VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF CIVIL ENGINEERING

M.Tech. Structural Engineering

(M.Tech – MST)

Curriculum

(2025-2026 admitted students)

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VISION STATEMENT OF VELLORE INSITITUE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education	:	Excellence in education, grounded in ethics and Critical thinking, for improvement of life
Cutting edge Research	:	An innovation ecosystem to extend knowledge and Solve critical problems
Impactful People	:	Happy, accountable, caring and effective workforce and students
Rewarding Co-creations	:	Active collaboration with national & international industries & universities for productivity and economic development
Service to Society	:	Service to the region and world through knowledge and compassion

VISION STATEMENT OF THE SCHOOL OF CIVIL ENGINEERING

- To be internationally recognized for ground-breaking contributions, exceptional leadership, strong commitment to creative problem-solving and professional integrity.

MISSION STATEMENT OF THE SCHOOL OF CIVIL ENGINEERING

- The school of Civil Engineering inspires and nurtures innovative leaders.
- Preparedness to address the complex societal –scale challenges in area of resilient infrastructure, smart and sustainable cites, water and energy security, climate change, mobility of goods and people, and environmental production.
- Pioneering the emerging skills in Civil Engineering.

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M.Tech. Structural Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.

3. Graduates will function in their profession with social awareness and responsibility.

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.

5. Graduates will be successful in pursuing higher studies in engineering or management.

6. Graduates will pursue career paths in teaching or research.

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M.Tech. Structural Engineering

PROGRAMME OUTCOMES (POs)

PO_01	:	An ability to independently carry out research/investigation and development work to solve practical problems.
PO_02	:	An ability to write and present a substantial technical report / document
PO_03	:	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelore program.

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M.Tech. Structural Engineering

PROGRAMME SPECIFICOUTCOMES (PSOs)

On completion of M.Tech Structural Engineering programme graduates will be able to

PSO_01	:	Analyse and design reinforced concrete structures and steel structures as per the standard design of codes.
PSO_02	:	Address the societal needs by interdisciplinary approach through advanced courses and get exposed to the latest technologies to be industry ready or to pursue advanced research.
PSO_03	:	Independently carry out research / investigations to solve practical problems and write / present a substantial technical report / document.

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M.Tech. Structural Engineering

CREDIT STRUCTURE

Programme Credit Structure	Credits
University Core Courses	39
Professional Core Courses	24
Professional Elective Courses	14
Open Elective	3
Total Graded Credit Requirement	**80**

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M.Tech. Structural Engineering

DETAILED CURRICULUM

Professional Core Courses 24

Sl. No	Course Code	Course Title	L	T	P	C
1	MAMAT502	Advanced Mathematical Methods	3	1	0	4
2	MASTE501	Theory of Elasticity and Plasticity	3	1	0	4
3	MASTE502	Design of Concrete Structural Systems	3	1	0	4
4	MASTE503	Structural Dynamics	3	1	0	4
5	MASTE504	Advanced Design of Steel Structures	3	1	0	4
6	MASTE505	Finite element analysis	3	0	2	4

University Core Courses 39

Sl. No.	Code	Title	L	T	P	C
1	MAENG501	Technical Report Writing	1	0	4	3
2	MASTS501	Qualitative and Quantitative Skills Practice I	3	0	0	3
3	MASTS502	Qualitative and Quantitative Skills Practice II	3	0	0	3
4	MASET697	Project Work	0	0	0	10
5	MASTE698	Internship I / Dissertation I	0	0	0	10
6	MASTE699	Internship II / Dissertation II	0	0	0	10

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M.Tech. Structural Engineering

Professional Elective Courses 14

Sl. No.	Code	Title	L	T	P	C
1	MASTE601	Design of Bridges	3	0	2	4
2	MASTE602	Advanced Concrete materials and technology	3	0	2	4
3	MASTE603	Offshore Structures	3	0	2	4
4	MASTE604	Earthquake Resistant Design	3	1	0	4
5	MASTE605	Analysis and Design of Tall Structures	3	1	0	4
6	MASTE606	Prestressed Concrete Structures	3	1	0	4
7	MASTE607	Matrix methods of Structural Analysis	3	1	0	4
8	MASTE608	Prefabricated Structures	3	0	0	3
9	MASTE609	Stability of Structures	3	0	0	3
10	MASTE610	Repair and Rehabilitation of Structures	3	0	0	3
11	MASTE611	3D Concrete Printing for Construction	3	0	0	3
12	MASTE612	Advanced Foundation Design	3	0	0	3
13	MACTM 612	Energy Efficient Building	3	0	0	3
14	MACTM 601	AI – Enhanced structural health monitoring	3	0	2	4

Open Elective 03

Sl. No.	Course Code	Course Title	L	T	P	C
1	MASTS601	Competitive Coding I	3	0	0	3

MAMAT502	Advanced Mathematical Methods	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives

1. Provide the students with sufficient exposure to advanced mathematical methods and tools that are relevant to engineering research.
2. Improving the knowledge of analytical and numerical techniques useful for solving problems arising in Structural and Construction Engineering.
3. Imparting the knowledge of real time applications of Autonomous systems, Nonlinear systems of ordinary differential equations and partial differential equations
4. Introduce optimization principles, problem classification, and the importance of mathematical optimization in engineering and science.

Course Outcomes

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

1. Apply calculus of variation techniques to extremize the functional and also find approximate series solution to ordinary differential equations.
2. Utilize phase plane phenomena to study system behavior and predict dynamic stability across linear and nonlinear cases.
3. Demonstrate solutions of PDEs using Eigen function expansions to simplify complex differential problems.
4. Develop a foundational understanding of optimization techniques, covering linear programming problems.
5. Apply optimization techniques to effectively solve unconstrained nonlinear optimization problems.

Module: 1	**Calculus of Variations**	**8 hours**

Introduction – functional – variational problems- extremals of functional of a single dependent variable and its first derivative- functional involving higher order derivatives- Isoperimetric problems – Galerkin's – Rayleigh Ritz methods.

Module: 2	**Linear and Non-Linear system of Ordinary Differential Equations**	**9 hours**

Eigen value problems – Eigen values and Eigen vectors – Properties of Eigen values. Linear Systems – Homogeneous linear systems with constant coefficients – Autonomous systems – Phase Plane Phenomena – Critical Points - Stability for linear systems. Simple critical points of nonlinear systems – Stability by Liapunov's method – Non-Linear Mechanics: Conservative systems.

Module: 3	**Partial Differential Equation and its applications**	**8 hours**
Classification of Second-Order Partial Differential Equations, Significance of characteristic curves, Canonical Form, Sturm–Liouville problems and Eigen function expansions. Wave equation- Displacements in a long string. Solution of wave equation by method of Separation of variables.		
Module: 4	**Optimization Techniques: Linear Programming**	**9 hours**
Introduction to linear programming models – Solving LPP using graphical and simplex methods – Concepts of feasible region, optimality, degeneracy, and unboundedness – Use of Big-M and Two-Phase methods for special cases – Introduction to duality and basic sensitivity analysis.		
Module: 5	**Optimization Techniques: Non-Linear Programming**	**9 hours**
Formulation and classification of nonlinear programming problems – First and second-order optimality conditions: necessary and sufficient conditions for local /global optimal Unconstrained nonlinear optimization methods: Steepest Descent Method, Newton's method – Sequential Unconstrained Minimization Techniques (SUMT): Penalty and Barrier methods.		
Module: 6	**Contemporary Topics**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial Class Module 1: 3 hours **Tutorial Class Module 2:** 3 hours **Tutorial Class Module 3:** 3 hours **Tutorial Class Module 4:** 3 hours **Tutorial Class Module 5:** 3 hours		
Total Tutorial hours		**15 hours**

Text Books	
1.	Krantz, S.G., Differential Equations: Theory, Technique, and Practice, 2022, 3rd Edition, Chapman and Hall / CRC, Boca Raton, FL, USA.
2.	Rao, S.S., Engineering Optimization: Theory and Practice, 2019, 5th Edition, John Wiley & Sons, Hoboken, NJ, USA.
Reference Books	
1.	Kreyszig, E., Advanced Engineering Mathematics, 2017, 10th Edition, Wiley India Pvt. Ltd., New Delhi, India.
2.	Taha, H.A., Operations Research: An Introduction, 2022, 11th Edition, Pearson Education, Boston, MA, USA

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE501	Theory of Elasticity and Plasticity	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To analyze stresses and strains in two-dimensional and three-dimensional elements, including understanding equilibrium and compatibility conditions in both Cartesian and polar coordinates.
2. To solve torsion problems for bars with various cross-sectional shapes.
3. To understand the fundamental principles of plasticity and the behavior of materials beyond the elastic range.

Course Outcomes

At the end of the course, the student will be able to
1. Analyse the stresses and strains for elasticity approach.
2. Solve two dimensional elements problems in Cartesian and polar coordinates.
3. Analyse the 3D problems in Cartesian coordinates.
4. Solve the problems using energy principle.
5. Understand the concept of plastic analysis.

Module: 1	Elasticity and Elasticity Solutions	9 hours

Elasticity, stress, strain, Hooke's law, two - dimensional idealisations, plane stress and plane strain problems, equations of equilibrium, strain- displacement relations, constitutive relations, compatibility conditions, displacement and traction boundary conditions. Two dimensional problems in rectangular coordinates: Stress function, solution by polynomials, Saint Vénant's principle, bending of a cantilever, determination of displacements.

Module: 2	Cartesian and Polar Coordinates	8 hours

Airy's stress function - Bending of cantilever beams - Axi-symmetrical problems - Thick cylinder under uniform pressure - Circular arc beams subjected to pure bending - Equations of equilibrium and compatibility conditions in Polar coordinates - Axi-symmetrical problems- bending of curved bars.

Module: 3	Elasticity 3D Solution	8 hours

Principal stresses and strains for three-dimensional element – Equations of equilibrium and compatibility conditions for 3D problems in Cartesian co-ordinates - Transformation laws of cartesian tensors.

Module: 4	Energy Theorems and Variational Principles of Elasticity	9 hours

Strain energy and complementary energy, Clapeyron's theorem, virtual work and potential energy principles, principle of complementary potential energy, Betti's reciprocal theorem, principle of linear superposition, uniqueness of elasticity solution. Torsion of straight bars: Elliptic and equilateral triangular cross-section, membrane analogy, narrow rectangular cross-section, torsion of rectangular bars, torsion of rolled profile sections, hollow shafts and thin tubes.		
Module: 5	**Introduction to Plasticity**	**9 hours**
One-dimensional elastic-plastic relations, isotropic and kinematic hardening, yield function, flow rule, hardening rule, incremental stress-strain relationship, governing equations of Elastoplasticity.		
Module: 6	**Contemporary issues**	**2 hours**
Total Lecture hours		**45 hours**
	Tutorial	
Tutorial problem in Module 1: 3 Hrs Tutorial problem in Module 2: 3 Hrs Tutorial problem in Module 3: 3 Hrs Tutorial problem in Module 4: 3 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial hours		**15 hours**

Text Book(s)	
1.	Timoshenko and Goodier, Theory of Elasticity, 2017, 3rd Edition, McGraw Hill Company, New York.
2.	Chakrabarty. J, Theory of Plasticity, 2007, 3rd Edition, Elsevier Butterworth - Heinmann – UK.
Reference Books	
1.	Mendelson, A., Plasticity: Theory and Applications, 1983, 2nd Edition Mac Millan and Co., New York.
2.	Sadhu Singh, Theory of Plasticity, 2014, 3rd Edition, Techno Series, New Delhi.
3.	Ansel. C. Ugural and Saul. K. Fenster, Advanced Strength and Applied Elasticity, 2003, 4th Edition, Prentice Hall Professional technical Reference, New Jersey.

Mode of Evaluation: CAT / Assignment / Quiz / FAT.			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE502	Design of Concrete Structural Systems	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To know the elastic and inelastic behaviour of beam.
2. To know the importance of serviceability criteria
3. To give an exposure to the various structural systems like slab, Deep beam, corbels and shear wall.

Course Outcomes

At the end of the course, the student will be able to
1. Analyse the beam for deflection and estimation of crack width.
2. Design the slender column using IS 456 and SP16.
3. Design the slab and spandrel beam based on IS method
4. Design the deep beam and corbels.
5. Analyse and design of structural wall systems.

Module: 1	Basic Design Concepts	9 hours

Limit state method - Design of beams - Short-term and long-term deflection of reinforced concrete beams - Estimation of crack width in reinforced concrete members - Moment curvature relationship – Plastic hinge formation - Moment redistribution in continuous beams.

Module: 2	Slender Columns	7 hours

Design of slender columns subjected to combined bending moment and axial force using IS 456-2000 and SP 16.

Module: 3	Slabs	9 hours

Yield line theory and Hillerborg's strip method of slab design - Design of ribbed, flat slabs and flat plates according to the IS method—Check for shear—Design of spandrel beams-—Grid floor – Design of Post Tensioned Slabs.

Module: 4	Special elements	9 hours

Design of deep beam - Design of corbel - Design of joint - Design of curved beam in plan- Ductile detailing - IS 13920 : 2016.

Module: 5	Structural wall	9 hours

Types of structural wall- Behaviour of structural wall- Interaction of structural wall and rigid jointed frame- Design of structural wall- Design of boundary elements- Detailing of structural wall.

Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial problem in Module 1: 3 Hrs Tutorial problem in Module 2: 3 Hrs Tutorial problem in Module 3: 3 Hrs Tutorial problem in Module 4: 3 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial hours		**15 hours**

Text Book(s)	
1.	S. Unnikrishna Pillai, and Devdas Menon, Reinforced Concrete Design, 2022, 4th Edition, McGraw Hill, New Delhi, India.
2.	S. Ramamrutham, Design of Reinforced Concrete Structures, 2016, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, India.
Reference Books	
1.	Gambhir. M. L., Design of Reinforced Concrete Structures, 2012, Prentice Hall of India, New Delhi, India.
2.	Varghese. P.C, Advanced Reinforced Concrete Design, 2011, PHI Learning Pvt. Ltd., New Delhi, India.
3.	Krishna Raju, N., Advanced Reinforced Concrete Design, 2020, CBS Publishers and Distributors Pvt. Ltd., 3rd Edition, New Delhi, India.
4.	IS 456 : 2000 Plain and Reinforced Concrete - Code of Practice, BIS, New Delhi, India.
5.	SP 16- Design Aids for Reinforced Concrete, BIS, New Delhi, India.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE503	Structural Dynamics	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To know various dynamic forces acting on a building and their response.
2. To study the analysis procedure for calculating the response of structures.
3. To understand the linear and non-linear behaviour of structures.

Course Outcomes

Upon completion of this course, the student will be able to
1. Differentiate static and dynamic behaviour of structures and their physical properties.
2. Identify and model a single degree of freedom system subjected to a dynamic load.
3. Evaluate the response of a single-storey building subjected to a dynamic load.
4. Identify and model a multi-degree-of-freedom system subjected to dynamic load.
5. Evaluate the dynamic behaviour of beams.

Module: 1	Introduction	8 hours

History of vibration - Oscillatory motion – Resonance - Engineering applications - Dynamic vs static analysis – Time - varying loads – Real - world case studies - System idealization - Degrees of freedom (DOF) - Lumped vs distributed systems - Generalized coordinates - Inertial forces - Virtual work - D'Alembert's principle - Energy methods - Lagrange's equation - Kinetic and potential energy - Simple harmonic motion.

Module: 2	Single Degree of Freedom	9 hours

Mathematical modeling - Mass-spring-damper system - Free vibration - Natural frequency - Logarithmic decrement - Underdamped, overdamped, critically damped systems - Damping ratio, viscous damping, Coulomb damping, structural damping - Measurement techniques - Damping estimation - Vibration measuring instruments.

Module: 3	Response of Single Degree of Freedom Systems	9 hours

Forced vibration - Harmonic excitation – Steady-state response - Dynamic amplification factor – Resonance – Transmissibility - Base excitation - Impulse response - Periodic loading Fourier series - Duhamel's integral, convolution integral - Response convolution - Analytical solutions - Numerical response evaluation - Wilson-Theta method, Newmark-Beta method - Nonlinear numerical techniques - Time stepping methods - Stability and convergence - Seismic excitation - Earthquake time histories - Base isolation - Response spectra - Design spectrum - Elastic and inelastic response.

Module: 4	Modeling and Response Analysis of Multi Degree of Freedom Systems	9 hours

Equation of motion (matrix form) - Free vibration of Multi Degree of Freedom systems - Damping models - Structural property matrices (mass, damping, stiffness) - Eigenvalues and eigenvectors - Mode shapes, modal analysis, orthogonality of mode shapes - Rayleigh's method, Rayleigh-Ritz method - Stodola's method - Matrix iteration - Stiffness and flexibility methods - Mode superposition - Coupling and decoupling of equations - Tuned mass dampers

Module: 5	**Continuous Systems**	**8 hours**
Differential equation of motion - Transverse vibration - Axial vibration - Natural frequency and mode shape of simple beams with different end conditions – Variable cross section beams - Orthogonality relationship.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial Class Module 1: 3 hours **Tutorial Class Module 2:** 3 hours **Tutorial Class Module 3:** 3 hours **Tutorial Class Module 4:** 3 hours **Tutorial Class Module 5:** 3 hours		
Total tutorial hours		**15 hours**

Text Book(s)	
1.	Mario Paz and William Leigh, Structural Dynamics – Theory and Computation, 2019, 6th Edition, Springer, USA.
2.	Clough and Penzien, Dynamics of Structures, 2015, CBS Publishers and Distributors, New Delhi, India.
Reference Books	
1.	Chopra. A. K., Dynamics of Structures – Theory and Applications to Earthquake Engineering, 2023, 6th Edition, Prentice Hall, London, UK.
2.	Roy R. Craig, Jr. and Andrew J. Kurdila, Fundamentals of Structural Dynamics, 2011, John Wiley and Sons, London, UK.

Mode of assessment: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE504	Advanced Design of Steel Structures	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objectives

1. To design the structural steel elements and connections.
2. To design the light-gauge steel structural elements.
3. To design the steel-concrete composite structures.

Course Outcomes

At the end of the course, the student will be able to
1. Design the steel structural elements.
2. Design steel bolted and welded connections.
3. Design the steel-concrete composite sections.
4. Evaluate fatigue loading and design of long-span structures.
5. Explain plastic analysis and design of steel structures.

Module: 1	Design of structural steel members and Beam-columns	10 hours

Structural Steel - Material properties of structural steel under normal and high temperature - Loads - Dead loads, Imposed load, and wind load - Design of beams - Design of tension members - Design of structural steel hollow sections - Design of compression members - General Behaviour of Beam-columns - Interaction Equations for Local Capacity Check - Design of Beam-columns, Beam-columns Subjected to Tension and Bending - Design of Base Plates.

Module: 2	Design of Connections	8 hours

Type of Fasteners - Bolts, Pins and welds - Bolted Connections, semi rigid Connections, Moment Resistant Connections, Beam-to-Beam Connections, Beam and Column Splices - Welded connections - Types and Properties of Welds, Semi rigid Connections, Moment Resistant Connections, Beam-to-Column Connections, Beam and Column Splices.

Module: 3	Design of Light-Gauge Steel and Composite Structures	10 hours

Types of cross sections - Failure modes - Local buckling and lateral buckling - Design of laterally supported and unsupported light gauge steel beams - Design of light gauge steel compression members - Cold formed steel structures - Introduction to steel - Concrete composite construction- Composite action – Shear connectors - Design of composite beams, slabs and columns.

Module: 4	Fatigue analysis and long-span structures	8 hours

Types of fatigue leading to failure - Fatigue test, endurance limit - S-N diagram - Various failure relations - Factors influencing fatigue strength - Influence of stress concentration on fatigue test - Gantry Girder - Loading Consideration - Fatigue Effect - Pre-engineered metal buildings - Long span structures.

Module: 5	**Plastic Analysis and Design of Steel Structures**	**7 hours**
Basis of plastic theory - Material Behaviour - Shape factors - Plastic Modulus - Mechanisms - Plastic hinge - Design of simply supported, Propped Cantilever, fixed and continuous beams - Analysis of portal frames.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial problem in Module 1: 3 Hrs Tutorial problem in Module 2: 3 Hrs Tutorial problem in Module 3: 3 Hrs Tutorial problem in Module 4: 3 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial hours		**15 hours**

Text Book(s)	
1.	Subramanian N., Design of Steel Structures, 2016, 2nd edition, Oxford University Press, New Delhi.
2.	Duggal S K., Limit State Design of Steel Structures, 2019, 3rd edition, McGraw Hill Education India, Pvt. Ltd. India.
Reference Books	
1.	Johnson R.P., Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings, 2004, 3rd edition, Willy Blackwell Scientific Publications, UK.
2	IS 800:2007, Indian Standard Code of Practice for General Construction in Steel, Bureau of Indian Standards, New Delhi.
3	IS 801:1975, Indian Standard Code of Practice for Use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction, Bureau of Indian Standards, New Delhi.
4	IS 811:1987, Specification for Cold formed light gauge structural Steel sections, Bureau of Indian Standards, New Delhi.
5	SP: 6 (1) - 1964, Handbook for Structural Engineers, Bureau of Indian Standards, New Delhi.

Mode of Evaluation: CAT, Assignment, Quiz, FAT and Project.			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE505	Finite Element Analysis	L	T	P	C
		3	0	2	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To have a detailed knowledge and understanding of the fundamental concepts of finite element methods.
2. To introduce basic aspects of finite element technology, including discretization in the finite element approach, forming stiffness matrices and load vectors for simple problems, learn the shape functions, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
3. To develop proficiency in the application of the finite element methods (modelling, analysis, and interpretation of results) to structural engineering problems.

Course Outcomes

At the end of the course, the student will be able to
1. To understand the fundamental concepts of finite element methods
2. To develop FE equations for systems and the significance of shape functions in finite element formulations and plane truss analysis
3. To use basic finite elements for structural applications
4. To have insights into the use of the basic finite elements for structural applications using Space truss and higher order isoparametric elements.
5. Identify appropriate idealization (type of element) and modelling techniques for structural applications.

Module: 1	Introduction	9 hours

Background – General description of the method – Analysis procedure - Principles of elasticity Stress and strain vectors – Strain displacement equations – Linear constitutive equations – Overall stiffness matrix – Overall load matrix- Concept of an element – Various element shapes - Discretisation of a body or structure.

Module: 2	Theory of Finite Element	9 hours

Displacement models – Approximation, displacements by polynomials – Convergence requirements – Shape functions – Element strains and stresses - Area and volume coordinates – Construction of stiffness matrix and loads for the assemblage – Boundary conditions – Mesh generation - Analysis of plane truss.

Module: 3	Two-Dimensional problems	9 hours

Analysis of Beams - Plane frame - Axisymmetric elements - Plane stress and plane strain conditions - Constant Strain Triangle (CST), Linear Strain Triangle (LST) and Quadratic Strain Triangle (QST) elements - Solution of problems.

Module: 4	**Isoparametric Formulation**	**8 hours**
Isoparametric Bar element - Plane bilinear isoparametric element - Plane stress element - Quadratic plane elements - Application of Gauss Quadrature formulation –Lagrange's and serendipity elements.		
Module: 5	**Three-Dimensional Problems**	**8 hours**
Three-dimensional elasticity - Governing differential equations - Analysis of space truss – Grid - Higher order Isoparametric solid elements.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**

Text Book(s)	
1.	Krishnamoorthy, C. S., Finite Element Analysis: Theory and Programming, 2017, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.
2.	Reddy, J. N., An Introduction to Finite Element Methods, 2013, McGraw-Hill, New Delhi, India.
Reference Books	
1.	Cook, R. D., Malkus, D. S., and Plesha, M. E., Concepts and Applications of Finite Element Analysis, 2007, John Wiley & Sons, New Delhi, India.
2.	S.S. Rao, Finite Element Method in Engineering, 2010, Butterworth-Heinemann, New Delhi, India.

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Indicative Experiments	
1.	Analysis of a stepped bar with different materials
2.	Analysis of a simply supported beam with different loading conditions
3.	Analysis of a plane truss
4.	Analysis of a plane frame
5.	Analysis of space truss
6.	Analysis of a space truss
7.	Analysis of a fixed beam
8.	Analysis of a 2D frame
9.	Analysis of a 3D frame
10.	Analysis of a grid
Total Laboratory Hours	**30 hours**

Mode of assessment: Assessment / FAT / Oral examination

Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE601	Design of Bridges	L	T	P	C
		3	0	2	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To understand the basic concept of the design of bridges and analyze the box culvert
2. To analyze and design the T girders, I girders, cable-stayed and suspension bridges by IRC method
3. To design piers, abutments, pile foundations and bearings

Course Outcomes

Upon completion of this course, the student will be able to

1. Classify the different types of bridges.
2. Analyze box culvert and girder bridges by using different methods.
3. Design T girders, I girders, and Box girder bridges by IRC method.
4. Analyze and design cable-stayed and suspension bridges
5. Design piers, abutments, pile foundation, bearings, and expansion joints.

Module: 1	Bridge Deck Analysis	10 hours

Definition - Different types (Permanent/Temporary) - Classification based on material, span, structural form, etc. - Field Surveys and selection of site. IRC loadings and introduction to bridge loading worldwide - Analysis of box culverts, solid slab bridges by IRC - Effective width method - Pigeaud's method, etc. - Analysis of girder bridges by Courbon's method and Grillage method - Introduction to other methods of analysis.

Module: 2	Design of Small Bridges and Culverts	6 hours

Design of box culverts - Short span slab decks in square & skew - Design of T and I girder and Introduction to Box girder bridges by IRC method.

Module: 3	Long span & Special type bridges	7 hours

Analysis and design principles of continuous bridges - Arch bridges, integral bridges, cable-stayed bridges, and suspension bridges.

Module: 4	Design of Substructure	12 hours

Design of piers and abutments -Introduction to wing walls & returns and Reinforced Earth in flyover approaches – Pile, Pile cap and well foundation.

Module: 5	Bridge Appurtenances	10 hours

Design of Bearings - Expansion joints - Deck drainage - Crash barriers & handrails.

Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Text Book(s)		
1.	Victor, D. Johnson, Essentials of Bridge Engineering, 2019, 6th edition, Oxford Publishing Company, New Delhi, India.	
2.	Praveen Nagarajan, Design of Concrete Bridges: As per Latest IRC Codes, 2020, Wiley, New Delhi, India.	
Reference Books		
1.	Krishna Raju. N., Design of Bridges, 2019, 5th edition, Oxford and IBH Publishing Co., New Delhi, India.	
2.	IRC 112: Code of Practice for Concrete Road Bridges, 2020, Indian Roads Congress, New Delhi, India.	
3.	IRC SP 105: Explanatory Handbook to IRC:112-2011: Code of Practice for Concrete Road Bridges, 2015, Indian Roads Congress, New Delhi, India.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT		
Indicative Experiments		
1.	Basic exercise on Bridge Structural Analysis	
2.	Analysis & Design of 2D Box Culvert	
3.	Analysis & Design of RC Slab Bridge	
4.	Analysis & Design of PSC Box Bridge along with Substructure & Pile Foundation	
5.	Analysis of Steel Composite Bridge	
6.	Composite Sections, Composite Construction Stage & Prestressed Composite Design using Grillage Modelling	
7.	Analysis of Cable-Stayed Bridge	
8.	Analysis of Suspension Bridge	
9.	Rail Structure Interaction (RSI) Analysis	
10.	Analysis of Heat of Hydration for Concrete-Concrete Interface	
Total Laboratory Hours		**30 hours**
Mode of assessment: Assessment / FAT / Oral examination		
Recommended by Board of Studies	28-05-2025	
Approved by Academic Council	No. 78	**Date** 12-06-2025

MASTE602	Advanced Concrete Materials and Technology	L	T	P	C
		3	0	2	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To study the roles of concrete constituent materials, the requirements and properties of the materials, and their effects on concrete.
2. To study the concrete mix design using different methods and to understand the behaviour of fresh concrete properties, Microstructural development, hardened and durability properties of concrete.
3. To study the testing procedure of different non-destructive testing methods and the different types of special concrete and concreting methods.

Course Outcomes

Upon completion of this course, the student will be able to
1. Identify and explain the role of ingredients of concrete and their effect on concrete properties.
2. Design a suitable concrete mixture proportion as per site requirements.
3. Explain the behaviour of fresh and hardened properties of concrete and enlighten the hydration and microstructural development in hardened concrete.
4. Determine the strength and quality of concrete using NDT methods and describe the methods used to evaluate the durability of concrete.
5. Explain the different types of special concrete and their application in construction.

Module: 1	Materials for concrete	8 hours

Cement, fine aggregate, coarse aggregate – Artificial aggregate – Supplementary cementitious materials SCM's - Chemical Admixtures – Admixture types – Properties and Applications.

Module: 2	Concrete mixture proportion	9 hours

Selection of Materials - Methods of mix design - design of concrete mixes by using IS code method and ACI method - stages of concrete.

Module: 3	Behaviour of concrete in fresh and hardened state	9 hours

Rheological Behaviour of concrete - Composition of cement and hydration of cement phases - Microstructural development - Compressive strength - Splitting tensile strength - Flexural strength - Modulus of elasticity of concrete - Stress-strain characteristics – Poisson ratio - Factors affecting strength of concrete.

Module: 4	Non- Destructive Testing and Durability Properties of Concrete	8 hours

Rebound hammer test – UPV test – Half cell Potential test – Thermography – Pull out test - Rapid chloride permeability test - Water absorption test – Resistance against sulphate

attack, acid attack, alkaline attack - Effect of elevated temperature.		
Module: 5	**Special Concretes and its application**	**9 hours**
Polymer concrete composites - Recycled aggregate concrete – Fibre-reinforced concrete - High density concrete – Ferro cement - High performance concrete - Self-compacting concrete – Light-weight concrete.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**

Text Book(s)	
1.	A. M. Neville, J.J. Brooks, Concrete Technology, 2019, 2nd Edition, Pearson India Education Services Pvt. Ltd. India.
2.	A. R. Santhakumar, Concrete Technology, 2018, 2nd Edition, Oxford University Press, New Delhi.
Reference Books	
1.	P. Kumar Mehta, Paulo J. M. Monteiro. Concrete: Microstructure, Properties, and Materials, 2014, 4th Edition, McGraw-Hill, New Delhi.
2.	IS : 12269:2013, Specification for 53 grade ordinary Portland Cement, BIS, New Delhi.
3.	IS : 383:2016, Coarse and Fine Aggregate for Concrete — Specification, BIS, New Delhi.
4.	IS : 10262:2019, Concrete Mix Proportioning –Guidelines, BIS, New Delhi.
5.	IS : 516 : Part 1 : Sec 1 : 2021: Hardened concrete methods of test part 1 testing of strength of hardened concrete section 1 compressive, flexural and split tensile strength, BIS, New Delhi.
6.	IS : 9013: 1978, Method of making, curing and determining compressive strength of accelerated cured concrete test specimens, BIS, New Delhi.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar.	
Indicative Experiments	
1.	Determination of properties of concrete materials (Binder, SCM's)
2.	Determination of properties of concrete materials (coarse and fine aggregate)
3.	Determine the pozzolanic activity index of binding materials using XRF and MIP results.
4.	Design a concrete mixture proportion for the required grade of concrete.
5.	Design a concrete mixture proportion that contains fiber reinforcement.
6.	Determine the early age strength of concrete using the Accelerating Curing Technique.

7.	Determine the Elastic modulus and Poisson ratio properties of concrete.			
8.	Determine the flexural behavior of a reinforced concrete beam.			
9.	Perform the Crack Tip Opening Displacement (CTOD) test determines a concrete resistance to crack propagation by measuring the displacement at the crack tip.			
10.	Determine the durability properties of concrete.			
Total Laboratory Hours				**30 hours**
Mode of assessment: Assessment / FAT / Oral examination.				
Recommended by Board of Studies	28-05-2025			
Approved by Academic Council	No. 78	**Date**	12-06-2025	

MASTE603	Offshore Structures	L	T	P	C
		3	0	2	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To learn the types and functions of offshore structure.
2. To study the behavior of structures subjected to hydrodynamic loads
3. To study different analysis procedures for different offshore structures and also study the wave structure interaction.

Course Outcomes

Upon completion of this course, the student will be able to

1. Understand the types and functions of offshore structures
2. Evaluate the loads and apply the wave hydrodynamics in Offshore Structures
3. Appy the concept of Jacket Platform
4. Design the steel tubular members
5. Understand the concept of Jack-up Rigs.

Module: 1	Wave hydrodynamics	10 hours

Hydrocarbons resources in India - Types of Offshore Structures -Types of Offshore Platforms -Functions of offshore structures - Components of a Typical Offshore Structure. Wave generation and Propagation - Small and finite amplitude wave theories - Wave energy and pressure distribution.

Module: 2	Loads on Offshore Structures	6 hours

Gravity Loads - Wind Load - Wave and Current Loads - Fatigue Load-Seismic Loads.

Module: 3	Analysis of fixed offshore structures	7 hours

Jacket concepts – Redundant framing arrangement - Launch and Lift jackets - Simple Deck Configurations for Lift and float - Over installations - In-service and Pre-service Loads and analysis.

Module: 4	Steel tubular member design	10 hours

Allowable stresses and Partial Safety Factors and Load and Resistance Factor Design (LRFD) - Tubular Members, Slenderness effects - Column Buckling - Design for Hydrostatic pressure - Design for combined axial and bending stresses. Simple tubular joints, design using allowable loads - Stress concentration factors - S-N curves, and fatigue damage calculations.

Module: 5	Analysis of Jack-up rig	10 hours

Configuration and operation of jack-ups - Simplified analysis – Spudcan - Penetration and extraction - Spudcan – Pile interaction.

Module: 6	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	D.V. Reddy, A. S. J. Swamidas, Essentials of Offshore Structures, 2014, CRC Press, Taylor & Francis Group, New Delhi, India.
2.	Mohamed A. El-Reedy, Offshore Structure: Design, Construction and Maintenance, 2012, Gulf Professional Publishing, New Delhi, India.
Reference Books	
1.	API, Recommended Practice for Planning, Designing and Construction of Fixed Offshore Platform, RP2A, 2014, American Petroleum Institute Publication, Dallas, Texas, USA.
2.	API RP 2A-LRFD: Planning, Designing, and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 2019 (R2024), American Petroleum Institute, Dallas, Texas, USA.
3.	Günther Clauss, Eike Lehmann, Carsten Östergaard, M.J. Shields, Offshore Structures: Volume I: Conceptual Design and Hydromechanics, 2012, Springer-Verlag, New Delhi, India.
4.	Eugenio Fortaleza, Active Control of Offshore Structures, 2012, Lambert Academic Publication, New Delhi, India.
5.	Subrata K. Chakrabarti, Handbook of Offshore Engineering (Vol. I & II), 2005, Elsevier Ocean Engineering, Elsevier, New Delhi, India.
Mode of Evaluation: CAT Assignment / Quiz / FAT	

Indicative Experiments		
1.	Analysis of Mono column	
2.	Modeling a Jacket and deck using wizard	
3.	In-place analysis of the Jacket structure	
4.	Pre-service analysis of the Jacket structure – lift, transport, etc.	
5.	Modelling a Jack-up rig	
Total Laboratory Hours		**30 hours**
Mode of assessment: Assessment / FAT / Oral examination		

Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE604	Earthquake Resistant Design	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To study the basic concepts of engineering seismology and ground motion characteristics and understand the strength and capacity design principles of earthquake resistant design.
2. To study the elastic and inelastic deformations and significance of ductility in beam-column joints.
3. To study the seismic behaviour of masonry and concrete shear wall systems and to study the significance of energy dissipating devices in seismic resistant design.

Course Outcomes

Upon completion of this course, the student will be able to

1. Identify the characteristics of seismic waves and its measures.
2. Understand the principles of earthquake resistant design and response spectrum.
3. Analyze and design the various types of structures under static and dynamic loading conditions.
4. Design various beam-column joints as per ductility requirements.
5. Analyze and design unreinforced and reinforced masonry and concrete shear wall structures and explain the types of dampers and base isolation systems

Module: 1	Seismology and Earthquake	9 hours

Internal structure of the earth, continental drift and plate tectonics, Faults, Elastic rebound theory, seismic waves and characteristics, earthquake size, strong ground motion, seismic zoning map of India, Seismic hazard assessment.

Module: 2	Principles of Earthquake Resistant Design	7 hours

Seismic design philosophy - Principles of earthquake resistant design - Response spectrum theory - Application of response spectrum theory to seismic design of structures - Capacity - Design Principles - Design criteria for strength - Stiffness and ductility.

Module: 3	Seismic Analysis of Moment Resisting Frames	9 hours

Determination of design lateral forces as per IS: 1893-2016 – equivalent static force and dynamic analysis procedure. Effect of infill stiffness on analysis of frames – Equivalent diagonal strut.

Module: 4	Design of Beam Column Junctions	9 hours

Elastic and Inelastic deformations of structures – ductility of the composite system – design of axial and flexural members – beam column junction detailing – strong column – weak beam effects as per IS: 13920: 2016.

Module: 5	Design of Shear Walls and Vibration Control Techniques	9 hours
Unreinforced and reinforced masonry shear walls – analysis and design of reinforced concrete shear walls. Vibration control – energy dissipating devices – principles and application, basic concept of base isolation – various systems - case studies.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial problem in Module 2: 4 Hrs Tutorial problem in Module 3: 4 Hrs Tutorial problem in Module 4: 4 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial hours		**15 hours**

Text Book(s)	
1.	Bhattacharjee, S.K., Seismic Analysis and Earthquake Resistant Design of Structures, 2018, 1st Edition, New Age International Pvt. Ltd., New Delhi, India.
2.	Agarwal, P., and Shrikhande, M., Earthquake Resistant Design of Structures, 2006, 1st Edition, Prentice Hall of India Pvt. Ltd., New Delhi, India.
Reference Books	
1.	Moehle, J., Seismic Design of Reinforced Concrete Buildings, 2015, 1st Edition, McGraw-Hill Education, New York, NY, USA
2.	Paulay, T., and Priestley, M.J.N., Seismic Design of Reinforced Concrete and Masonry Buildings, 1992, 1st Edition, Wiley-Interscience, New York, NY, USA.
3.	Ingle, R.K., and Jain, S.K., Explanatory Examples for Ductile Detailing of RC Buildings, 2005, IITK-GSDMA Project on Building Codes, Indian Institute of Technology Kanpur, Kanpur, India.
4.	IS 1893 (Part 1): 2016 – Criteria for Earthquake Resistant Design of Structures: Part 1 General Provisions and Buildings, 2016, Bureau of Indian Standards, New Delhi, India.
5.	IS 13920: 2016 – Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces – Code of Practice, 2016, Bureau of Indian Standards, New Delhi, India.

Mode of Evaluation: CAT, Assignment, Quiz, FAT, Project.			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE605	Analysis and Design of Tall Structures	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To understand the behaviour of tall structures subjected to dynamic loads.
2. To study the behaviour of Braced Frame and Tubular Structures.
3. To study the behaviour of different types of tall structural systems.

Course Outcomes

1. Analyse the tall structure for gravity and lateral loads.
2. Evaluate the structural systems in tall buildings.
3. Understand the behaviour of various structural systems under gravity and lateral loading.
4. Examine different types of outrigger system.
5. Understand shear wall systems and Identify the importance of infilled frames.

Module: 1	Types of Buildings and Loads Calculations	9 hours

Fundamentals of Tall Building analysis and Design - Design Criteria- Wind load - Seismic load - Quasi-static approach combination of loading - Analysis of gravity and horizontal loading - Overall buckling analysis of frames, wall – frames–second order effects of gravity of loading– simultaneous first order and P-delta analysis Translational - torsional instability, out of plum effects.

Module: 2	Structural Systems and Rigid frame	9 hours

Factors influencing the analysis of structural systems - High rise behaviour- Structural Forms - Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger-braced and hybrid mega systems. Rigid frame behaviour - analysis of gravity loading - analysis of horizontal loading.

Module: 3	Braced Frame and Tubular Structures	8 hours

Bracing Frame – types - behaviour of bracing - methods of analysis - member force analysis - drift analysis - Tubular Structures - types of structural behaviour- chimney – mast structures- silos.

Module: 4	Core and Outrigger System	8 hours

Lateral load behaviour - optimum location of single outrigger- optimum location of two outrigger- framed tube system.

Module: 5	Shear Wall System and in-filled framed structures	9 hours

Behaviour and analysis of shear wall - coupled shear wall - Importance - Methods of analysis - Equivalent truss and frame method - Force-displacement method - Effect of perforation in the in-filled frame.

Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial problem in Module 1: 3 Hrs Tutorial problem in Module 2: 3 Hrs Tutorial problem in Module 3: 3 Hrs Tutorial problem in Module 4: 3 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial hours		**15 hours**

Text Book(s)	
1.	Taranath, B.S., Tall Building Design: Steel, Concrete, and Composite Systems, 2016, 1st Edition, CRC Press, Taylor & Francis Group, Boca Raton, FL, USA.
2.	Zalka, K., Structural Analysis of Multi-Storey Buildings, 2020, 2nd Edition, CRC Press, Taylor & Francis Group, Boca Raton, FL, USA.
Reference Books	
1.	Taranath, B.S., Structural Analysis and Design of Tall Buildings: Steel and Composite Construction, 2011, 1st Edition, CRC Press, Taylor & Francis Group, Boca Raton, FL, USA.
2.	Smith, B.S., and Coull, A., Tall Building Structures: Analysis and Design, 2011, 1st Edition, John Wiley & Sons, New York, NY, USA.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project.			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE606	Prestressed Concrete Structures	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objectives

1. To understand the mechanical properties of concrete and steel materials and concepts of pre-stressing.
2. To analyse and design of prestressed concrete beams against flexure, shear and torsion with the consideration of losses in prestress and serviceability checks.
3. To analyse and design of end blocks and to find the line of pressure in continuous beams.

Course Outcome

At the end of the course, the student will be able to
1. Understand the concepts of prestressing.
2. Evaluate the losses in prestress and deflection in beams.
3. Analyse and design of cracked and un-cracked beams.
4. Design the beams subjected to shear and torsion.
5. Design the end block reinforcement and to analyse the continuous beams.

Module: 1	**Properties of materials and Concepts of Prestressing**	**4 hours**

Mechanical properties of concrete and steel, Basic concepts - Development of pre-stressed concrete – Types of pre-stressing – Pre-stressing systems & devices.

Module: 2	**Losses in Pre-stress and Deflection of beams**	**10 hours**

Losses in Pre-stress – Immediate losses – Time dependent losses - Calculation of deflection in un-cracked section - Immediate deflection and long-term deflection.

Module: 3	**Analysis and design of Members under Flexure**	**13 hours**

Analysis of elastic flexural stresses at various stages of loading in determinate beams – Stress, strength and load balancing concepts - Permissible stresses – Cracking moment – Kern limits – Analysis of inelastic flexural stresses in partially pre-stressed beams. Basis of design - Fully pre-stressed beams - Flexural design based on limit state of serviceability – Flexural design based on limit state of collapse – IS codal method – Partially pre-stressed beams - Strain compatibility method.

Module: 4	**Design of Members against Shear and Torsion**	**8 hours**

Diagonal shear and flexural shear failures – Resistance against shear – Cracked section – Un-cracked section – Design for shear reinforcement - Equilibrium torsion & compatibility torsion– Modes of failure under combined bending, shear and torsion – Design for longitudinal and transverse torsional reinforcement.

Module: 5	**Transmission of Pre-stress & concept of concordant cable profile**	**8 hours**

Introduction – Pre-tensioned members – Transmission length – development length – end zone reinforcement – Post-tensioned members – end zone reinforcement – bearing plate. Calculation of primary & secondary moments – pressure line due to pre-stressing force – concordant cable profile.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial problem in Module 1: 3 Hrs Tutorial problem in Module 2: 3 Hrs Tutorial problem in Module 3: 3 Hrs Tutorial problem in Module 4: 3 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial Hours		**15 Hours**

Text Book(s)	
1.	Raju, N. K., Prestressed Concrete, 2018, 6th Edition, Tata McGraw-Hill, New Delhi.
2.	Arthur H. Nilson, Design of Pre-stressed Concrete, 1987, John Wiley & Sons, Canada.
Reference Books	
1.	T.Y. Lin and N.H. Burns, Design of Prestressed Concrete Structures, 1981, 3rd Ed., Wiley, New York.
2.	IS: 1343: 2012 Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.

Mode of Evaluation: CAT / Assignment / Quiz / FAT.

Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE607	Matrix Methods of Structural Analysis	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To understand the concept of principle of Superposition and Strain energy.
2. To analyse the forces in structures like continuous beam, truss and frames using stiffness and flexibility method.
3. To analyse the grid structures and knows the behaviour of structures due to thermal expansion and lack of fit.

Course Outcomes

On completion of the course, the students will be able to

1. Apply the basic concepts of matrix methods in structural analysis.
2. Analyse the structures using flexibility method.
3. Analyse the structures using stiffness method.
4. Analyse space truss, frame and compute the forces in various members due to lack of fit and thermal expansion.
5. Analyse grid structures.

Module: 1	Energy Concepts	8 hours

Transformation of Coordinates - Basic assumptions - Types of loads – Compatibility conditions - Static and kinematic indeterminacy - Principles of superposition - Strain energy - Stiffness for beam element from strain energy.

Module: 2	Flexibility Method	9 hours

Properties of flexibility matrix- solution of simple problems - Flexibility method applied to statically indeterminate structures - Analysis of continuous beam, plane truss and plane frame.

Module: 3	Stiffness Method	9 hours

Properties of stiffness matrix Stiffness method applied to kinematically indeterminate structures - Analysis of continuous beam, plane truss and plane frame.

Module: 4	Space Truss and Special Conditions	9 hours

Analysis of space truss and space frame by stiffness matrix method - Effects of temperature change and lack of fit. Related numerical problems by flexibility and stiffness method

Module: 5	Grid Structures	8 hours

Analysis of grid by matrix methods- Special analysis procedures - static condensation and sub structuring - initial and thermal stresses.

Module: 6	**Contemporary issues**	**2 hours**
Total Lecture hours		**45 hours**
Tutorial		
Tutorial problem in Module 1: 3 Hrs Tutorial problem in Module 2: 3 Hrs Tutorial problem in Module 3: 3 Hrs Tutorial problem in Module 4: 3 Hrs Tutorial problem in Module 5: 3 Hrs		
Total Tutorial hours		**15 hours**

Text Book(s)	
1.	Bhavikatti, S.S., and Mogali, M.B., Matrix Method of Structural Analysis: Structures & Element Approach, 2023, 1st Edition, I.K. International Publishing House Pvt. Ltd., New Delhi, India.
2.	Wang, C.K., Intermediate Structural Analysis, 2017, 1st Edition, McGraw Hill Education (India), New Delhi, India.
Reference Books	
1.	Godbole, P.N., Sonparote, R.S., and Dhote, S.U., Matrix Methods of Structural Analysis, 2014, 1st Edition, PHI Learning Pvt. Ltd., New Delhi, India.
2.	Natarajan, C., and Revathi, P., Matrix Methods of Structural Analysis: Theory and Problems, 2014, PHI Learning Pvt. Ltd., New Delhi, India.
3.	Jain, A.K., Advanced Structural Analysis, 2015, 4th Edition, Nem Chand & Bros., Roorkee, India.

Mode of Evaluation: CAT / Assignment / Quiz / FAT.			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE608	Prefabricated Structures	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objectives

1. Explain the design principles related to prefabrication elements.
2. Acquire knowledge in joints and connections of precast systems.
3. Obtain the concepts of production, transportation, assembling & erection of precast buildings.

Course Outcomes

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

1. Explain various structural systems and identify and differentiate structural behaviour of building elements.
2. Select appropriate materials for manufacturing precast concrete products.
3. Apply the design philosophy in designing the precast elements and applications.
4. Identify and describe the working principles of various joints and connections.
5. Identify and describe various tools used in assembling and erection of prefabricated structural elements.

Module: 1	**Prefabrication - A Local and global Perspective**	**5 hours**

Need and Principles of prefabrication, Types of Prefabrication, Modular coordination, Standardization, Prefabrication systems production, Transportation, disuniting of structures - Code provisions, Industrialized Building System (IBS), Complexities in Precast Construction, Prefabrication Building Construction - A Indian and global Perspective.

Module: 2	**Materials and Precast Products**	**6 hours**

Materials requirements for production of precast products include concrete, steel, and chemical admixtures; special products – Lightweight aggregate concrete, Aerate concrete, hollow core slabs, Acoustic control panels and floors, Thermal insulation panels – Quality control and assurance in precast products.

Module: 3	**Precast Concrete Building Systems**	**12 hours**

Designing and detailing of Different types of Structural Systems - Skeletal Frame System, Large Panel System, Cell System; Systems for Lateral Load Resistance - Low-Rise Portals and Frames, Multi-Storied Frames, Wall System - Components –Beams, Columns, Slabs, Walls and prestressed elements - Precast Foundations - Construction of Shallow Precast Foundations, Precast Pile Foundations, Precast Facial Elements for Reinforced Earth Walls.

Module: 4	Joints and Connections	10 hours
Dimensioning and detailing of joints for different structural connections - Different types of connection - Column to foundation connection - Socketed connection, Bolted or Base plate Connections, Mechanical Splice Connection, Grouted Connections; Wall Panel to Foundation Connections - Beams to Column Connections; Dry Connections - Hidden Connections, Visible Connections - Beam to Column Head Connection, Connections with Mechanical Couplers, Connections with Corbel – Wall to wall connections - Connection Materials; Tolerances.		
Module: 5	**Production, Handling, Erection and Machineries**	**10 hours**
Production Set up & Planning - Moulds for Beams, columns, slabs and walls; Production, Mould Tolerances, Concreting & Vibration, Demoulding Techniques, Precast Concrete Products Tolerances, Curing and Storage. Transportation, Handling Equipment's for Precast Components, Handling Devices for Lifting; Erection Schemes and Supports, Installation of precast elements - Machineries and equipment for prefabrication – Common deflects & acceptance criteria.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**

Text Book(s)

1.	Handbook on Precast Concrete Buildings, 2016, 1st Edition, Indian Concrete Institute (ICI) - Technical Committee (ICI - TC / 02), ICI Publication, Chennai, India.
2.	Kim S. Elliot, Precast Concrete Structures, 2016, 2nd Edition, CRC Press - Taylor & Francis Group, Boca Raton, Florida, USA.

Reference Books

1.	Kim S. Elliott and Zuhairi Abd. Hamid, Modernisation, Mechanisation and Industrialisation of Concrete Structures Precast Concrete Structures, 2017, 1st Edition, Wiley Blackwell, UK.
2	Hubert Bachmann, Alfred Steinle, Precast Concrete Structures, 2018, 1st Edition, Ernst & Sohn, Germany.

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE609	Stability of Structures	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To understand the stability and post-buckling behaviours.
2. To develop differential equations and to derive the elastic critical buckling loads for columns and beam-columns.
3. To analyse the stability of planar frames and to derive equations for elastic critical loads under flexural-torsional buckling in columns.

Course Outcome

Upon completion of this course, the student will be able to

1. Apply equilibrium and energy methods for stability problems.
2. Derive the expressions for elastic critical buckling loads in planar columns.
3. Apply differential and slope-deflection equations for stability analysis of beam-columns.
4. Analyse the stability of frames through equilibrium, slope-deflection and matrix methods.
5. Understand deformation characteristics of torsional buckling.

Module: 1	Fundamentals of Stability Theory	5 hours

Basics of Stability Behaviour : The Spring-Bar System, Fundamentals of post-buckling behaviour – Static Equilibrium Method – Energy Method, Snap through buckling, Multi Degrees of Freedom.

Module: 2	Elastic Buckling of Planar Columns	8 hours

Differential Equation for planar flexure in columns – linear column theory, Effective-length concept and design curve, Large-deformation theory of columns, Behaviour of imperfect columns, Eccentrically loaded columns.

Module: 3	Beam-column	10 hours

Theory of Beam-column – Stability analysis of beam column with different types of loads – Basic differential equations, slope deflection equations, Failure of beam-columns, Design interaction equations.

Module: 4	Planar Frame Stability	10 hours

Modes of Buckling, Stability of planar frame - Neutral Equilibrium, Slope-Deflection Equations, Matrix Analysis, Second Order Elastic Analysis.

Module: 5	Flexural - Torsional Buckling	10 hours

Torsional load-Deformation characteristics of structural members- strain energy of torsion – Torsional and flexural torsional buckling of columns, Lateral Buckling of beams.

Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**
Text Book(s)		
1.	Theodore V. Galambos, Andrea E. Surovek., Structural Stability of Steel: Concepts and Application for Structural Engineers, 2008, John Wiley & Sons, Inc. New Jersy.	
2.	Iyengar. N.G.R., Elastic Stability of Structural Elements, 2007, McMillan, New Delhi.	
Reference Books		
1.	Ashwini Kumar,. Stability of Structures, 2003, Allied Publishers Ltd.,. New Delhi.	
2.	Chajes. A,. Principles of Structures Stability Theory, 1974, Prentice Hall, New Jersy.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT.		
Recommended by Board of Studies	28-05-2025	
Approved by Academic Council	No. 78	**Date** 12-06-2025

MASTE610	Repair and Rehabilitation of Structures	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objectives

1. To study the causes and deterioration reinforced concrete structures.
2. To assess the corrosion mechanism of embedded steel reinforcement and deteriorated concrete using various NDT techniques.
3. To study the protection strategies to control the different cementitious disintegration, surface protection methods and repair & rehabilitation techniques using a suitable repair material.

Course Outcomes

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

1. Examine the potential causes and disintegration mechanism of reinforced concrete structures.
2. Evaluate the corrosion mechanism of embedded steel reinforcement in concrete structures.
3. Apply the non-destructive testing methods to assess the condition of reinforced concrete structures.
4. Identify a suitable surface treatment and protection method.
5. Apply a suitable rehabilitation technique to enhance performance of structural element.

Module: 1	**Causes and Deterioration of Concrete**	**8 hours**

Failures of structures — Physically Induced Deterioration — Freeze-Thaw Deterioration, Mechanical Abrasion, Erosion and Cavitation — Chemically Reaction — Acid, Alkali-Silica Reaction, Sulphate Attack — Design Errors — Shrinkage and Movement — Temperature changes — Fire attack.

Module: 2	**Corrosion Mechanism and Protection Methods**	**8 hours**

Fundamentals of Corrosion – Corrosion of embedded metal – Carbonation Induced Corrosion – Chloride Induced Corrosion – Corrosion on prestressed concrete – Effects of Cover thickness and Cracking, Methods of Corrosion protection – Corrosion Inhibitors – Corrosion Resistant Steels – Coatings – Cathodic Protection Methods.

Module: 3	**Condition Evaluation**	**9 hours**

Preliminary and Detailed Surveys - Condition assessment of concrete structures – exposure condition – visual inspection – NDT Methods – Surface Hardness - Windsor Probe test –Ultrasonic Pulse Velocity – Pull-out test – Pull off method –Core test – Impact echo test – Ground Penetrating Radar - Half Cell measurements – Carbonation Test – Resistivity Measurements – Ground-penetrating radar (GPR), Infrared – Thermography, and Tomography.

Module: 4	Demolition, Surface Preparation and Treatments and Materials for repair	8 hours
Engineered demolition methods, surface preparation, cleaning process of reinforcement and protection, Bonding materials to existing concrete and surface protection methods – Planning and Design of concrete repair– Removal methods and preparation for repair – Waterproofing of concrete structures – Repair materials - Materials – Cement Mortars, Polymer concrete – Ferro cement, Fibre reinforced concrete – Fibre reinforced polymer reinforcement.		
Module: 5	**Repair and Strengthening Methods**	**10 hours**
Repair Techniques – Shotcreting, Grouting, Epoxy-cement mortar injection, Ceiling of cracks, Dry packing – Pre-packed concrete – Strengthening Techniques – Concrete and Steel Jacketing, Section Enlargement, Steel and FRP Plate Bonding, Near Surface Mounted FRP, Sprayed Concrete, external post tensioning, Textile Reinforced Mortars.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**

Text Book(s)	
1.	Emmons, P.H., Concrete Repair and Maintenance Illustrated: Problem Analysis, Repair Strategy, Techniques, 2002, 1st Edition, RS Means, Kingston, MA, USA.
2.	Bhattacharjee, J., Concrete Structures: Repair, Rehabilitation and Retrofitting, 2020, 1st Edition, CBS Publishers & Distributors Pvt. Ltd., New Delhi, India.
Reference Books	
1.	ACI 440.2R-17: Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures, 2017, ACI, Farmington Hills, MI, USA.
2	ACI PRC 546-23 Concrete Repair Manual, 2014, 4th Edition, Volumes I & II, ACI, Farmington Hills, MI, USA.
3	Raupach, M., and Büttner, T., Concrete Repair to EN 1504: Diagnosis, Design, Principles and Practice, 2014, 1st Edition, CRC Press, Boca Raton, FL, USA.
4	Von Fay, K.F., Guide to Concrete Repair, 2015, 2nd Edition, U.S. Department of the Interior, Bureau of Reclamation, Denver, CO, USA.
5	Woodson, R.D., Concrete Structures: Protection, Repair and Rehabilitation, 2009, 1st Edition, Butterworth-Heinemann (Elsevier), Oxford, UK.
6.	El-Reedy, M.A., Steel-Reinforced Concrete Structures: Assessment and Repair of Corrosion, 2023, 3rd Edition, Taylor & Francis Group, Boca Raton, FL, USA.

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE611	3D Concrete Printing for Construction	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To study the classification of 3D printing technologies and challenges in 3D printing in construction.
2. To study the requirement of printable materials and properties of fresh and hardened 3D printing concrete.
3. To study the mechanics of printer, extrusion & casting process, and application & impact of 3D printing in industry.

Course Outcomes

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

1. Explain the 3D printing technology and challenges in 3D printing in construction.
2. Distinguish the different types of 3D printing techniques.
3. Assess the properties of fresh and hardened properties of 3D printing concrete.
4. Discuss the working process of 3D concrete printer.
5. Assess the influencing parameters in extrusion and casting process.

Module: 1	3D Printing Technology	8 hours

3D Printing – Main concepts of 3D printing – general classification of printing technologies, emerging objects – advantages of 3D Printing – phases in method of construction in 3D printing - future direction and challenges.

Module: 2	Methods of 3D printing	9 hours

Method of printing by injection into a particle bed – process and applications – Process variants – selective binder – selective paste intrusion – coarse aggregate binding – binder jetting – Printing methods using extrusion and deposition Process and applications – Robotic concrete printing – Gantry based 3D Printing – process and applications – shotcrete 3D printing (SC3DP) – Principles and requirements of SC3DP process and applications– Specific parameters for SC3DP Classification parameters for 3D printing – Nozzle distance and air pressure – Application speed – layer bonding – Integration of reinforcement – D-Shape 3D Printing technique – process and applications – Wire and arc additive manufacturing – process and applications.

Module: 3	Mechanics of 3D Concrete Printer	8 hours

Mechanics of printer – motion along the axes, nozzle design – working mechanism of tank and pump – Material Delivery System – Control system – Printing parameters.

Module: 4	Properties of fresh and hardened 3DCP	9 hours
Raw materials – supplementary cementitious materials, admixtures, fibers, cement and aggregates, mix design – performance requirement of 3DCP – printability, extrudability, open time and buildability – Testing measurements for 3D printable fresh concrete – Performance of the cement materials using extrusion and deposition methods – mechanical behaviour of 3D printed materials – non fibrous material and fibrous materials – Effect of printing parameters on Mechanical properties hardened 3DCP.		
Module: 5	**Extrusion and Casting**	**9 hours**
Stages of 3D printing process - Criteria for pumping material in a fresh state – effect of time intervals between successive deposits and effect of water content – Change of rheology: physico-chemical activity over time – pumping – extrusion – Other problems occurring during concrete extrusion printing – effect of bond between layers – Shrinkage and cracking during drying of concrete.		
Module: 6	**Contemporary Issues**	**2 hours**
Total Lecture hours		**45 hours**

Text Book(s)	
1.	Panda, B., Shakor, P., and Laghi, V., Additive Manufacturing for Construction, 2024, 1st Edition, Emerald Publishing, Leeds, UK.
2.	Perrot, A., 3D Printing of Concrete: State of the Art and Challenges of the Digital Construction Revolution, 2019, 1st Edition, John Wiley & Sons, Hoboken, NJ, USA.
Reference Books	
1.	Caneparo, L., Digital Fabrication in Architecture, Engineering and Construction, 2014, Springer, Dordrecht, Netherlands.
2	Sanjayan, J.G., Nazari, A., and Nematollahi, B., 3D Concrete Printing Technology: Construction and Building Applications, 2019, 1st Edition, Butterworth-Heinemann (Elsevier), UK.

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025

MASTE612	Advanced Foundation Design	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To identify and design suitable foundation for major civil engineering projects.
2. To identify and design suitable deep excavation protection measures.
3. Analyze stability of Reinforced Earth walls.

Course Outcomes

Upon completion of this course, the student will be able to:

1. Estimate safe load carrying capacity and settlement of piles in different modes.
2. Estimate bearing capacity and settlement of raft and piled-raft foundation.
3. Analyze stability of well foundation.
4. Analyse sheet pile and find embedment depth.
5. Analyze internal and external stability of Reinforced Earth wall.

Module: 1	Pile Foundations	10 hours

Types of piles and construction - Load capacity of piles in sands and clays; Laterally loaded piles - Brom's analysis; Uplift capacity of piles; Pile group capacity; Group interaction effects; Settlement of piles and pile group; Pile load test – Maintained load and Cyclic load tests - Seismic performance of piles.

Module: 2	Raft Foundations and Combined Piled-Raft Foundations	9 hours

Rafts on clays and sands; Bearing capacity of rafts; Compensated raft; Flexible and rigid rafts; Settlement analysis of rafts; Contact pressure, SFD and BMD; Concept of a piled raft - Examples, definitions and terminology; Piled raft as a composite construction; Advantages of piled rafts; Performance of pile raft; Design, construction and monitoring of combined pile raft - Limit state approach and analysis method.

Module: 3	Well Foundations	8 hours

Well Foundations; Types of wells or caissons; Drilled shafts and caissons; Design and construction; Lateral stability – Elastic theory and Ultimate resistance methods.

Module: 4	Deep Excavation Protection Systems	7 hours

Sheeting and bracing systems in shallow and deep open cuts in different soil; types - Cantilever sheet piles, Anchored sheet piles; Stability and design of braced supports; Diaphragm walls - Design and construction.

Module: 5	**Reinforced Earth Walls**	**8 hours**
Advantages of RE walls; Behaviour of RE walls; Mechanism - Soil-reinforcement interaction; Internal and external stability analysis; Field applications of RE walls. Stability enhancement of slopes.		
Module: 6	**Contemporary Issues**	**3 hours**
Total Lecture hours		**45 hours**

Text Book(s)	
1.	Coduto, D.P., Kitch, W.A., and Yeung, M.R., Foundation Design: Principles and Practices, 2016, 3rd Edition, Pearson, Boston, MA, USA.
2.	Handy, R.L., Foundation Engineering: Geotechnical Principles and Practical Applications, 2020, 1st Edition, McGraw Hill LLC, New York, NY, USA.
Reference Books	
1.	Reul, O., and Randolph, M., Combined Pile-Raft Foundations: Design and Practice, 2024, 1st Edition, CRC Press, Boca Raton, FL, USA
2.	Poulos, H.G., Tall Building Foundation Design, 2017, 1st Edition, CRC Press, Boca Raton, FL, USA.
3.	Murthy, V.N.S., Textbook of Soil Mechanics and Foundation Engineering: Geotechnical Engineering Series, 2022, CBS Publishers & Distributors, New Delhi, India.

Mode of Evaluation: CAT, Assignment, Quiz and FAT.			
Recommended by Board of Studies	28-05-2025		
Approved by Academic Council	No. 78	**Date**	12-06-2025