectangular, T-beams, and I-sections with respect to bending, shear, and torsional resistance.		
MODULE 3	**LOSSES IN PRE-STRESS**	**6 HOURS**
Different types of pre-stress losses, including elastic shortening, creep, shrinkage, relaxation of steel, anchorage slip, and frictional losses. Methods to quantify these losses and assess their impact on the performance of pre-stressed members. Calculation techniques for determining effective pre-stress after accounting for all losses.		

MODULE 4	**DESIGN OF PRE-STRESSED CONCRETE MEMBERS**	**6 HOURS**
Design principles for pre-stressed concrete members, with a focus on simply supported beams under bending, shear, and torsion. Guidelines and requirements from design codes such as IS: 1343. Practical design examples of rectangular and flanged beams, emphasizing durability, serviceability, and safety considerations.		
MODULE 5	**ANCHORAGE ZONE STRESSES AND DESIGN**	**5 HOURS**
Stresses developed in the anchorage zone of post-tensioned members, including bursting, spalling, and transverse tensile stresses. Design methods for anchorage zones and reinforcement detailing to resist these stresses. Real-world applications and design examples demonstrating the critical role of anchorage in pre-stressed concrete structures.		
MODULE 6	**COMPOSITE CONSTRUCTION IN PRE-STRESSED CONCRETE**	**8 HOURS**
Composite construction techniques integrating pre-stressed and reinforced concrete for enhanced structural performance(UHPC-Prestressed Composite Beams for Modular Bridge Systems) Analysis and design principles for composite beams, precast pre-stressed elements, and slab systems. Applications and advantages of composite construction, particularly in bridge and high-rise building projects.		
MODULE 7	**APPLICATIONS AND ADVANCED TOPICS IN PRE-STRESSED CONCRETE**	**7 HOURS**
Applications of pre-stressed concrete in bridges, high-rise buildings, and industrial structures(Example-Precast Prestressed Hollow Core Slabs for High-Rise Buildings: A Sustainability Perspective), Advanced topics such as partially pre-stressed sections, long-span structures, and circular pre-stressed concrete elements like tanks and pipes. Emerging trends and technologies in pre-stressing, including segmental and precast construction(for example Carbon Fiber-Reinforced Prestressing Tendons for Corrosion-Free Structures), providing a modern perspective on the subject.		
TOTAL		**45 HOURS**

Books:

1. T. Y. Lin and N. H. Burns, *Design of Prestressed Concrete Structures*, 3rd Edition, John Wiley & Sons, 1981.
2. N. Krishna Raju, *Prestressed Concrete*, 5th Edition, Tata McGraw Hill, 2012.
3. P. Dayaratnam, *Prestressed Concrete Structures*, Oxford & IBH Publishing, 2000.
4. S. Ramamrutham, *Prestressed Concrete*, Dhanpat Rai Publishing, 2017.
5. S. K. Mallick and A. P. Gupta, *Prestressed Concrete*, Oxford & IBH Publishing, 2007.
6. M. K. Hurst, *Prestressed Concrete Design*, 2nd Edition, E & FN Spon, 1998.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	2	1	-	1	-	-	-	1			

CO2	3	3	3	2	-	1	-	-	-	2			
CO3	3	3	3	3	1	1	-	-	-	2			
CO4	3	3	3	3	-	2	1	-	-	2			
CO5	3	3	3	2	-	2	1	-	-	2			
CO6	3	3	3	3	-	3	1	1	1	3			
	3	2.8	2.8	2.3	1	1.6	1	1	1	2.5			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Elective-II (Numerical Methods in Structural Engineering)	**Subject Code:** TIU-PCE-E103A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:

1- Understand fundamental concepts of probability and statistics for structural engineering applications.
2- Apply numerical techniques to solve systems of linear equations relevant to structural analysis.
3- Implement numerical methods for solving ordinary and partial differential equations encountered in structural problems.
4- Analyze the stability and consistency of numerical schemes used in engineering computations.

COURSE OUTCOME :

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

CO1	Recall fundamental concepts of numerical methods and their applications in structural engineering.	K1
CO2	Understand and apply numerical techniques to solve ordinary and partial differential equations relevant to structural analysis.	K2
CO3	Utilize finite element methods for modeling and analyzing structural systems.	K2
CO4	Assess the accuracy, stability, and convergence of numerical solutions in structural analysis.	K3
CO5	Implement numerical methods using programming tools for solving structural engineering problems.	K3
CO6	Evaluate the effectiveness of numerical methods in handling real-world structural engineering challenges.	K2

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO NUMERICAL METHODS AND ERROR ANALYSIS**	**5 HOURS**
Role of numerical methods in structural engineering and their importance in computational analysis. Overview of different types of errors in numerical calculations, including truncation and round-off errors. Error estimation techniques and the significance of accuracy and stability in numerical computations used for engineering applications.		
MODULE 2	**SOLUTION OF LINEAR ALGEBRAIC EQUATIONS**	**6 HOURS**
Various methods for solving linear algebraic equations, which are fundamental in structural analysis. Techniques such as Gaussian elimination, LU decomposition, and iterative approaches like Jacobi and Gauss-Seidel methods. Applications in structural systems like trusses and frames, with a focus on computational implementation.		

MODULE 3	**EIGENVALUE PROBLEMS IN STRUCTURAL ENGINEERING**	**5 HOURS**
Importance of eigenvalue problems in understanding the dynamic behavior and stability of structures. Methods for calculating eigenvalues and eigenvectors, including the power method and QR algorithm. Applications in determining natural frequencies and mode shapes of structural systems.		
MODULE 4	**NUMERICAL INTEGRATION AND DIFFERENTIATION**	**5 HOURS**
Numerical integration and differentiation techniques used in structural engineering. Methods such as the trapezoidal rule, Simpson's rule, and Gaussian quadrature. Applications include calculating deflections, slopes, and areas under structural curves to analyze bending and shear behavior.		
MODULE 5	**FINITE DIFFERENCE METHOD (FDM) AND APPLICATIONS**	**5 HOURS**
Introduction to the finite difference method (FDM) for solving differential equations in structural analysis. Approximation of partial differential equations (PDEs) related to structural behavior, including deflection in beams and plate bending problems. Boundary value problems and hands-on exercises in FDM application.		
MODULE 6	**FINITE ELEMENT METHOD (FEM) FOR STRUCTURAL ANALYSIS**	**5 HOURS**
Overview of the finite element method (FEM) and its application in structural engineering. Concepts of discretization, shape functions, and stiffness matrix formulation for elements like bars, beams, and 2D elements. Formulation and solution of basic FEM problems with an emphasis on complex structural systems(FEM-Based Seismic Analysis of Mid-Rise Structures Using Python Libraries (e.g., FEniCS)), Comparative Study of FEM vs. FDM for Solving Structural Stability Problems		
MODULE 7	**OPTIMIZATION TECHNIQUES IN STRUCTURAL ENGINEERING**	**5 HOURS**
Exploration of optimization techniques, including linear and nonlinear programming and gradient-based optimization methods. Objective function formulation, constraint handling, and applications in structural design optimization, such as weight minimization and material cost efficiency in structural components.		
MODULE 8	**ADVANCED TOPICS AND COMPUTATIONAL TOOLS**	**9 HOURS**
Advanced topics, including nonlinear numerical methods and an introduction to computational tools such as MATLAB and Python for numerical analysis. Case studies demonstrating the application of numerical methods in real-world structural engineering challenges, integrating theoretical and practical perspectives.		
TOTAL		**45 HOURS**

Books: .

1. M.K. Jain, S.R.K. Iyengar, and R.K. Jain – Numerical Methods: Problems and Solutions, Wiley Eastern Limited.
2. S. Ross – Introduction to Probability Models, Wiley India.
3. A.M. Gun, M.K. Gupta, and B.S. Gupta – Fundamentals of Statistics. .
4. J.B. Scarborough – Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
5. R.W. Hamming – Numerical Methods for Scientists and Engineers, McGraw-Hill.
6. J.H. Mathews and K.D. Fink – Numerical Methods Using MATLAB, Pearson Education.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	3	3	2	-	-	-	1	-			
CO2	3	3	2	2	2	-	-	-	1	-			
CO3	3	2	2	2	2	-	-	-	1	-			
CO4	3	2	2	3	2	-	-	-	1	-			
CO5	3	2	2	2	2	-	-	-	1	-			
CO6	3	3	2	2	3	-	-	-	1	-			
	3	2.3	2.16	2.3	2.16	-	-	-	1	-			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Elective-III (Advanced RCC)	**Subject Code:** TIU-PCE-E105A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:
Enable the student to:

1- Understand advanced concepts and methodologies in reinforced cement concrete (RCC) design.
2- Apply relevant design codes and standards to ensure structural safety and performance.
3- Analyze RCC structures under different loading conditions and optimize structural design.
4- Utilize software tools for modeling, analysis, and design of advanced RCC structures.

COURSE OUTCOME :

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

CO1	**Identify** the advanced material properties and behavior of concrete and reinforcement, including high-performance and fiber-reinforced concrete.	K1
CO2	**Explain** the principles of durability and serviceability in RCC structures, including environmental effects and maintenance strategies.	K2
CO3	**Apply** advanced design codes and standards (IS, ACI, Eurocodes) in RCC design for structural integrity and safety.	K3
CO4	**Identify** the behavior of complex RCC structural elements like deep beams, flat slabs, silos, and pile foundations using modern techniques.	K1
CO5	**Explain** the design of special RCC structures like water tanks, chimneys, and machine foundations, including crack width calculation and control.	**K2**
CO6	**Apply** RCC structural modeling techniques using advanced software tools (SAP2000, ETABS, STAAD.Pro) for design and analysis.	**K3**

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO ADVANCED RCC DESIGN**	**4 HOURS**
Overview of advanced concepts in RCC design, including a comparison of traditional and modern design approaches. Importance of advanced design techniques in improving structural performance and safety. Introduction to Performance based philosophy.		
MODULE 2	**MATERIAL PROPERTIES AND BEHAVIOR**	**5 HOURS**
Exploration of material properties and behavior in RCC, including concrete(UHPC, Self-healing concrete etc) and reinforcement(GFRP, BFRP, CFRP and shape memory alloy). Mechanical properties of concrete, stress-strain relationships, and the influence of different types of reinforcement on structural behavior.		
MODULE 3	**ADVANCED TECHNOLOGIES IN RCC DESIGN**	**4 HOURS**
Integration of advanced technologies in RCC design, including fiber-reinforced concrete, high-performance concrete, and sustainability considerations. Advancements in materials and their applications in structural design.		
MODULE 4	**DESIGN FOR DURABILITY AND SERVICEABILITY**	**4 HOURS**
Principles of designing RCC structures for durability and serviceability. Effects of environmental factors, maintenance strategies, and importance of serviceability in design.		

MODULE 5	**ADVANCED DESIGN CODES AND STANDARDS**	**4 HOURS**
Study of latest design codes and standards governing RCC design, including Eurocodes, ACI codes, and IS codes. Emphasis on adhering to standards to ensure safety and structural integrity.		
MODULE 6	**DESIGN OF COMPLEX STRUCTURAL ELEMENTS**	**5 HOURS**
Design considerations and methodologies for complex RCC structural elements, including deep beams, corbels, flat slabs, silos & bunkers, piles & pile foundations.		
MODULE 7	**DESIGN OF SPECIAL STRUCTURES**	**5 HOURS**
Structural systems, analysis & design of special structures. Analysis & design techniques for water towers, calculation of crack widths and crack control designs, RCC chimney, and machine foundations.		
MODULE 8	**SOFTWARE APPLICATIONS IN RCC DESIGN**	**6 HOURS**
Introduction to software tools used in RCC design and analysis. Hands-on experience with software packages such as SAP2000, ETABS, and STAAD.Pro for modeling, analysis, and design processes.		
MODULE 9	**CASE STUDIES AND PRACTICAL APPLICATIONS**	**8 HOURS**
Analysis of real-world case studies in advanced RCC design. Exploration of successful projects, lessons learned, and application of advanced design principles in practice. Encouraging critical thinking about design challenges and solutions.		
TOTAL		**45 HOURS**

Books: .

1. S. S. Rao, *Applied Numerical Methods for Engineers and Scientists*, Prentice Hall, 2002.
2. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson, 2004.
3. R. D. Cook, D. S. Malkus, and M. E. Plesha, *Concepts and Applications of Finite Element Analysis*, Wiley, 2001.
4. K. A. Smith, R. W. Hutton, and J. S. Picher, *Numerical Methods in Structural Engineering*, McGraw-Hill, 1976.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	-	-	-	-	-	-	-	-			
CO2	3	3	2	-	-	-	-	-	-	2			
CO3	3	3	3	3	-	-	-	-	-	3			
CO4	3	3	2	3	2	-	-	-	-	3			
CO5	3	3	3	3	2	-	-	-	2	3			
CO6	3	3	3	3	2	3	-	-	3	3			
	3	2.8	2.6	3	2	3			2.5	2.8			

TECHNO INDIA UNIVERSITY

WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Structural Engineering Laboratory	**Subject Code:** TIU-PCE-S105
Contact Hours/Week: 0–0–3 (L–T–P)	**Credit: 1.5**

COURSE OBJECTIVE:

Enable the student to:

1- Know advanced programming concepts and their application in structural engineering using latest software applications.
2- Develop computational models for structural analysis and design using modern engineering tools.
3- Apply numerical methods, mix design principles, and strength prediction techniques in solving real-world structural engineering problems using state-of-the-art software applications.

COURSE OUTCOME :

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

CO1	Understand the **fundamentals of Python programming** and apply control structures to automate calculations.	K2
CO2	Apply **Python libraries** (NumPy, Pandas, Matplotlib) for array manipulation and **data visualization** in structural engineering.	K3
CO3	Develop scripts for **matrix operations, structural analysis, and finite element formulations**.	K3
CO4	Perform **mix design calculations** and analyze the impact of various parameters on concrete strength using Python.	K4
CO5	Analyze the effectiveness of **machine learning techniques** in Python for predicting **concrete compressive strength**.	K4
CO6	Evaluate the applicability of **Python-based numerical methods** for solving structural engineering problems.	K4

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO PYTHON AND BASICS**	**6 HOURS**
Overview of Python programming language, history, and evolution. Basic Python syntax and structure. Data types and variables. Arithmetic and logical operations. Reading and writing data. Formatting output. File handling in Python.		
MODULE 2	**CONTROL STRUCTURES IN PYTHON**	**6 HOURS**
Control structures (if statements, loops). Practice problems using Python. Programming using loops, conditional statements, and formatted output.		
MODULE 3	**PYTHON FUNCTIONS AND MODULES**	**6 HOURS**
Writing and using functions. Importing and utilizing built-in and external modules. Creating reusable functions and modular programming concepts. Examples of functions relevant to structural analysis.		
MODULE 4	**ARRAY PROCESSING AND MIX DESIGN USING PYTHON**	**6 HOURS**
Introduction to NumPy arrays. Array operations and manipulation. Multi-dimensional arrays and matrix operations in Python. Basic mix design calculations using Python for proportioning concrete ingredients. Analyzing the effect of water-cement ratio, aggregate gradation, and admixtures using		

Python-based data visualization (Matplotlib, Pandas).		
MODULE 5	**STRENGTH PREDICTION AND APPLICATIONS IN STRUCTURAL ENGINEERING**	**21 HOURS**
Structural analysis using Python. Using libraries like NumPy, SciPy, and Matplotlib for solving structural problems. Design and analysis of Reinforced Concrete (RCC) structures. Finite Element Analysis (FEA) using Python-based tools (e.g., FEniCS, PyNite). Developing scripts for beam and frame analysis. **Strength prediction of concrete using machine learning models in Python (Scikit-Learn, TensorFlow).** Implementing regression models to predict compressive strength based on mix proportions and curing conditions. Individual or group projects applying Python to solve real-world structural engineering problems.		
TOTAL		**45 HOURS**

Books: .

1. "Python for Engineers and Scientists" – Kuldeep Singh .
2. "Numerical Methods in Engineering with Python" – Jaan Kiusalaas
3. "Machine Learning for Civil Engineering" – Anil K. Bera & S. Rajasekaran

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3			2									
CO2	3			2									
CO3	3		2	3									
CO4	3		2	2		1							
CO5			3	3					2				
CO6	3		2	3					2				
	3		2.24	2.5		1			2				

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Advanced Software Laboratory	**Subject Code:** TIU-PCE-S107
Contact Hours/Week: 0–0–3 (L–T–P)	**Credit: 1.5**

COURSE OBJECTIVE:

Enable the student to:.

i. Software tools commonly used in structural and civil engineering for analysis and design.
ii. Develop computational skills to perform mathematical and matrix operations related to structural analysis.
iii. Enhance data visualization abilities by generating graphs and charts for effective project reporting.

COURSE OUTCOME :

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

CO1	Recall fundamental concepts of programming, algorithms, and software development methodologies.	K1
CO2	Identify various advanced software tools, libraries, and frameworks used in computational analysis and simulation.	K1
CO3	Explain the working principles of software development life cycle (SDLC), debugging techniques, and version control systems.	K2
CO4	Interpret and analyze algorithms for optimization, numerical methods, and data processing in engineering applications.	K2
CO5	Apply programming skills to develop, test, and optimize computational models for engineering simulations.	K3
CO6	Implement advanced coding techniques and software tools to solve real-world problems in structural engineering.	K3

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO NUMERICAL COMPUTATIONS**	**6 HOURS**
Overview of numerical methods and their role in structural analysis and design. Importance of computational tools in civil engineering.(use of some free/open sources-opensees, SAFI)		
MODULE 2	**FUNDAMENTALS OF SOFTWARE FOR STRUCTURAL ANALYSIS**	**6 HOURS**
Introduction to commonly used software. Understanding the interface, basic operations, and application areas(ETABS/ANSYS/MATLAB)		
MODULE 3	**MODELING AND ANALYSIS TECHNIQUES**	**9 HOURS**
Methods for structural modeling, application of loads, boundary conditions, and analysis procedures		
MODULE 4	**STRUCTURAL DESIGN IMPLEMENTATION USING SOFTWARE**	**8 HOURS**

Application of computational tools for the design of structural elements and validation of results with standard codes.(ETABS/ANSYS/SAP2000)		
MODULE 5	**AUTOMATION AND OPTIMIZATION IN STRUCTURAL ANALYSIS**	**7 HOURS**
Introduction to scripting, automation, and optimization techniques for enhancing computational efficiency.		
MODULE 6	**PRACTICAL APPLICATIONS AND CASE STUDIES**	**9 HOURS**
Hands-on practice, case studies, comparative analysis of software results, and report preparation.		
TOTAL		**45 HOURS**

Books:

1. Numerical Methods in Engineering with MATLAB" – Jaan Kiusalaas
2. "Numerical Methods for Engineers" – Steven C. Chapra, Raymond P. Canale
3. "Applied Numerical Methods for Engineers and Scientists" – Singiresu S. Rao
4. . "ETABS & SAP2000: Computers & Structures, Inc. Manuals"
5. **"MATLAB for Engineers"** – Holly Moore
6. **"Structural Analysis with MATLAB"** – F. Yang, X. Kirk Chen, Y. Tsavdaridis

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	3	3	2	-	-	-	1	-			
CO2	3	3	2	2	2	-	-	-	1	-			
CO3	3	2	2	2	2	-	-	-	1	-			
CO4	3	2	2	3	2	-	-	-	1	-			
CO5	3	2	2	2	2	-	-	-	1	-			
CO6	3	3	2	2	3	-	-	-	1	-			
	3	2.3	2.16	2.3	2.16	-	-	-	1	-			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 1st Sem
Course Title: Entrepreneurship Skill Development	**Subject Code:** TIU-PES-S189
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE:

Enable the student to:.

1- Research and analyze current trends in civil engineering, particularly in structural engineering and materials, through case studies and literature reviews.
2- Develop well-structured conference papers that address sustainability challenges in civil engineering, incorporating real-world examples and case studies.
3- Enhance technical communication skills by presenting and discussing research findings at conferences, improving public speaking and professional networking abilities.

COURSE OUTCOME :

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

CO1	Identify entrepreneurship opportunities in civil engineering and explain the role of innovation in structural engineering and materials.	K2
CO2	Analyze current trends in sustainable construction using research methodologies and industry reports.	K4
CO3	Evaluate sustainability challenges in structural engineering and assess the environmental and economic impact of new materials and techniques.	K4
CO4	Develop well-structured conference papers focused on sustainability and innovative solutions in civil engineering.	K3
CO5	Demonstrate effective public speaking and presentation skills for technical content in research seminars and conferences.	K3
CO6	Apply the peer review process by evaluating research papers constructively and revising based on feedback.	K4

COURSE CONTENT:

Module1	**INTRODUCTION TO ENTREPRENEURSHIP IN CIVIL ENGINEERING**	
Overview of entrepreneurship opportunities in civil engineering, emphasizing the importance of innovation in structural engineering and materials. Discussion on the role of entrepreneurs in sustainable construction practices.		
Module 2	**RESEARCH TECHNIQUES FOR CURRENT TRENDS**	
Methods for identifying emerging trends in civil engineering, including industry reports and case studies on advancements in sustainable construction. Analysis of research methodologies for identifying and evaluating new technologies		
Module 3	**SUSTAINABILITY ISSUES IN CIVIL ENGINEERING**	
Understanding key sustainability challenges in structural engineering, formulating research questions related to sustainability, and evaluating the environmental and economic impact of new materials and techniques in construction.		

Module 4	**WRITING CONFERENCE PAPERS**	
Structure and key components of an effective conference paper, techniques for writing impactful papers on sustainability and innovative solutions, and ethical considerations in research and technical writing		
Module 5	**PRESENTATION SKILLS**	
Techniques for effective public speaking, crafting engaging visual aids for technical content, and handling Q&A sessions to confidently present research findings in seminars and conferences.		
Module 6	**PEER REVIEW PROCESS**	
Understanding the peer review process for conference submissions, techniques for constructive evaluation of peer research papers, and revising research papers based on feedback.		
Module 7	**MOCK CONFERENCE PRESENTATIONS**	
Conducting mock presentations to simulate real conference environments, engaging in discussions and Q&A sessions, and evaluating presentation styles and technical content delivery		
Module 8	**CASE STUDY & TECHNICAL PAPER PRESENTATION**	
Preparation of a conference paper on a chosen topic related to sustainability and innovation in structural engineering, followed by peer review and final submission. The final presentation will be conducted in a simulated conference setting		
TOTAL		

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3				2	2				2			
CO2	3		3	2		3				3			
CO3	2	2	3	2	2	2				3			
CO4	3	2	2			2	2		3	3			
CO5								3	3	3			
CO6	3		3				3	3	3	2			
	2.8	2	2.75	2	2	2.5	2.5	3	3	2.66			

TECHNO INDIA UNIVERSITY

WEST BENGAL

2nd Semester

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 2nd Sem
Course Title: Theory of Elasticity and Plasticity	**Subject Code:** TIU-PCE-T102
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:

1- Provide a comprehensive understanding of elasticity and plasticity in materials.
2- Focus on the mechanical behavior of materials under various loading conditions.
3- Introduce analytical approaches for modeling stress and strain in elastic and plastic materials.
4- Develop essential skills for advanced structural analysis and design applications.

COURSE OUTCOME :

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

CO1	Define and explain the fundamental concepts of elasticity and plasticity, including stress-strain relationships and material behavior under loading.	**K1**
CO2	Identify and describe stress and strain tensors, compatibility equations, and equilibrium conditions in elastic materials.	**K2**
CO3	Apply mathematical formulations such as Airy's stress function to solve two-dimensional elasticity problems in engineering structures.	**K3**
CO4	Analyze the torsion of non-circular sections and determine stress distribution in beams, shafts, and other structural members.	**K3**
CO5	Evaluate yield criteria, plastic flow rules, and material hardening models in plasticity theory for structural applications.	**K3**
CO6	Solve real-world problems in structural mechanics using advanced elasticity and plasticity principles.	**K3**

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO ELASTICITY**	**9 HOURS**
Overview of elasticity concepts. Stress, strain, and their interrelationships. Stress-strain relationships for linear elastic materials. Properties of stress and strain tensors. Fundamental equations of equilibrium. Plane stress and plane strain conditions. Compatibility equations.		
MODULE 2:	**TWO-DIMENSIONAL PROBLEMS IN ELASTICITY**	**6 HOURS**
Formulation and solution of 2D elasticity problems. Airy's stress function and applications in rectangular and polar coordinates. Stress distribution in cantilever beams, thick-walled cylinders, and rotating discs. Practical applications in plane stress and plane strain conditions.		

MODULE 3:	**TORSION OF NON-CIRCULAR SECTIONS**	**6 HOURS**
Theory of torsion for non-circular sections (rectangular, elliptical). Prandtl's stress function and its applications. Stress and displacement field derivations. Engineering applications in shafts, beams, and other structural members.		
MODULE 4:	**INTRODUCTION TO PLASTICITY**	**9 HOURS**
Fundamentals of plasticity. Stress-strain relationships beyond the elastic limit. Yield criteria: Tresca and von Mises. Flow rule and hardening rules. Plastic deformation behavior in ductile materials. Applications in metal forming and structural design.		
MODULE 5:	**PLASTICITY MODELS AND SOLUTIONS**	**6 HOURS**
Perfectly plastic and strain-hardening material models. Solutions for one-dimensional plastic deformation. Slip-line field theory. Plastic collapse analysis. Applications to beams, plates, and frames in the plastic range.		
MODULE 6:	**ADVANCED TOPICS IN ELASTICITY AND PLASTICITY**	**9 HOURS**
Anisotropic elasticity and viscoelasticity. Plasticity under cyclic loading. Applications in fracture mechanics, fatigue, and residual stresses. Computational and analytical tools for material behavior modeling		
TOTAL		**45 HOURS**

Books:

1. Timoshenko, S. P., and Goodier, J. N., *Theory of Elasticity*, McGraw-Hill, 1970.
2. Sadhu Singh, *Theory of Elasticity*, Khanna Publishers, 2003.
3. Chakrabarty, J., *Theory of Plasticity*, Butterworth-Heinemann, 2006.
4. Mendelson, A., *Plasticity: Theory and Applications*, Krieger Publishing, 1983.
5. Ugural, A. C., *Advanced Mechanics of Materials and Applied Elasticity*, Pearson, 2011.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3		-	-	-	-	-	-	-	-			
CO2	3	2		-	-	-	-	-	-	-			
CO3	3	3	2	2	-	-	-	-	-	-			
CO4	3	3	2	2		-	-	-	-	-			
CO5	3	3	3	3	2	-	-	-	-	-			
CO6	3	3	3	3	2	2	-	-	-	2			
	3	2.8	2.5	2.5	2	2	-	-	-	2			

TECHNO INDIA UNIVERSITY

WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 2nd Sem
Course Title: Finite Element Analysis	**Subject Code:** TIU-PCE-T104
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:.

1- Provide a comprehensive understanding of the fundamental principles and formulation techniques of the Finite Element Method (FEM) in structural analysis.
2- Equip students with the ability to apply FEM to solve structural problems involving beams, frames, plates, shells, and three-dimensional stress analysis.

COURSE OUTCOME :

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

CO1	**Recall** fundamental principles and solution techniques in FEM.	K1
CO2	**Explain** different solution approximations and discretization methods.	K2
CO3	**Apply** element formulations and numerical integration techniques in FEM.	K3
CO4	**Analyze** framed structures, plane stress, plane strain, and shell problems.	K3
CO5	**Develop** computational algorithms for FEM applications in structural analysis.	K3
CO6	**Evaluate** eigenvalue problems and dynamic responses using FEM.	K3

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO FINITE ELEMENT ANALYSIS**	**6 HOURS**
Introduction to finite element analysis, basic principles, and applications in structural mechanics. Overview of elasticity and steps involved in FEA.		
MODULE 2	**FINITE ELEMENT FORMULATION TECHNIQUES**	**6 HOURS**
Mathematical formulation of FEM, virtual work and variational principles, Galerkin method, and displacement approach. Development of stiffness matrix and boundary conditions. Mesh Convergence Study		
MODULE 3	**ELEMENT PROPERTIES**	**6 HOURS**
Characteristics of various finite elements, natural coordinates, triangular and rectangular elements, Lagrange and Serendipity elements. Isoparametric formulation, stiffness matrix computation, and numerical integration in 1D, 2D, and 3D.		
MODULE 4	**ANALYSIS OF FRAME STRUCTURES**	**6 HOURS**
Stiffness of truss and beam members, analysis of trusses and continuous beams, finite element analysis of plane frames, grids, and space frames.		
MODULE 5	**FEM FOR TWO AND THREE DIMENSIONAL SOLIDS**	**6 HOURS**
Application of FEM to 2D and 3D solids: constant strain triangle, linear strain triangle, rectangular elements. Numerical evaluation of stiffness, stress computation, geometric nonlinearity, static		

condensation, axisymmetric elements, and 3D element formulation.Brief about FE modeling of ultra-high-performance fiber-reinforced concrete (UHPFRC), case study on real-world UHPFRC structure (e.g., *Sherbrooke footbridge, Canada* or *Lapa Bridge, Portugal*)		
MODULE 6	**FEM FOR PLATES AND SHELLS**	**6 HOURS**
Analysis of plate and shell structures, finite element methods for thin and thick plates, skew plates, finite strip method, and shell structure analysis.		
MODULE 7	**ADDITIONAL APPLICATIONS OF FEM**	**9 HOURS**
Advanced FEM applications in elastic stability, fluid mechanics, and dynamic analysis of structures.		
TOTAL		**45 HOURS**

Books:

1. Reddy, J. N. – An Introduction to the Finite Element Method, McGraw-Hill.
2. Zienkiewicz, O. C. & Taylor, R. L. – The Finite Element Method, Butterworth-Heinemann.
3. Bathe, K. J. – Finite Element Procedures, Prentice Hall.
4. Cook, R. D., Malkus, D. S., & Plesha, M. E. – Concepts and Applications of Finite Element Analysis, Wiley.
5. Chandrupatla, T. R. &Belegundu, A. D. – Introduction to Finite Elements in Engineering, Pearson Education.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	1	2	-	-	-	-	-	2			
CO2	3	3	2	3	-	-	-	-	-	2			
CO3	3	3	3	3	2	-	-	-	2	3			
CO4	3	3	3	3	2	2	-	-	2	3			
CO5	3	3	3	3	2	3	-	-	3	3			
CO6	3	3	3	3	3	3	2	2	3	3			
	3	2.8	2.5	2.8	2.2	2.6	2	2	2.5	2.6			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester:** 1st Yr., 2nd Sem
Course Title: Repair And Rehabilitation Of Structures	**Subject Code:** TIU-PCE-E102A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OBJECTIVE:

Enable the student to:

1- Identify the causes of deterioration and distress in structures.
2- Understand and plan appropriate repair and rehabilitation strategies.
3- Select suitable repair materials and techniques for structural restoration.
4- Develop retrofitting strategies and formulate guidelines for repair management of deteriorated structures.

COURSE OUTCOME :

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

CO1	**Explain** the causes of structural deterioration and damage mechanisms in concrete, steel, and masonry structures.	K2
CO2	**Identify** and **assess** structural distress using non-destructive testing (NDT) and condition evaluation techniques.	K3
CO3	**Differentiate** between various materials and techniques used for repair, retrofitting, and strengthening of structures.	K4
CO4	**Demonstrate** appropriate selection and **application** of repair materials and methodologies for restoring structural integrity.	K3
CO5	**Examine** and **evaluate** rehabilitation strategies considering durability, sustainability, and cost-effectiveness.	K4
CO6	**Investigate** the role of modern repair technologies and best practices in extending the service life of structures.	K4

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO REPAIR AND REHABILITATION**	**6 HOURS**
Fundamentals of repair and rehabilitation, significance of maintaining structural integrity, and ethical considerations. Discussion on structural deterioration causes and timely interventions. Case studies illustrating common repair scenarios in civil engineering.		
MODULE 2	**DETERIORATION MECHANISMS**	**7 HOURS**
Examination of deterioration causes, including environmental effects, material fatigue, corrosion, and structural overloading. Analysis of physical and chemical processes affecting concrete and steel structures. Development of effective repair strategies based on deterioration mechanisms.		

MODULE 3	**ASSESSMENT TECHNIQUES**	**7 HOURS**
Methods for assessing existing structures, including visual inspection, non-destructive testing (NDT), and structural health monitoring, Use of drones for inspection.Interpretation of NDT results and decision-making for repairs. Practical skills in evaluating structural conditions and repair needs.		
MODULE 4	**REPAIR MATERIALS AND TECHNIQUES**	**8 HOURS**
Selection and properties of repair materials, including epoxy resins, fiber-reinforced polymers, and specialized concrete mixtures. Common repair techniques such as patching, strengthening, and retrofitting, with a focus on material compatibility and long-term performance.		
MODULE 5	**STRUCTURAL REHABILITATION STRATEGIES**	**8 HOURS**
Strengthening and rehabilitation strategies for beams, columns, and foundations. Implementation of external prestressing and advanced composite materials. Consideration of original load-carrying capacity and serviceability in repair design.		
MODULE 6	**CASE STUDIES AND FUTURE TRENDS**	**9 HOURS**
Case studies of successful repair and rehabilitation projects, discussing best practices and lessons learned. Contemporary challenges, sustainability considerations, and emerging technologies. Future trends, including smart materials and adaptive reuse of structures.		
TOTAL		**45 HOURS**

Books:

1. "Concrete Repair and Maintenance Illustrated" – Peter H. Emmons
2. "Handbook on Repair and Rehabilitation of RCC Buildings" – CPWD (Central Public Works Department, India)
3. "Concrete Technology: Theory and Practice" – M.S. Shetty & A.K. Jain
4. "Structural Rehabilitation of Old Buildings" – Poul Beckmann & Robert Bowles
5. "Repair and Rehabilitation of Structures" – P.C. Varghese

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	2	2	1	2	1	0	1	2			
CO2	3	3	3	2	2	2	1	1	1	3			
CO3	3	3	3	3	2	3	2	1	2	3			
CO4	3	3	3	3	3	3	2	1	2	3			
CO5	3	3	3	3	3	3	3	1	2	3			
CO6	2	3	3	3	3	3	3	1	2	3			
	2.83	2.83	2.83	2.67	2.33	2.67	2.00	0.83	1.67	2.83			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester:** 1st Yr., 2nd Sem
Course Title: Structural Stability	**Subject Code:** TIU-PCE-E104A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit: 3**

COURSE OUTCOME :

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

CO1	Recall fundamental concepts of structural stability, buckling, and post-buckling behaviour of structures.	K1
CO2	Identify various advanced software tools, libraries, and frameworks used in computational analysis and simulation.	K1
CO3	Explain the principles of stability analysis for columns, beams, frames, and plates under various loading conditions.	K2
CO4	Interpret analytical and numerical methods for solving stability problems, including energy methods and differential equations.	K2
CO5	Apply classical and modern approaches to analyze and design stable structures under axial, lateral, and combined loads.	K3
CO6	Evaluate the stability of real-world engineering structures such as bridges, towers, and tall buildings using theoretical and computational techniques.	K3

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO STABILITY CONCEPTS**	**5 HOURS**
Criteria for design: Stability, Strength, and Stiffness Classical concept of stability Linear and nonlinear behavior of structures Stability of discrete systems Stability of continuous systems Stability of Structures under Progressive Collapse Scenarios Influence of Material Anisotropy on Global Stability		
MODULE 2	**STABILITY OF COLUMNS**	**8 HOURS**
Axial-flexural buckling Lateral bracing of columns Combined axial-flexural-torsion buckling Stability of High-Strength Concrete Columns		
MODULE 3	**STABILITY OF FRAMES**	**7 HOURS**
Member buckling vs. global buckling Slenderness ratio of frame members		
MODULE 4	**STABILITY OF BEAMS**	**7 HOURS**
Lateral-torsional buckling of beams		
Torsional effects on stability		

MODULE 5	**STABILITY OF PLATES**	**9 HOURS**
Axial-flexural buckling of plates Shear-flexural buckling Buckling under combined loads		
MODULE 6	**ADVANCED STABILITY CONCEPTS**	**9 HOURS**
Introduction to inelastic buckling Dynamic stability Time-Dependent Buckling of Structures under Creep and Fatigue Brief on dynamic Stability of Offshore Wind Turbine Structures		
TOTAL		**45 HOURS**

Books:

1. Bažant, Zdeněk P., and Luigi Cedolin. *Stability of Structures: Elastic, Inelastic, Fracture, and Damage Theories.* World Scientific, 2010.
2. Ashwini Kumar. *Stability of Structures.* Allied Publishers Ltd.
3. Timoshenko, S. P., and Gere, J. M. *Theory of Elastic Stability.* McGraw Hill.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	3	3	2	-	-	-	1	-			
CO2	3	3	2	2	2	-	-	-	1	-			
CO3	3	2	2	2	2	-	-	-	1	-			
CO4	3	2	2	3	1	-	-	-	1	-			
CO5	3	2	2	2	2	-	-	-	1	-			
CO6	3	3	2	2	2	-	-	-	1	-			
	3	2.3	2.16	2.3	1.83	-	-	-	1	-			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 2nd Sem
Course Title: Offshore Structures	**Subject Code:** TIU-PCE-E106B
Contact Hours/Week: 4–0–0 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE:

Enable the student to:

1- Equip students with fundamental knowledge of offshore structures, including environmental loads, stability, and hydrodynamic considerations.
2- Develop skills in analyzing and designing offshore platforms, pipelines, and joints by applying industry standards and computational techniques.
3- Enable students to evaluate structural safety under extreme conditions such as fire, blast, and seismic events.

COURSE OUTCOME :

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

CO1	**Identify** the types of offshore structures, their functions, and applications in various marine environments.	K1
CO2	**Explain** the environmental and geotechnical considerations affecting offshore structures, including loads and foundation types.	K2
CO3	**Apply** design principles and load analysis for fixed offshore structures such as jackets, gravity-based structures, and tripods.	K3
CO4	**Identify** the characteristics, stability, and motion response of floating offshore structures and their mooring systems.	K1
CO5	**Explain** the dynamic response, fatigue analysis, and maintenance strategies for offshore structural integrity.	**K2**
CO6	**Apply** offshore industry standards, safety regulations, and risk management practices in real-world projects.	**K3**

COURSE CONTENT:

MODULE 1	**INTRODUCTION TO OFFSHORE STRUCTURES**	**5 HOURS**
Definition and types of offshore structures (fixed, floating, compliant towers, etc.). Shore Protection Structures. Challenges and considerations in offshore engineering. Overview of offshore industry sectors (oil & gas, renewable energy, etc.). Docks & Harbors, Jetty.Hybrid offshore structures for multi-purpose utility , 3D-printed concrete and modular marine infrastructure		
MODULE 2	**DESIGN CONSIDERATIONS**	**6 HOURS**
Environmental loads (waves, wind, currents, ice) and their effects on offshore structures. Geotechnical considerations: soil mechanics, seabed conditions, foundation types. Structural materials and corrosion protection in marine environments. Advanced materials: FRP, corrosion-resistant alloys, coatings		
MODULE 3	**FIXED STRUCTURES**	**5 HOURS**
Types: jackets, gravity-based structures (GBS), tripods. Design principles and load paths. Installation		

methods and considerations. Examples of notable fixed offshore platforms.		
MODULE 4	**FLOATING STRUCTURES**	**6 HOURS**
Types: semi-submersibles, tension leg platforms (TLPs), spar platforms, FPSOs. Stability and motion response in waves. Mooring systems and risers. Applications and advantages of floating structures. Floating Offshore Wind Turbines (FOWTs)		
MODULE 5	**DYNAMIC RESPONSE AND STRUCTURAL INTEGRITY**	**5 HOURS**
Analysis of dynamic response to environmental loads. Fatigue and reliability considerations. Inspection, maintenance, and repair strategies.		
MODULE 6	**EMERGING TRENDS AND FUTURE DIRECTIONS**	**6 HOURS**
Advances in offshore wind energy: floating wind turbines. Subsea structures and underwater technology. Sustainability and environmental impact considerations.		
MODULE 7	**CASE STUDIES AND PRACTICAL APPLICATIONS**	**6 HOURS**
Real-world examples of offshore structure projects. Lessons learned from past failures and successes. Integration of new technologies and innovative designs.		
MODULE 8	**REGULATORY AND SAFETY STANDARDS**	**6 HOURS**
International codes and standards (e.g., API, ISO, ABS rules). Safety considerations and risk management in offshore operations. Environmental regulations and compliance.		
TOTAL		**45 HOURS**

Books: .

1. Chakrabarti, S.K. – Handbook of Offshore Engineering, Elsevier.
2. API RP 2A-WSD – Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms, American Petroleum Institute.
3. DNV-OS-F101 – Submarine Pipeline Systems, Det Norske Veritas.
4. Bhattacharya, S.K. – Design of Steel Structures for Offshore Structures, Wiley.
5. Taranath, B.S. – Offshore Structures: Design, Construction, and Maintenance, CRC Press.

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	-	-	-	-	-	-	-	-			
CO2	3	3	2	-	-	-	-	-	-	2			
CO3	3	3	3	3	-	-	-	-	-	3			
CO4	3	3	2	3	2	-	-	-	-	3			
CO5	3	3	3	3	2	-	-	-	2	3			

CO6	3	3	3	3	2	3	-	-	3	3			
	3	2.8	2.6	3	2	3			2.5	2.8			

TECHNO INDIA UNIVERSITY
WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester:** 1st Yr., 2nd Sem
Course Title: Term Paper	**Subject Code:** TIU-PCE-S106
Contact Hours/Week: 0–0–8 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE:

Enable the student to:.

1- Equip with the skills necessary to conduct a comprehensive literature review on current trends and innovations in civil engineering.
2- Identify gaps in existing research and formulate relevant project topics.
3- Analyze and evaluate scholarly articles and journals to support project development.
4- Select a final project topic that addresses contemporary challenges within the civil engineering field.

COURSE OUTCOME :

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

CO1	Recall fundamental research concepts, including literature review techniques, citation methods, and technical writing.	K1
CO2	Identify relevant research papers, technical reports, and scholarly articles related to the chosen topic.	K1
CO3	Explain key findings from the literature and summarize different methodologies used in previous research.	K2
CO4	Interpret research gaps and formulate a structured approach for analyzing the selected topic.	K2
CO5	Apply critical thinking and analytical skills to evaluate research findings and propose improvements or new perspectives.	K3
CO5	Develop a well-structured technical document, adhering to academic writing standards, and present findings effectively.	K3

COURSE CONTENT:

MODULE 1	**LITERATURE REVIEW**	
Learn techniques for conducting comprehensive literature reviews focusing on current trends in civil engineering.		
MODULE 2	**RESEARCH GAP IDENTIFICATION**	
Explore methodologies to identify gaps in existing research and formulate relevant project topics.		
MODULE 3	**CRITICAL ANALYSIS**	
Engage in the analysis and evaluation of scholarly articles and journals to support research findings and project development.		
MODULE 4	**PROJECT TOPIC CONCLUSION**	

Guided process to conclude a final project topic that addresses contemporary challenges in civil engineering.		
MODULE 5	**ACADEMIC WRITING AND PRESENTATION SKILLS**	
Emphasis on effective academic writing and presentation skills for communicating research effectively.		
TOTAL		

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	3	3	2	-	-	-	1	-			
CO2	3	3	2	2	2	-	-	-	1	-			
CO3	3	2	2	2	2	-	-	-	1	-			
CO4	3	2	2	3	1	-	-	-	1	-			
CO5	3	2	2	2	2	-	-	-	1	-			
CO6	3	3	2	2	2	-	-	-	1	-			
	3	2.3	2.16	2.3	1.83	-	-	-	1	-			

TECHNO INDIA UNIVERSITY
W E S T B E N G A L

Program: M. Tech. in Civil Engineering	**Year, Semester:** 1st Yr., 2nd Sem
Course Title: Seminar on Term Paper	**Subject Code:** TIU-PCE-S108
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit: 2**

COURSE OBJECTIVE:

Enable the student to:.

1- Develop students' ability to research, analyze, and present emerging trends and innovations in structural engineering through seminars and technical discussions.

2- Enhance students' communication and critical thinking skills by facilitating interactive discussions, constructive feedback sessions, and the preparation of technical papers for potential conference presentations.

COURSE OUTCOME :

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

CO1	Recall fundamental concepts of technical communication, research methodologies, and presentation techniques.	K1
CO2	Identify key research findings, methodologies, and relevant literature to support the seminar topic.	K1
CO3	Explain the objectives, significance, and conclusions of the term paper in a structured and concise manner.	K2
CO4	Interpret research data, analytical results, and technical arguments to enhance understanding of the subject.	K2
CO5	Apply effective communication and presentation skills to deliver a well-organized seminar on the term paper topic.	K3
CO6	Develop critical thinking skills by addressing questions, engaging in discussions, and receiving constructive feedback.	K3

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	3	3	2	-	-	-	2	-			
CO2	3	3	2	2	2	-	-	-	1	-			
CO3	3	2	2	2	2	-	-	-	2	-			
CO4	3	2	2	3	1	-	-	-	1	-			
CO5	3	2	2	2	2	-	-	-	2	-			
CO6	3	3	2	2	2	-	-	-	2	-			
	3	2.3	2.16	2.3	1.83	-	-	-	1.67	-			

TECHNO INDIA UNIVERSITY

WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester: 1st**Yr., 2nd Sem
Course Title: Entrepreneurship Skill Development	**Subject Code:** TIU-PES-S188
Contact Hours/Week: 0–0–2 (L–T–P)	**Credit: 1**

COURSE OBJECTIVE:

Enable the student to:.

1- Research and analyze current trends in civil engineering, particularly in structural engineering and materials, through case studies and literature reviews.

2- Develop well-structured conference papers that address sustainability challenges in civil engineering, incorporating real-world examples and case studies.

3- Enhance technical communication skills by presenting and discussing research findings at conferences, improving public speaking and professional networking abilities.

COURSE OUTCOME :

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

CO1	Identify entrepreneurship opportunities in civil engineering and explain the role of innovation in structural engineering and materials.	K2
CO2	Analyze current trends in sustainable construction using research methodologies and industry reports.	K4
CO3	Evaluate sustainability challenges in structural engineering and assess the environmental and economic impact of new materials and techniques.	K4
CO4	Develop well-structured conference papers focused on sustainability and innovative solutions in civil engineering.	K3
CO5	Demonstrate effective public speaking and presentation skills for technical content in research seminars and conferences.	K3
CO6	Apply the peer review process by evaluating research papers constructively and revising based on feedback.	K4

COURSE CONTENT:

MODULE1	**INTRODUCTION TO ENTREPRENEURSHIP IN CIVIL ENGINEERING**	
Overview of entrepreneurship opportunities in civil engineering, emphasizing the importance of innovation in structural engineering and materials. Discussion on the role of entrepreneurs in sustainable construction practices.		
MODULE 2	**RESEARCH TECHNIQUES FOR CURRENT TRENDS**	
Methods for identifying emerging trends in civil engineering, including industry reports and case studies on advancements in sustainable construction. Analysis of research methodologies for identifying and evaluating new technologies		
MODULE 3	**SUSTAINABILITY ISSUES IN CIVIL ENGINEERING**	
Understanding key sustainability challenges in structural engineering, formulating research questions		

related to sustainability, and evaluating the environmental and economic impact of new materials and techniques in construction.		
MODULE 4	**WRITING CONFERENCE PAPERS**	
Structure and key components of an effective conference paper, techniques for writing impactful papers on sustainability and innovative solutions, and ethical considerations in research and technical writing		
MODULE 5	**PRESENTATION SKILLS**	
Techniques for effective public speaking, crafting engaging visual aids for technical content, and handling Q&A sessions to confidently present research findings in seminars and conferences.		
MODULE 6	**PEER REVIEW PROCESS**	
Understanding the peer review process for conference submissions, techniques for constructive evaluation of peer research papers, and revising research papers based on feedback.		
MODULE 7	**MOCK CONFERENCE PRESENTATIONS**	
Conducting mock presentations to simulate real conference environments, engaging in discussions and Q&A sessions, and evaluating presentation styles and technical content delivery		
MODULE 8	**CASE STUDY & TECHNICAL PAPER PRESENTATION**	
Preparation of a conference paper on a chosen topic related to sustainability and innovation in structural engineering, followed by peer review and final submission. The final presentation will be conducted in a simulated conference setting		
TOTAL		

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3				2	2				2			
CO2	3		3	2		3				3			
CO3	2	2	3	2	2	2				3			
CO4	3	2	2			2	2		3	3			
CO5								3	3	3			
CO6	3		3				3	3	3	2			
	2.8	2	2.75	2	2	2.5	2.5	3	3	2.66			

TECHNO INDIA UNIVERSITY

WEST BENGAL

3rd Semester

Program: M. Tech. in Civil Engineering	**Year, Semester:2nd**Yr., 3rdSem
Course Title: Progress Report	**Subject Code:**TIU-PCE-S201
Contact Hours/Week: 0–0–28(L–T–P)	**Credit: 14**

COURSE OBJECTIVE :

Enable the student to:.

1- **Ensure effective project execution** by documenting progress, assessing methodologies, and formulating experimental procedures to maintain alignment with best practices.

2- **Enhance problem-solving and decision-making** by evaluating outcomes, analyzing results, and providing insights for necessary project adjustments and improvements.

COURSE OUTCOME:

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

CO1	**Apply** structured methodologies to monitor and assess the progress of project work.	K3
CO2	**Analyze** and **design** experimental setups, selecting appropriate research tools and techniques	K4
CO3	**Evaluate** collected data using statistical tools and interpret results in alignment with project objectives.	K5
CO4	**Develop** technical documentation and progress reports with clear and structured writing techniques.	K4
CO5	**Demonstrate** effective communication through project presentations and discussions.	K3
CO6	**Critically assess** peer work through reviews and constructive feedback for project improvement.	K5

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO 1	3	3	3	2	-	-	-	2	3	3			
CO 2	3	3	3	3	-	2	-	2	2	3			
CO 3	3	3	3	3	-	2	-	-	3	3			
CO 4	3	3	2	2	-	-	-	2	3	3			

CO 5	3	2	2	2	-	-	-	3	3	3			
CO 6	3	2	3	2	-	-	-	3	3	3			
	3	2.67	2.83	2.33		2		2.33	2.83	3			

Program: M. Tech. in Civil Engineering	**Year, Semester:2nd**Yr., 3rdSem
Course Title: Seminar on Progress Report	**Subject Code:**TIU-PCE-S203
Contact Hours/Week: 0–0–40 (L–T–P)	**Credit: 10**

COURSE OBJECTIVE :

Enable the student to:.

1- **Develop communication and analytical skills** by presenting and defending thesis progress through reports and viva-voce discussions.

2- **Enhance research impact and critical thinking** by reviewing published work, engaging in peer feedback, and refining presentation techniques.

COURSE OUTCOME:

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

CO1	**Demonstrate** effective research presentation and communication skills.	K3
CO2	**Analyze** research findings and methodologies critically**.**	K4
CO3	**Defend** research methodologies and outcomes in oral examinations.	K4
CO4	**Engage** in scholarly discussions and peer evaluations.	K3
CO5	**Evaluate and integrate** feedback to refine research work**.**	**K5**
CO6	**Develop** structured and impactful academic presentations.	**K4**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	2	2	2	-	-	-	3	3	3			
CO2	3	3	3	2	-	-	-	3	3	3			
CO3	3	3	3	2	-	-	-	3	3	3			
CO4	3	2	2	2	-	-	-	3	3	3			
CO5	3	3	3	2	-	-	-	3	3	3			
CO6	3	3	3	2	-	-	-	3	3	3			
	3	2.67	2.67	2				3	3	3			

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WEST BENGAL

4th Semester

Program: M. Tech. in Civil Engineering	**Year, Semester:2nd**Yr., 4thSem
Course Title: Thesis	**Subject Code:**TIU-PCE-S204
Contact Hours/Week: 0–0–28(L–T–P)	**Credit: 14**

COURSE OBJECTIVE :

Enable the student to:.

1- **Ensure project completion and documentation** by finalizing deliverables and compiling a detailed technical report.
2- **Develop research and analytical skills** by conducting independent research and applying theoretical knowledge to solve practical problems.

COURSE OUTCOME:

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

CO1	**Identify** and **explain**research gaps in the chosen domain of civil engineering using a comprehensive literature review.	K4
CO2	**Develop** and **construct** research methodologies, experimental setups, or computational models to address the identified problem.	K4
CO3	**Examine** and **differentiate** various approaches, materials, and techniques to **determine** optimal solutions for the research problem.	K3
CO4	**Illustrate** and **demonstrate** the research findings through structured reports, presentations, and publications.	K4
CO5	**Compare** and **question** experimental or simulation results to **infer** meaningful conclusions.	K3
CO6	**Prepare** and **produce** a well-documented thesis following academic and professional guidelines.	K4

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	3	3	2	2	2	1	1	3	3			
CO2	3	3	3	3	2	2	2	2	3	3			
CO3	3	3	3	3	2	2	2	2	3	3			
CO4	3	3	3	3	2	3	2	2	3	3			
CO5	3	2	2	2	1	2	1	1	3	3			
CO6	3	2	3	2	3	3	3	3	3	3			
	3	2.67	2.83	2.50	2.00	2.33	1.83	1.83	3	3			

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WEST BENGAL

Program: M. Tech. in Civil Engineering	**Year, Semester:2nd**Yr., 4thSem
Course Title: Seminar on Thesis	**Subject Code:**TIU-PCE-S206
Contact Hours/Week: 0–0–20(L–T–P)	**Credit: 10**

COURSE OBJECTIVE :

Enable the student to:.

1- **Develop effective research communication skills** by presenting and discussing thesis findings in academic and professional settings.

2- **Enhance critical thinking and analytical abilities** by evaluating research implications and engaging in discussions.

3- **Promote collaboration and peer learning** by providing constructive feedback and participating in interactive Q&A sessions.

COURSE OUTCOME:

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

CO1	**Examine** and **categorize** research papers, technical reports, and case studies related to the chosen research domain.	K4
CO2	**Develop** and **construct** the research problem statement, objectives, and scope based on a **systematic literature review**.	K3
CO3	**Investigate** and **differentiate** between different methodologies, experimental setups, and computational approaches to **determine**the most suitable techniques for research.	K4
CO4	**Demonstrate** and **illustrate** technical presentations with clarity and precision using appropriate tools.	K3
CO5	**Compare** and **debate** research ideas in discussions and **infer** insights from peer feedback to refine thesis work.	K4
CO6	**Prepare** and **produce** structured research summaries, progress reports, and technical documentation.	K4

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)										**PROGRAM SPECIFIC OUTCOMES (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**
CO1	3	3	3	2	2	1	1	1	3	3			
CO2	3	3	3	2	2	2	2	2	3	3			
CO3	3	3	3	3	2	2	2	2	3	3			
CO4	2	2	2	2	1	1	1	1	3	3			
CO5	2	2	3	2	2	2	2	2	3	3			
CO6	2	2	2	2	1	1	1	1	3	3			
	2.50	2.50	2.67	2.17	1.67	1.50	1.50	1.50	3	3			