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

(2022-2023 admitted students)

VISION STATEMENT OF VELLORE INSTITUTE 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 areas of resilient infrastructure, smart and sustainable cities, water and energy security, climate change, mobility of goods and people, and environmental protection.
- Pioneering the emerging skills in Civil Engineering.

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.

M. Tech. Structural Engineering

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering Applications

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_03:Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_04: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_05: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_06: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management skills related to project management and finance

PROGRAMME SPECIFIC OUTCOMES (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 / investigation to solve practical problems and write / present a substantial technical report / document.

M. Tech. Structural Engineering

CREDIT STRUCTURE

Programme Credit Structure	Credits
Discipline Core Courses	24
Skill Enhancement Courses	05
Discipline Elective Courses	12
Open Elective Courses	03
Project/ Internship	26
Total Graded Credit Requirement	**70**

M. Tech. Structural Engineering

DETAILED CURRICULUM

Discipline core courses 24

S. No.	Course Code	Course Title	L	T	P	C
1.	MMAT502L	Advanced Mathematical Methods	3	0	0	3
2.	MSTE501L	Theory of Elasticity and Plasticity	3	0	0	3
3.	MSTE502L	Design of Concrete Structural Systems	3	1	0	4
4.	MSTE503L	Structural Dynamics	3	1	0	4
5.	MSTE504L	Advanced Design of Steel Structures	2	1	0	3
6.	MSTE505L	Finite Element Analysis	2	1	0	3
7.	MSTE505P	Finite Element Analysis Lab	0	0	2	1
8.	MSTE506L	Prestressed Concrete Structures	2	1	0	3

Skill Enchantment Courses 05

S. No.	Course Code	Course Title	L	T	P	C
1.	MENG501P	Technical Report Writing	0	0	4	2
2.	MSTS501P	Qualitative Skills Practice	0	0	3	1.5
3.	MSTS502P	Quantitative Skills practice	0	0	3	1.5

Discipline Elective Courses 12

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MSTE601L	Matrix Methods of Structural Analysis	2	1	0	3
2.	MSTE602L	Design of Bridges	2	1	0	3
3.	MSTE603L	Prefabricated Structures	2	1	0	3
4.	MSTE604L	Stability of Structures	2	1	0	3
5.	MSTE605L	Advanced Concrete Materials and Technology	2	1	0	3
6.	MSTE606L	Advanced Foundation Design	3	0	0	3
7.	MSTE607L	Earthquake Resistant Design	2	1	0	3
8.	MSTE608L	Analysis and Design of Tall Structures	2	1	0	3
9.	MSTE609L	Offshore Structures	2	1	0	3
10.	MSTE610L	Repair and Rehabilitation of Structures	3	0	0	3
11.	MSTE611L	Energy Efficient Buildings	3	0	0	3

Open Elective Courses 03

Engineering Disciplines / Social Sciences

Project and Internship 26

S. No.	Course Code	Course Title	L	T	P	C
1.	MSTE696J	Study Oriented Project				2
2.	MSTE697J	Design Project				2
3.	MSTE698J	Internship I / Dissertation I				10
4.	MSTE698J	Internship II / Dissertation II				12

Discipline core courses

MMAT502L	ADVANCED MATHEMATICAL METHODS	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. Provide the students with sufficient exposure to advanced mathematical methods and tools that are relevant to engineering research.
2. Improving the computational skills of students by giving sufficient knowledge of analytical and numerical techniques useful for solving problems arising in Mechanical Engineering.
3. Imparting the knowledge of real time applications of Autonomous systems, Non-linear systems of ordinary differential equations and partial differential equations.

Expected Course Outcomes:

At the end of the course students are able to

1. Distinguish and analyse a variety of tools for solving linear systems and finding eigenvalues of these systems.
2. Derive and use the numerical techniques needed for the solution of a given engineering problems
3. Understand and correlate the analytical and numerical methods
4. Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.
5. Demonstrate the understanding of how physical phenomena are modelled by partial differential equations

Module: 1	Eigenvalue Problems	5 hours

Standard Eigen value problems–Eigenvalues and Eigenvectors–Gerschgorin Circles theorem–Rutishauser method, Power method, Inverse Power method.

Module: 2	Iteration Methods	6 hours

Sturm sequence, Jacobi method, Given's method, Householder method, Deflation, Lanczo's method.

Module: 3	Calculus of Variations	9 hours

Euler-Lagrange's equation –Isoperimetric problems, Rayleigh–Ritz method - Galerkin method.

Module: 4	System of First Order Ordinary Differential Equations	6 hours

Linear Systems - Homogeneous linear systems with constant coefficients - Autonomous systems - Phase Plane Phenomena - Critical Points - Stability for linear systems.

Module: 5	Nonlinear systems	6 hours

Simple critical points of nonlinear systems-Stability by Liapunov's method –
Non- Linear Mechanics: Conservative systems.

Module: 6	**Partial Differential Equations**	**5 hours**
Classification of Second-Order Partial Differential Equations, Significance of characteristic curves, Canonical Form, Sturm–Liouville problems and Eigen function expansions.		
Module: 7	**Wave equation**	**6 hours**
Displacements in a long string – a long string under its weight – a bar with prescribed force on one end – free vibrations of a string. Method of Separation of variables, Solution by method of Laplace transforms		
Module: 8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Differential Equations: Theory, Technique and Practice, G.F. Simmons, S. G. Krantz, Tata Mc GrawHill Publishing, 2007. (Topics from Chapters 10, 11)
2	Elements of Partial differential equations, Ian N. Sneddon, Dover Publications, New York, 2006. (Topics from Chapters 3, 5)
3	Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International publishers, 7th edition, New Delhi, 2019. (Topics from Chapter 3, 7)
4	Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2015. (Topics from Chapter 11)
5	The Calculus of Variations, Bruce van Brunt, Springer, 2004. (Topics from Chapters 2, 4, 5)

Reference Books	
1	Differential Equations and Dynamical Systems, Lawrence Perko, 3rd ed., Springer-Verlag, 2001.
2	An introduction to Ordinary Differential Equations, James C. Robinson, Cambridge University Press, New York, 2008 (4th print).
3	Elementary Applied Partial Differential Equations, Richard Haberman, Prentice Hall International, 1998.
4	Numerical Analysis, R. L. Burden and J. D. Faires, 10th Edition, Cengage Learning, India edition, 2015.

Mode of Evaluation: Continuous Assessment Tests, Final Assessment Test, Digital Assignments, Quizzes.			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE501L	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To Analyse the stresses and strains for two dimensional and three dimensional elements
2. To Understand the equilibrium and compatibility condition
3. To Understand the compatibility conditions in polar coordinates
4. To Solve the problems on Torsion for different shaped bars
5. To Understand the concept of plasticity

Expected Course Outcome:

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 coordinates
3. Understand the bending of cantilever beams and circular arc beams
4. Know the 3D problems in Cartesian coordinates
5. Understand the compatibility conditions in polar coordinates
6. Solve the problems on Torsion for different shaped bars.
7. Understand the concept of plastic analysis and yield criteria.

Module: 1	Elasticity	6 hours

Analysis of Stress and Strain - Elasticity approach – Definition and notation of stress – Components of stress and strain – Generalized Hooke's law

Module: 2	Elasticity Solutions	5 hours

Plane stress and plain strain problems with practical examples - Equations of equilibrium and compatibility conditions in Cartesian coordinates – Two dimensional Problems in Cartesian Coordinates

Module: 3	Cartesian Coordinates	6 hours

Airy's stress function - Bending of cantilever beams- Axi-symmetrical problems - Thick cylinder under uniform pressure - Circular arc beams subjected to pure bending.

Module: 4	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 of stresses and strains.

Module: 5	Polar Co-ordinates	6 hours

Equations of equilibrium and compatibility conditions in Polar coordinates- Axi-symmetrical problems-bending of curved bars

Module: 6	Torsion-Non-Circular Sections	6 hours

Torsion - Torsion of various shaped bars - Pure torsion of prismatic bars - Prandtle's membrane analogy - Torsion of thin walled tubes and hollow shafts

Module: 7	Plasticity and Theory of Failure	6 hours

Introduction to plasticity – Stress – Strain diagram – Plastic analysis – Yield criteria – St. Venant'stheory – Von mises criterion – Plastic work – Strain hardening

Module: 8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Timoshenko and Goodier, (2000), Theory of Elasticity, McGraw Hill Company, New York.
Reference Books	
1.	Mendelson, A., (2002), Plasticity: Theory and Applications, Mac Millanand Co., New York.
2.	Sadhu Singh, (2004), Theory of Plasticity, Dhanpat Rai sons Private Limited, New Delhi.
3.	Ansel. C. Ugural and Saul. K. Fenster, (2003), Advanced Strength and Applied Elasticity, Fourth Edition, Prentice Hall Professional technical Reference, New Jersey
4.	Chakrabarty. J, (2006), Theory of Plasticity, Third Edition, Elsevier Butterworth - Heinmann – UK.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE502L	DESIGN OF CONCRETE STRUCTURAL SYSTEMS	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To know the elastic and inelastic behaviour of beam.
2. To analyze the frame for various loading conditions.
3. To give an exposure to the various structural systems like flat slab, Deep beam, corbels and shear wall.

Expected Course Outcome:

1. Analyse the beam for deflection and estimation of crack width.
2. Analyse the multistorey frame for various loading condition.
3. Evaluate the plastic moment capacity of continuous beam.
4. Design the deep beam and corbels.
5. Design the flat slab, spandrel beam.
6. Design the slender column using SP16.
7. Analyse the shear wall structure.

Module: 1	**Basic Design Concepts**	**6 hours**
Limit state method - Design of beams- Short-term and long-term deflection of reinforced concrete beams and slab- Estimation of crack width in reinforced concrete members		
Module: 2	**Frame Analysis and Design**	**6 hours**
Static and dynamic loading of structures		
Module: 3	**Inelastic Behaviour of Concrete Beams**	**6 hours**
Moment curvature relationship – plastic hinge formation-moment redistribution in continuous beams		
Module: 4	**Deep Beams and Corbels**	**6 hours**
Strut and tie method of analysis for corbels and deep beams, Design of corbels, Design of deep beams		
Module: 5	**Flat Slab**	**7 hours**
Design of flat slabs and flat plates according to IS method – Check for shear - Design of spandrel beams -Yield line theory and Hillerborg's strip method of design of slabs - Grid floor		
Module: 6	**Slender Columns**	**6 hours**
Design of slender columns subjected to combined bending moment and axial force using IS 456-2000 and SP 16		
Module: 7	**Shear Wall**	**6 hours**
Analysis and design of shear wall framed buildings		
Module: 8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**45 hours**
	Tutorial Hours	**15 hours**

Text Book(s)			
1.	Subramanian. N., (2013), Design Of Reinforced Concrete Structures, Oxford University Press, New Delhi.		
Reference Books			
1.	Gambhir. M. L., (2012), Design of Reinforced Concrete Structures, Prentice Hall of India, New Delhi.		
2.	Varghese. P.C., (2011), Advanced Reinforced Concrete Design, PHI Learning Pvt. Ltd., New Delhi.		
3.	IS 456 Plain and Reinforced Concrete - Code of Practice		
4.	IS 13920 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces -Code of Practice		
5.	IS 1893 Criteria for earthquake resistant design of structures-Code of Practice		
6.	SP 16- Design Aids for Reinforced Concrete		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE503L	STRUCTURAL DYNAMICS	L	T	P	C
		3	1	0	4
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To know various dynamic forces acting on a building and their response.
2. To obtain knowledge on modes of failure and remedial solutions.
3. To study the analysis procedure for calculating the response of structures.
4. To understand the linear and no-linear behaviour of structures.

Expected Course Outcome:

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

1. Differentiate static and dynamic behavior of structures and their physical properties.
2. Identify and model a single degree of freedom system subjected to dynamic load.
3. Evaluate the response of single storied building subjected to dynamic load.
4. Identify and model a multi degree of freedom system subjected to dynamic load.
5. Evaluate the response of multi-storied building subjected to dynamic load.
6. Evaluate the dynamic behavior of beams.
7. Describe the nonlinearity of a system by various techniques.

Module: 1	Introduction	6 hours

History of vibration - Dynamic analysis and their importance to structural engineering problems - Degrees of freedom - D'Alembert's principle - Lagrange's equation - Simple harmonic motion.

Module: 2	Single Degree of Freedom	6 hours

Mathematical model for SDOF systems - Free vibration - Undamped - Damped - Critical damping - Measurement of damping - Vibration measuring instruments.

Module: 3	Response of SDOF Systems	6 hours

Response of SDOF system to Harmonic Loading, Periodic loading and Impulse Loading - Transmissibility - Fourier series - Duhamel's integral - Numerical integration.

Module: 4	Multi Degree of Freedom System	7 hours

Equation of motion - Free vibration - Undamped - Damped - Evaluation of structural property matrices - Mode shape - Orthogonality relationship.

Module: 5	Response of MDOF Systems	6 hours

Rayleigh's method - Rayleigh-Ritz method - Stodola's method - Stiffness method - Mode superposition method.

Module: 6	Continuous Systems	6 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: 7	Non-linear Numerical Techniques	6 hours

Wilson Theta method - Newmark Beta method –Runge-Kutta method.

Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**45 hours**
	Tutorial Hours	**15 hours**
Minimum of three problems to be worked out by students in every tutorial class.		
Text Book(s)		
1.	Mario Paz and William Leigh (2010), Structural Dynamics - Theory and Computation, Springer.	
Reference Books		
1.	Clough and Penzien (2015), Dynamics of Structures, CBS Publishers and Distributors, New Delhi.	
2.	Chopra. A. K. (2011), Dynamics of Structures - Theory and Applications to Earthquake Engineering, 4th edition, Prentice Hall, London.	
3.	Roy R.Craig, Jr. Andrew J. Kurdila (2011), Fundamentals of Structural Dynamics, John Wiley and Sons, London.	
Mode of assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test		
Recommended by Board of Studies	05.07.2022	
Approved by Academic Council		Date

MSTE504L	ADVANCED DESIGN OF STEEL STRUCTURES	L	T	P	C
		2	1	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To classify the structures and analyse the frame for wind loads.
2. To design the welded connections and to give exposure to fatigue.
3. To design light gauge steel members, steel – concrete composite and hollow sections.

Expected Course Outcome:

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

1. Classify the structures and wind load analysis for frames.
2. Design the welded connections.
3. Understand the fatigue and the factors that influence fatigue.
4. Analyse and design the beams and frames using plastic method.
5. Design the Light gauge structures.
6. Design the Steel- Concrete Composite sections.
7. Design the Hollow sections.

Module: 1	**Stability and Plate Buckling**	**4 hours**
Classification of structures-wind load analysis		
Module: 2	**Beam- column Connections/Semi Rigid Connections**	**4 hours**
Throat and Root Stresses in Fillet Welds – Seated Connections Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections		
Module: 3	**Fatigue**	**4 hours**
Types of fatigue leading and failure- Fatigue test, endurance limit- S-N diagram- Various failure relations- Factors influencing fatigue strength- Influence of stress concentration on fatigue test		
Module: 4	**Plastic Analysis and Design of Structures**	**4 hours**
Introduction - Shape factors - Mechanisms - Plastic hinge - Analysis of beams and portal frames - Design of fixed and continuous beams.		
Module: 5	**Design of Light Gauge Steel Structures**	**4 hours**
Types of cross sections - Local buckling and lateral buckling - Design of compression and tension members - Beams - Deflection of beams- Cold formed steel structures-Pre-engineered metal buildings- long span structures.		
Module: 6	**Design of Steel -concrete Composite Sections**	**4 hours**
Design of beam – columns- composite slabs		
Module: 7	**Design of Steel Members with Hollow Sections**	**4 hours**
Design of structural steel hollow sections		
Module: 8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)

1.	GalyordandGalyord (2012), Design of Steel Structures, Tata McGraw Hill, Education		
Reference Books			
1.	Duggal.S.K., (2014), Limit State Design of Steel Structures, Tata McGraw-Hill Education, New Delhi.		
2.	Subramanian. N., (2011), Design of Steel Structures, Oxford University Press, New Delhi.		
3.	Bhavikatti. S.S., (2012), Design of Steel Structures, I.K. International Publishing House Pvt. Ltd. New Delhi.		
4.	IS 800 General Construction in Steel — Codeof Practice		
5.	IS 801Code of Practice for use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction		
6.	IS 811Specification for Cold formed light gauge structural Steel sections		
7.	IS 11384 Code of practice for composite construction in structural steel and concrete		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final As			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE505L	FINITE ELEMENT ANALYSIS	L	T	P	C
		2	1	0	3
Pre-requisite	MSTE501L Theory of Elasticity and Plasticity	Syllabus version			

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 domain discretization, polynomial interpolation, 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 (modeling, analysis, and interpretation of results) to realistic engineering problems

Expected Course Outcome:

Upon completing this course, the students will be able to:

1. Understand the fundamental theory of finite element methods
2. Develop the ability to generate the governing FE equations for systems governed by partial differential equation
3. Demonstrate the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
4. Acquire knowledge in direct and formal (basic energy and weighted residual) methods for deriving finite element equations
5. Have insights into the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements
6. Identify appropriate space (planar (plane stress or strain), axisymmetric, or spatial), idealization (type of element), and modeling techniques
7. Understand the professional level finite element software to solve the engineering problems

Module: 1	Introduction	4 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

Module: 2	Theory of Finite Element	4 hours

Concept of an element – Various element shapes – Displacement models – Approximation displacements by polynomials – Convergence requirements – Shape functions – Element strains and stresses – Analysis of beams

Module: 3	Natural Coordinates	4 hours

Area and volume coordinates- Discretisation of a body or structure – Minimization of band width – Construction of stiffness matrix and loads for the assemblage – Boundary conditions – Mesh generation.

Module: 4	Two and Three Dimensional Problems	5 hours

Analysis of plane truss, space truss, plane frame and grid- Axisymmetric elements

Module: 5	**Plane Stress and Plane Strain Conditions**	**5 hours**
CST, LST & QST elements - solutions of problems		
Module: 6	**Isoparametric Formulation**	**4 hours**
Iso parametric Bar element - Plane bilinear isoparametric element - Plane stress element - Quadratic plane elements - Application of Gauss Quadrature formulation –Lagrange's and serendipity elements		
Module: 7	**Introduction to 3-D Elements**	**2 hours**
Three dimensional elasticity-Governing differential equations- Higher order Isoparametric solid elements		
Module: 8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)	
1.	Krishnamoorthy, C.S, "Finite Element Analysis ; Theory and programming", Tata McGraw Hill Publishing Co. Ltd., (2017)
Reference Books	
1.	Cook R.D., Malkas D.S. &Plesha M.E, "Concepts and applications of Finite Element Analysis", John Wiley &Sons., (2007)
2.	Reddy,J, "An Introduction to Finite Element Methods", McGraw Hill Co., (2013).
3.	Zeinkeiwich O.C.,R.L.Tayler " The Finite Element Method for Solid and Structural Mechanics", Butterworth-Heinemann,(2013).

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE505P	FINITE ELEMENT ANALYSIS LABORATORY	L	T	P	C
		0	0	2	1
Pre-requisite	MSTE501L Theory of Elasticity and Plasticity	Syllabus version			

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 domain discretization, polynomial interpolation, 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 realistic engineering problems

Expected Course Outcome:

Upon completing this course, the students will be able to:

1. Understand the fundamental theory of finite element methods
2. Develop the ability to generate the governing FE equations for systems governed by partial differential equation
3. Demonstrate the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
4. Acquire knowledge in direct and formal (basic energy and weighted residual) methods for deriving finite element equations
5. Have insights into the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements
6. Identify appropriate space (planar (plane stress or strain), axisymmetric, or spatial), idealization (type of element), and modelling techniques
7. Understand the professional level finite element software to solve the engineering problems

List of Experiments (Indicative)		3 hours
1	Discretisation of geometry	3 hours
2	Meshing a rectangular plate using 4 node elements	3 hours
3	Meshing a circular plate using 3 node and 4 node elements	3 hours
4	Analysis of a spring assembly using 1D elements	3 hours
5	Analysis of an assembly of bar elements	3 hours
6	Analysis of a stepped bar	3 hours
7	Analysis of a plane truss	2 hours
8	Analysis of a space truss	2 hours
9	Analysis of a fixed-fixed beam	2 hours

10	Analysis of a 2D frame	**2 hours**
11	Analysis of a 3D frame	**2 hours**
12	Analysis of a grid	**2 hours**
	Total Laboratory Hours	**30 hours**

Text Book(s)	
1.	Krishnamoorthy, C.S, "Finite Element Analysis ; Theory and programming", Tata McGraw Hill Publishing Co. Ltd., (2017)
Reference Books	
1.	Cook R.D., Malkas D.S. &Plesha M.E, "Concepts and applications of Finite Element Analysis", John Wiley &Sons., (2007)
2.	Reddy,J, "An Introduction to Finite Element Methods", McGraw Hill Co., (2013).
3.	Zeinkeiwich O.C.,R.L.Tayler " The Finite Element Method for Solid and Structural Mechanics", Butterworth-Heinemann,(2013).
Mode of Evaluation: Continuous Assessment Test & Final Assessment Test	

Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE506L	PRESTRESSED CONCRETE STRUCTURES	L	T	P	C
		2	1	0	3
Pre-requisite	MSTE502L Design of Concrete Structural systems	Syllabus version			

Course Objectives:

1. To learn the principles, materials, methods and systems of prestressing
2. To know the different types of losses and deflection of prestressed members
3. To learn the design of prestressed concrete beams for flexural members

Expected Course Outcome:

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

1. Understand the concepts of pre-tensioning and post-tensioning members
2. Design a prestressed concrete beam accounting for losses
3. Evaluate the deflection and crack width of prestressed members
4. Design the member subjected to flexure and shear.
5. Design the member subjected to torsion.
6. Design the anchorage zone reinforcement
7. Analyse and design the indeterminate structures.

Module: 1	Introduction	3 hours

Introduction – Development of Pre-stressed Concrete, General Principles of Pre-stressed Concrete, Classification and types of pre-stressing, Stages of loading, Materials – Concrete and Steel - stress, strain characteristics.

Module: 2	Losses in Pre-stress	3 hours

Significance of loss of Pre-stress, Immediate losses and time dependent losses

Module: 3	Deflections	7 hours

Deflections- calculation for short term/immediate and long term deflection

Module: 4	Design for Flexure and Shear	4 hours

Design For Flexure and shear– Flexural analysis of beams for limit state of serviceability, design for simply supported beams for limit state of collapse – Shear and Diagonal tension in Un-cracked beams, Diagonal cracking in shear, shear design for Limit state of collapse

Module: 5	Design for Torsion	4 hours

Torsion in concrete structures – Torsional design for pre-stressed concrete structures – Limit State of Collapse

Module: 6	Design of End Anchorages	3 hours

Stress distribution in end block – design of anchorage zone reinforcement

Module: 7	Indeterminate Structures	4 hours

Concept of concordant cable and profile – sketching of pressure lines for continuous beams.

Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial hours	**15 hours**

Text Book(s)	
1.	Krishna Raju. N., (2014), Pre-stressed Concrete - Problems and Solutions, CBS Publishers and Distributors, Pvt. Ltd., New Delhi.
Reference Books	
1.	Praveen Nagarajan, Advanced Concrete Design, Person, 2013
2.	N. Rajagopalan., (2013), Prestressed Concrete – Second Edition, Narosa Publishers, New Delhi
3.	IS: 1343: Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.
4.	IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, BIS, New Delhi.
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test	

Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

Discipline Elective Courses

MSTE601L	MATRIX METHODS OF STRUCTURAL ANALYSIS	L	T	P	C
		2	1	0	3
Pre-requisite	**Nil**	**Syllabus version**			

Course Objectives:

1. To understand the significance of degrees of freedom and the concept of principle of superposition
2. To recognize the concept of strain energy and principle of virtual work
3. To learn the transformation of system matrices and element matrices for the determinate and indeterminate structures.
4. To analyse the forces in structures like continuous beam, truss and frames using stiffness and flexibility method.
5. To comprehend the behaviour of structures due to thermal expansion and lack of fit.

Expected Course Outcome:

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

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

Module: 1	**Energy Concepts**	**4 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	**Matrix Methods**	**4 hours**

Properties of stiffness and flexibility matrices- solution of simple problems

Module: 3	**Flexibility Method**	**4 hours**

Flexibility method applied to statically indeterminate structures - Analysis of continuous beam, plane truss and plane frame

Module: 4	**Stiffness Method**	**4 hours**

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

Module: 5	**Space Truss**	**4 hours**

Analysis of space truss and space frame by stiffness matrix method

Module: 6	**Grid Structures**	**4 hours**
Analysis of grid by matrix methods- Special analysis procedures - static condensation and sub structuring - initial and thermal stresses.		
Module: 7	**Special Conditions**	**4 hours**
Effects of temperature change and lack of fit. Related numerical problems by flexibility and stiffness method		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial hours	**15 hours**

Text Book(s)	
1.	Bhavikatti S S, (2011), Matrix Methods of Structural Analysis, IK Publishing, India
Reference Books	
1.	Natarajan C, Revathi P., (2014), Matrix Methods of Structural Analysis: Theory and Problems, PHI,Prentice Hall of India, New Delhi.
2.	Godbole P. N., Sonparote R. S., Dhote S. U., (2014), Matrix Methods of Structural Analysis, PHI Learning Pvt. Ltd., New Delhi.
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test	

Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE602L	DESIGN OF BRIDGES	L	T	P	C
		2	1	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To understand the basic concept of design of bridges
2. To analyse box culvert
3. To design T and I girders
4. To analyse and design cable stayed and suspension bridges
5. To design piers and abutments
6. To design pile foundation and bearings

Expected Course Outcome:

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

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

Module: 1	General	3 hours

Definition, History, Different types (Permanent/Temporary), Classification based on material, span, structural form etc., Field Surveys and selection of site

Module: 2	Bridge Deck Analysis	4 hours

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 like Finite element, Finite strip method etc.,.

Module: 3	Design of Small Bridges & Culverts	5 hours

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

Module: 4	Long span & Special type bridges	4 hours

Analysis & design principles of continuous bridges, arch bridges, integral bridges, cable stayed bridges and suspension bridges.

Module: 5	Design of Substructure	4 hours

Design of piers & abutments -Introduction to wing walls & returns and Reinforced Earth in flyover approaches.

Module: 6	Design Foundations	4 hours

Pile, Pile cap and well foundation

Module: 7	Bridge Appurtenances	4 hours

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

Module: 8	Contemporary issues	2 hours

		Total Lecture hours	**30 hours**
		Tutorial Hours	**15 hours**
Text Book(s)			
1.	Johnson Victor. D., (2012), Essentials of Bridge Engineering, Oxford Publishing Company, New Delhi		
Reference Books			
1.	Jain and Jai Krishna.,(2007), Plain and reinforced concrete, Vol.2.,Nem Chand Brothers, New Delhi.		
2.	Krishna Raju. N., (2014), Design of Bridges, Oxford and IBH Publishing Co., New Delhi		
3.	Rakshit. K. S., (2010), Design and Construction of Highway Bridges, New central Book Agency, New Delhi.		
3	Standard specifications and code of practice for road bridges, (2005) – IRC section I, II, III and IV.		
4	Ponnuswamy (2008), Bridge Engineering, McGraw-Hill Education (India) Pvt Limited		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE603L	PREFABRICATED STRUCTURES	L	T	P	C
		2	1	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To study the design principles related to prefabrication.
2. To understand the concepts of precast floors, beams etc.,

Expected Course Outcome:

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

1. Understand the principles behind prefabricated structure
2. Design the precast concrete floor
3. Understand the composite and non- composite precast beam
4. Design the precast column and walls
5. Understand the principles of joint mechanism
6. Understand the various connection between the precast structural elements
7. Identify the machinery and equipment for precast manufacturing

Module: 1	Design Principles	3 hours

General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Types of foundation - Modular co-ordination – Components - Prefabrication systems and structural schemes - Design considerations - Economy of prefabrication- assessment of handling and erection spaces

Module: 2	Precast Concrete Floors	3 hours

Precast flooring options-flooring arrangements-design of individual units-design of composite floors- Beams and roof elements

Module: 3	Precast Concrete Beams	4 hours

Types of composites -non composite-reinforced beam -pre stressed beam

Module: 4	Columns and Shear Wall	6 hours

Precast column design -precast shear walls- infill walls-cantilever walls -distribution of horizontal forces

Module: 5	Joints	5 hours

Basic mechanism-compression joint-shear joint - tension joint

Module: 6	Connections	5 hours

Pin jointed connection-moment resisting connections- beam to column- column foundation connections

Module: 7	Machinery and Equipment	2 hours

Plant machinery, casting yard- casting and stacking

Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)	
1.	Kims S. Elliot (2017), Precast Concrete Structures, CRC Press, Taylor & Francis
Reference Books	
1.	Handbook of Precast Concrete Buildings (2016) ICI publications
2.	Ryan E. Smith, (2010), Prefab Architecture: A Guide to Modular Design and Construction, John Wiley and Sons. Inc. London
3.	Hubert Bachmann, Alfred Steinle, (2011), Precast Concrete Structures, Ernst &Sohn, Wiley Publication

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE604L	STABILITY OF STRUCTURES	L	T	P	C
		2	1	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To understand the difference between stability and instability.
2. To evaluate the structural stability of columns
3. To analyse the stability of beam column
4. To analyse stability of frames
5. To understand deformation characteristics of torsional buckling
6. To identify the differential equation of buckling of plates and shells

Expected Course Outcome:

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

1. Understand the difference between stability and instability.
2. Evaluate the structural stability of columns
3. Analyse the stability of beam column
4. Analyse stability of frames
5. Understand deformation characteristics of torsional buckling
6. Identify the differential equation of buckling of plates and shells

Module: 1	Introduction	3 hours
Static equilibrium – Governing equation for columns – Analysis for various boundary conditions.		
Module: 2	**Analysis of Column**	**4 hours**
Eccentrically loaded column and Initial Imperfect column -Numerical Problems		
Module:3	**Beam column**	**5 hours**
Theory of Beam column – Stability analysis of beam column with different types of loads – Failure of beam columns.		
Module: 4	**Analysis and Stability of Frames**	**5 hours**
Various Boundary Conditions – Differential equations – Slope Deflection method		
Module: 5	**Torsional Buckling**	**5 hours**
Torsional load-Deformation characteristics of structural members- strain energy of torsion – Torsional and flexural torsional buckling of columns		
Module: 6	**Buckling of Plates**	**3 hours**
Differential Equation of plate buckling –linear theory – critical load of a plate uniformly compressed in one direction.		
Module: 7	**Buckling of Shells**	**3 hours**
Differential equation – Analysis – Application		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**

		Tutorial Hours	**15 hours**
Text Book(s)			
1.	Iyengar. N.G.R., (2007), Elastic Stability of Structural Elements, McMillan, New Delhi		
Reference Books			
1.	Galambos. T.V., Surovek A. E(2008), Structural Stability of Steel: Concepts and Applications for Structural Engineers, Wiley, London		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE605L	ADVANCED CONCRETE MATERIALS AND TECHNOLOGY	L	T	P	C
		2	1	0	3
Pre-requisite	Nil	Syllabus version			

Course Objective:

1. To study the roles of concrete constituent materials, the requirements and properties of the materials and their effects on concrete.
2. To understand the behaviour of fresh and hardened of concrete with and without admixtures.
3. To study the concrete mix design using different methods.
4. To study the mechanical properties and durability of concrete.
5. To study the testing procedure of different non-destructive testing methods.
6. To study the different types of special concrete and concreting methods.

Expected Course Outcome:

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. Explain the behaviour of fresh and hardened properties of concrete.
3. Design of concrete mix using different methods.
4. Apply the destructive and non-destructive testing methods to assess the hardened properties of concrete.
5. Describe testing procedures for durability properties of concrete.
6. Explain the different types of special concretes

Module: 1	Concrete Materials and Admixtures	4 hours

Cement, Fine and Coarse aggregates –Mineral and Chemical Admixtures – Properties and applications.

Module: 2	Behaviour of Fresh Concrete and Hardened Concrete	4 hours

Behaviour of Concrete with and without admixtures - Modern trends in concrete manufacture and placement techniques - Ready mix concrete - Rheological behaviour of fresh concrete and hardened concrete.

Module: 3	Concrete Mix Design	4 hours

Methods of mix design-Design of concrete mixes by using IS code method and ACI method

Module: 4	Mechanical Properties of Concrete	4 hours

Compressive strength test- Split tensile strength test-Flexural test- Modulus of elasticity of concrete-Static modulus -Stress-strain characteristics- Dynamic modulus- Factors affecting strength of concrete.

Module: 5	Non-destructive Testing of Concrete	3 hours

Rebound hammer test – UPV test – Half cell Potential test – Thermography – Pull out test.

Module: 6	Durability Properties of Concrete	4 hours

Rapid chloride permeability test- Water absorption test – Resistance against sulphate attack, acid attack, alkaline attack- Effect of elevated temperature.

Module: 7	**Special Concrete and Concreting Methods**	**5 hours**
High performance concrete- Lightweight concrete – High density concrete - Polymer concrete - Fibre reinforced concrete – Self compacting concrete - Cold weather concreting - Hot weather concreting -Pre-packed concrete - Vacuum concrete		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)

1.	Metha.P.K, (2005), Concrete: Microstructure, Properties and Materials, McGraw-Hill, New Delhi.

Reference Books

1.	Neville.A.M.,Brooks.J.J., (2008), Concrete Technology, Pearson Education, New Delhi.
2.	Gambir.M.L., (2009), Concrete Technology, Tata Mc-Graw Hill-Education, New Delhi.
3.	Shetty.M.S.,(2017), Concrete Technology, S. Chand and Company Ltd, New Delhi.
4.	IS : 12269, Specification for 53 grade ordinary Portland Cement, BIS, New Delhi
5.	IS : 383, Specification for Coarse and fine natural sources for Concrete, BIS, New Delhi
6.	IS:10262, Concrete Mix Proportioning -Guidelines
7.	ACI 211.1-91 Reapproved 2009, Standard Practice for selecting Proportions for Normal, Heavyweight, and Mass Concrete.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE606L	ADVANCED FOUNDATION DESIGN	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

To impart the knowledge in the area of analysis and design of foundations and earth retaining structures.

Expected Course Outcome:

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

1. Estimate bearing capacity of raft foundation
2. Determine safe load carrying capacity of pile for a given site condition
3. Design a reinforced earth wall and analyse its stability
4. Analyse sheet pile and find embedment depth
5. Distinguish f piled-raft and load sharing between raft and pile
6. Evaluate stability of well foundation
7. Identify suitable type of cofferdam for a given construction problem

Module: 1	Raft Foundations	6 hours

Bearing capacity of rafts; Rafts on clays and sands; Compensated raft; Flexible and rigid rafts (IS: 2950); Settlement analysis of rafts (under embankment loading).

Module: 2	Pile Foundations	7 hours

Load capacity of piles in sands and clays; α - method; Brom's analysis; Laterally loaded piles; Uplift capacity of piles; Pile group capacity; Pile load test. Analysis of stress waves in pile driving.

Module: 3	Piled Rafts	7 hours

Concept of a piled raft - Examples, definitions and terminology; Piled raft as a composite construction; Advantages of piled rafts; Performance and design of a piled raft; Steps involved in piled raft design.

Module: 4	Well Foundations	6 hours

Well Foundations - Types of wells or caissons – Drilled shafts and caissons - Design and construction

Module: 5	Deep Excavation Protection Systems	6 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

Module: 6	Coffer Dams	5 hours

Types of Coffer dams, merits and demerits; Design of single wall coffer dams; Stability aspects, TVA method and Cumming's method.

Module: 7	Reinforced Earth Walls	5 hours

Advantages of RE walls, Behaviour of RE walls, Soil-reinforcement interaction; Internal and external stability conditions; Field applications of RE walls.

Module: 8	**Contemporary issues**	**3 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Bowles, J. E., (2011), Foundation Analysis and Design, 7th Edition, McGraw Hill Book Co., New York.
2.	Das. B. M., (2010), Principles of Foundation Engineering, CL Engineering.
Reference Books	
1.	Fang. H.Y.,(2012), Foundation Engineering Handbook, Springer Science and Business Media.
2.	Varghese. P. C., (2009), Design of Reinforced Concrete Foundations, Prentice Hall of India, New Delhi.
3.	Murthy. V. N. S., (2009), Soil Mechanics and Foundation Engineering - CBS Publications, Delhi.
4.	Swami Saran ., (2010), Reinforced Soil and Its Engineering Applications., I. K. International Pvt Ltd.
5.	Swami Saran., (2006), Analysis and Design of Substructures: Limit State Design, Oxford & IBH Publishing Company Pvt. Limited.
6.	Tomlinson M and Woodward J. (2008). Pile Design and Construction Practice" 5th Edition. Taylor and Francis.
7.	Fleming K, Weltman A, Randolph M and Elson K (2009). Piling Engineering. 3rd Edition. Taylor and Francis.
8.	K. R. Arora., (2011) Soil Mechanics and Foundation Engineering, Standard publishers

Mode of Evaluation: Continuous Assessment Test, Final Assessment Test, Quiz, Assignments

Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE607L	EARTHQUAKE RESISTANT DESIGN	L	T	P	C
		2	1	0	3
Pre-requisite	MSTE503L Structural Dynamics	Syllabus version			

Course Objectives:

1. To study the basic concepts of engineering seismology and ground motion characteristics.
2. To understand the strength and capacity design principles of earthquake resistant design.
3. To study the behavior of various types of buildings under static and dynamic forces.
4. To study the elastic and inelastic deformations and significance of ductility in beam-column joints.
5. To study the seismic behavior of masonry and concrete shear wall systems.
6. To study the significance of energy dissipating devices in seismic resistant design.

Expected Course Outcome:

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.
6. Explain the types of dampers and base isolation systems and its importance in seismic resistant design.

Module: 1	Seismology and Earthquake	6 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	3 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	5 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	Modelling, Analysis and Design of Structures	3 hours

Seismic analysis and design of RC structures using software - static and dynamic methods – equivalent static, response spectrum and time history methods.

Module: 5	Design of Beam Column Junctions	5 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: 6	Design of Shear Walls	3 hours

Unreinforced and reinforced masonry shear walls – analysis and design of reinforced concrete shear walls.

Module: 7	**Vibration Control Techniques**	**3 hours**
Vibration control – energy dissipating devices – principles and application, basic concept of base isolation – various systems - case studies.		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)	
1.	Pankaj Agarwal and Manish Shrikhande., (2010), Earthquake resistant design of structures, Prentice-Hall India Pvt. Ltd., New Delhi.
Reference Books	
1.	Pauley and Priestly. (1992), Seismic design of reinforced concrete and masonry buildings, John Wiley and Sons, London.
2.	Jack Moehle (2015), Seismic Design of Reinforced Concrete Buildings, McGraw-Hill Education, New Delhi.
3.	IS: 1893:2016 (Part 1), Criteria for earthquake resistant design of structures.
4.	IS: 13920: 2016, Ductile detailing of reinforced concrete structures subjected to seismic forces.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE608L	ANALYSIS AND DESIGN OF TALL STRUCTURES	L	T	P	C
		2	1	0	3
Pre-requisite	MSTE504L Advanced Design of Steel Structures	Syllabus version			

Course Objectives:

1. To understand the behaviour of tall structures subjected to dynamic loads
2. To study the behaviour of different types of tall structural systems

Expected Course Outcome:

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

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
6. Identify the importance of infilled frames
7. Examine three dimensional analysis of floors

Module: 1	Types of Buildings and Loads Calculations	5 hours

Classification of buildings according to NBC – Wind load – Seismic load – Quasi static approach- combination of loading

Module: 2	Rigid frame	4 hours

Rigid frame behaviour- analysis of gravity loading-Substitute frame method for dead load and live loads- analysis of horizontal loading- Portal - Cantilever and factor methods – Kani's method- Equivalent frame method- Diaphragm openings

Module: 3	Braced Frame	4 hours

Types of bracing- behaviour of bracing- methods of analysis- member force analysis- drift analysis

Module:4	Core and Outrigger System	4 hours

Behaviour- optimum location of single outrigger- optimum location of two outrigger- framed tube systems

Module:5	Shear Wall System	5 hours

Behaviour and analysis of shear wall- coupled shear wall

Module:6	In-filled Frame Systems	3 hours

Importance – Methods of analysis – Equivalent truss and frame method – Force-displacement method – Effect of perforation in the in-filled frame.

Module:7	Three Dimensional Analysis	3 hours

Basic principles – Centre of rotation of a rigid floor, Force displacement method

Module:8	Contemporary issues	2 hours
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)			
1.	B.S. Taranath (2011), Structural analysis and design of tall building, CRC Press		
Reference Books			
1.	Ghali.A., Neville.A.M and Brown.T.G, (2003), Structural Analysis – A unified classical and Matrix Approach (Fifth Edition), Span press		
2.	IS 13920 Ductile detailing of reinforced concrete structures, BIS, India		
3.	IS 1893 Criteria for earthquake resistant design BIS, India		
4.	IS 875 Code of practice for design loadsBIS, India		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE609L	OFFSHORE STRUCTURES	L	T	P	C
		2	1	0	3
Pre-requisite	Nil	Syllabus version			

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.

Expected Course Outcome:

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

1. Understand the types and functions of offshore structure
2. Evaluate the loads experienced by offshore structure
3. Understand the concept of fixed offshore structures
4. Understand the wave hydrodynamics
5. Evaluate the wave forces on offshore structures
6. Design the framed structure in offshore.
7. Analyse the offshore structures subjected to dynamic loads.

Module: 1	Introduction	4 hours
Types of Offshore Structures-Types of Offshore Platforms -Functions of offshore structures-Components of a Typical Offshore Structure		
Module: 2	**Loads on Offshore Structures**	**4 hours**
Gravity Loads-Wind Load- Offshore Loads- Fatigue Load-Seismic Loads.		
Module:3	**Concepts of Fixed Platform Jacket and Deck**	**4 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	**Wave Theories**	**4 hours**
Wave generation and Propagation - Small and finite amplitude wave theories - Wave energy and pressure distribution		
Module: 5	**Wave force on Offshore Structures**	**4 hours**
Slender Vertical Cylindrical Members-Linearization of Nonlinear Wave Drag Force-Wave Forces on Arbitrarily Oriented Cylindrical Members - Wave Forces on Large Diameter Structures		
Module: 6	**Fundamental Considerations for Framed Offshore Structural Analysis**	**4 hours**
Site Characteristics and Modelling Procedures for Analysis-Hydrostatic Pressure and Buoyancy-Finite Element Applications for Framed Offshore Structural Analysis		
Module: 7	**Considerations for Dynamic Analysis**	**4 hours**
Characterization of Offshore Structure as an SDOF System-SDOF Models in Offshore Structures-MDOF Systems		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**30 hours**
	Tutorial Hours	**15 hours**

Text Book(s)			
1.	D.V. Reddy, A. S. J. Swamidas(2014), Essentials of Offshore Structures, CRC Press, Taylor & Francis Group		
Reference Books			
1.	Mohamed A. El-Reedy (2012), Offshore Structure, Design, Construction and Maintenance, Gulf Professional Publishing,		
2.	API (2014), Recommended Practice for Planning, designing and Construction, Fixed offshore platform, American Petroleum Institute publication, RP2A, Dallas, Texas.		
3.	Günther Clauss, Eike Lehmann, Carsten Östergaard, M.J. Shields (2012), Offshore Structures: Volume I: Conceptual Design and Hydromechanics: 1, Springer- Verlag.		
4.	Eugenio Fortaleza (2012), Active Control of Offshore Structures, Lambert Academic Publication.		
Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE610L	REPAIR AND REHABILITATION OF STRUCTURES	L	T	P	C
		3	0	0	3
Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To impart broad knowledge in the area of repair and rehabilitation of structures
2. To understand about various causes of deterioration of structures
3. To obtain the knowledge about corrosion of structures
4. To understand the properties of repair materials
5. To know various repair techniques and strengthening methods

Expected Course Outcome:

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

1. Identify the role of the maintenance engineer
2. Understand the causes of deterioration of structures
3. Identify the effect of corrosion on structures
4. Apply the NDT techniques to assess the condition of the structures
5. Evaluate various properties and applications of repair materials
6. Assessing the techniques for repairing
7. Apply the strengthening techniques for distressed buildings

Module: 1	Introduction	5 hours

Importance of maintenance - Types of maintenance - Decay of structures- Role of the Maintenance Engineer - Quality Assurance for concrete construction - Design and construction errors.

Module: 2	Deterioration of Structures	6 hours

Causes of deterioration of concrete, steel, masonry and timber structures - surface deterioration - efflorescence - Causes and preventive measures.

Module: 3	Corrosion of Structures	6 hours

Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Coatings - Cathodic protection for reinforcements.

Module: 4	Inspection and Assessment of Distressed structures	6 hours

Visual inspection – Non-destructive tests –Ultrasonic pulse velocity method – Rebound hammer technique– Pullout tests – Core test.

Module: 5	Materials for Repair	6 hours

Special concretes and mortar - Concrete chemicals - Special elements for accelerated strength gain - Expansive cement- Polymer concrete – Ferro cement, Fibre reinforced concrete - Fibre reinforced plastics.

Module: 6	Techniques for Repair	6 hours

Techniques for repairing of spalling and disintegration of structures - Grouting –Autogenous healing- Pre-packed concrete- Protective surface coating.

Module: 7	**Strengthening of distressed buildings**	**6 hours**
Repairs to overcome low member strength – Deflection - Chemical disruption - Weathering wear - Fire leakage - Marine exposure- Use of FRP- NDT tests		
Module: 8	**Contemporary issues**	**4 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Modi, P.I., Patel, C.N. (2016). Repair and Rehabilitation of Concrete Structures, PHI India, New Delhi.
Reference Books	
1.	IABSE, (2010). Case Studies of Rehabilitation, Repair, Retrofitting, and Strengthening of Structures, Volume 12, Structural Engineering Documents (SED), Switzerland.
2.	Varghese, P.C. (2014), Maintenance, Repair & Rehabilitation and Minor Works of Buildings, PHI India, New Delhi.
3.	Bhattacharjee, J. (2017), Concrete Structures Repair Rehabilitation And Retrofitting, CBS Publishers & Distributors, New Delhi.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies	05.07.2022		
Approved by Academic Council		Date	

MSTE611L	ENERGY EFFICIENT BUILDINGS	L	T	P	C
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Pre-requisite	Nil	Syllabus version			

Course Objectives:

1. To understand the concept of reduction in energy consumption through low energy building design
2. To Understand the sources of Renewable Energy
3. To Highlight strategies to integrate daylighting and low energy heating/cooling in buildings
4. To Model air flow and Ventilation
5. To know illumination requirements artificial lighting and factors affecting day lighting
6. To Design for climatic zones

Expected Course Outcome:

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

1. Understand the concept of reduction in energy consumption through low energy building design
2. Understand the sources of renewable Energy
3. Examine strategies to integrate day lighting and low energy heating / cooling in buildings
4. Understand model air flow and Ventilation
5. Know illumination requirements artificial lighting and factors affecting day lighting
6. Design for climatic zones

Module: 1	Green Buildings, Energy and Environment	6 hours

Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Rebound Effect, Pollution, Better Buildings, Reducing energy consumption, Low energy design.

Module: 2	Renewable Energy sources	7 hours

Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy: Direct gain - Trombe wall, convective air loop, Photovoltaics, Climate and Energy, Macro and Microclimate - Indian Examples.

Module: 3	Heating and Cooling	8 hours

Building Form Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, Grouping of buildings – Robin's Spatial Proportion – Orientation of building –Heat transmission through buildings –Thermal properties of building materials – Thermal Comfort –Psychrometric Chart –Heat transfer – Cosine Effect - Insulation - Cooling buildings, passive cooling, and mechanical cooling – Measurement of heating and cooling loads.

Module: 4	Ventilation and Infiltration	8 hours

Natural ventilation and forced ventilation in commercial buildings, passive cooling, modelling air flow and ventilation – stack effect - ventilation calculation – Mass effect

Module: 5	Day lighting and Artificial Lighting	8 hours

Illumination requirements - Concepts of daylight factors and day lighting, daylight assessment, sky dome - sun path diagram, sky exposure angle, sun protection, shading coefficient, visualizing day lighting: Source-Path-Target and apparent size, illuminance calculation, penetration and spread of sky component, artificial lighting, efficacy, Radiant barriers - new light sources –luminaries - light

shelves - Supplementary artificial lighting design – light distribution – electric lighting control		
Module: 6	**Design for Climatic Zones**	**3 hours**
Energy efficient building strategies for various climatic zones – cold and cloudy – cold and sunny – composite – warm and humid – moderate – hot and dry – case studies.		
Module: 7	**EnergyAssessment and Compliances Procedures**	**3 hours**
Energy awareness, monitoring energy consumption, Building Environmental Assessment-environmental criteria – embodied energy of building materials - assessment methods - assessment tools (e.g. GRIHA, LEED) - Ecohomes - Sustainable architecture and urban design – principles of environmental architecture.		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Satyajit Ghosh and Abhinav Dhaka (2015), Green Structures: Energy Efficient Buildings, Ane Books.
Reference Books	
1.	Charles Eley (2016), Design Professional's Guide to Zero Net Energy Buildings, Island Press.
2.	Ian M. Shapiro (2016), Energy Audits and Improvements for Commercial Buildings, John Wiley & Sons.
3.	Moncef Krarti (2016), Energy Audit of Building Systems: An Engineering Approach, Second Edition.
4.	EngHwa Yap., (2017), Energy Efficient Building, Published by InTech.,Crotia.
5.	Lal Jayamaha (2006), Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance, McGraw Hill Professional.

Mode of Evaluation: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
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