M.Tech, AR - 26

1st & 2nd Year M. Tech.,

COURSE STRUCTURE AND SYLLABUS

For

STRUCTURAL ENGINEERING

(Applicable for the batches admitted from 2026-27)

DEPARTMENT OF CIVIL ENGINEERING

ADITYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AUTONOMOUS)

Approved By AICTE, New Delhi
Recognized under 2(f),12(b) of UGC
Permanently Affiliated to JNTUGV, Vizianagaram
Accredited by NBA (UG Programs; CSE, ECE, EEE, ME, CE & IT)
Accredited by NAAC (UGC) with A+ Grade
K. Kotturu, TEKKALI-532 201, Srikakulam, Andhra Pradesh

VISION OF THE INSTITUTE

To evolve into a premier engineering institute in the country by continuously enhancing the range of our competencies, expanding the gamut of our activities and extending the frontiers of our operations.

MISSION OF THE INSTITUTE

Synergizing knowledge, technology and human resource, we impart the best quality education in Technology and Management. In the process, we make education more objective so that the efficiency for employability increases on a continued basis.

DEPARTMENT OF CIVIL ENGINEERING

Aditya Institute of Technology and Management established the Department of Civil Engineering (CE) in 2011 with an initial intake of 60 students and got approval for additional intake of another 60 seats in 2011-12. Further the UG B.Tech. intake has been enhanced to 120 in the year 2013. A Post Graduate Program (M. Tech) in Structural Engineering was introduced in 2015-16 with an intake of 18 seats. The Department of CE feels proud to announce that this Institution has got accredited by NAAC. The college has got TEQIP funds in phase-II under sub-component 1.1. These two important additions surely enhance the prestige of the institution and in turn help students to improve their academic standards. Both the B. Tech and M. Tech programs were duly approved by the AICTE and Govt. of A.P. and permanently affiliated to JNTUGV, Vizianagaram. The Department has its UG Civil Engineering Program accredited thrice by NBA in 2019 and 2022. The Department has JNTUGV authorized research center for scholars pursuing their Ph.D. The DST-FIST fund has been sanctioned to purchase high end state of art laboratories.

VISION OF THE DEPARTMENT

To become a pioneer in the field of civil engineering by providing high quality education and research to serve the public consistently with competitive spirit professional ethics.

MISSION OF THE DEPARTMENT

1. Provide quality knowledge and advance skills to the students in order to expertise theoretically and practically in the areas of civil engineering.
2. Improve the professional potentiality of the students and staff through educational programs to expand the knowledge in the field of civil engineering
3. Inculcate healthy competitive spirit towards the higher education and successful career in the field of civil engineering to serve the nation ethically.
4. Provide students and faculty with opportunities to create, disseminate and apply knowledge by maintaining a state of the art research.

COURSE STRUCTURE

Semester	COURSE CODE	Theory/Lab	L	T	P	C
I	26MSE1001	Advanced Structural Analysis	4	0	0	4
	26MSE1002	Analytical and Numerical Methods for Structural Engineering	4	0	0	4
	26MSE1003	Design of Pre Stressed Concrete Structures	4	0	0	4
	Elective – 1		3	0	0	3
	26MSE1E11	Theory of Thin Plates and Shells				
	26MSE1E12	Stability of Structures				
	26MSE1E13	Advanced Concrete Technology				
	Elective – 2		3	0	0	3
	26MSE1E21	Advanced Solid Mechanics				
	26MSE1E22	Structural Health Monitoring				
	26MSE1E23	Structural Optimization				
	26MSE1101	Advanced Concrete Technology Lab	0	0	4	2
	26MSE1102	Structural Design Lab	0	0	4	2
	Audit Course		2	0	0	0
	26MAC1001	English for Research Paper Writing				
	26MAC1002	Disaster Management				
	26MAC1003	Constitution of India				
Total			**20**	**0**	**8**	**22**

Semester	COURSE CODE	Theory/Lab	L	T	P	C
II	26MSE1004	Finite Element Analysis	4	0	0	4
	26MSE1005	Structural Dynamics	4	0	0	4
	26MSE1006	Design of Formwork	4	0	0	4
	Elective – 3		3	0	0	3
	26MSE1E31	Advanced Steel Design				
	26MSE1E32	Repair And Rehabilitation of Structures				
	26MSE1E33	Bridge Engineering				
	Elective – 4		3	0	0	3
	26MSE1E41	Design of Advanced Concrete Structures				
	26MSE1E42	Advanced Design of Foundations				
	26MSE1E43	Design of Industrial Structures				
	26MSE1103	Analytical and Numerical Methods for Structural Engineering lab	0	0	4	2
	26MCC1001	Research Methodology and IPR / Swayam 12 week MOOC course – RM&IPR	2	0	0	2
Total			**20**	**0**	**4**	**22**

Semester	COURSE CODE	Theory/Lab	L	T	P	C
III	26MSE2I01	Internship/ Industrial Training (8weeks)	-	-	-	3
	26MSE2201	Technical Seminar	-	-	4	2
	26MSE2202	Comprehensive Viva	-	-	-	2
	26MSE2203	Dissertation Phase – 1	0	0	20	10
Total			**0**	**0**	**24**	**17**

Semester	COURSE CODE	Theory/Lab	L	T	P	C
IV	26MSE2204	Dissertation Phase – 2	0	0	32	16
Total			**0**	**0**	**32**	**16**

NOTE: L: Lecture T: Tutorial P: Practical C: Credits

Advanced Structural Analysis

L	T	P	C
4	0	0	4

COURSE CODE: 26MSE1001

COURSE OBJECTIVES:

1. To study Basic concepts in structural analysis like Static Indeterminacy and kinematic indeterminacy, Applications of principle of virtual work
2. To study Force methods, Displacement Methods.
3. To study Matrix concepts and coordinate systems & element and structure stiffness matrices.
4. To study Matrix analysis of structures with axial elements of Plane trusses, Space trusses with different degree of freedoms.
5. To study Stiffness method, development of grid elemental stiffness matrix, idealizing the beam stiffness solutions, curved beam element stiffness matrix.

COURSE OUTCOMES:

1. Analyze Basic concepts in structural analysis
2. Analysis the skeleton structures using Force methods, Displacement Methods
3. Study Matrix concepts, coordinate systems, Contra-gradient principle.
4. Study& Analyze Matrix analysis of structures with axial elements with different degree of freedoms.
5. Analyze the beams and grids by Stiffness method & Matrix applications.

UNIT-I

Basic concepts in structural analysis: Structure -structural elements, joints and supports, stability, rigidity and static indeterminacy, kinematic indeterminacy; Loads-direct actions, indirect loading; Response -equilibrium, compatibility, force-displacement relations; Levels of analysis; analysis of statically determinate structures (trusses, beams, frames); Applications of principle of virtual work and displacement-based and force-based energy principles; deriving stiffness and flexibility coefficients.

UNIT-II

Analysis of indeterminate structures: Force methods: Statically indeterminate structures (method of consistent deformations; theorem of least work). Displacement Methods: Kinematically indeterminate structures (slope-deflection method; moment distribution method).

UNIT-III

Matrix concepts and Matrix analysis of structures: Matrix; vector; basic matrix operations; rank; solution of linear simultaneous equations; Eigen values and eigenvectors. Introduction; coordinate systems; displacement and force transformation matrices; Contra-gradient principle; element and structure stiffness matrices Element and structure flexibility matrices; equivalent joint loads; stiffness and flexibility approaches

UNIT-IV

Matrix analysis of structures with axial elements: Introduction: Axial stiffness and flexibility; stiffness matrices for an axial element (two dof), plane truss element (four dof) and space truss element (six dof); One-dimensional axial structures: Analysis by conventional stiffness method (two dof per element) and reduced element stiffness method (single dof); Analysis by flexibility method; Plane trusses: Analysis by conventional stiffness method (four dof per element) and reduced element stiffness method (single dof); Analysis by flexibility method; Space trusses: Analysis by conventional stiffness method (six dof per element) and reduced element stiffness method (single dof).

UNIT-V

Matrix analysis of beams and grids: Conventional stiffness method for beams: Beam element stiffness (four dof); generation of stiffness matrix for continuous beam; dealing with internal hinges, hinged and guided-fixed end supports; accounting for shear deformations; Reduced stiffness method for beams: Beam element stiffness (two dof); dealing with moment releases, hinged and guided-fixed end supports.

Textbooks:

1. Matrix Analysis of Framed Structures, Weaver and Gere.
2. Computer Methods in Structural Analysis, MeekJ. L., E and FN, Span Publication.
3. Devdas Menon,"Advanced Structural Analysis", Narosa Publishing House, 2009.
4. AsslamKassimali,"Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
5. Amin Ghali,Adam M Neville and Tom G Brown,"StructuralAnalysis:A Unified Classical and Matrix Approach",Sixth Edition, 2007, Chapman & Hall.
6. DevdasMenon,"StructuralAnalysis", Narosa Publishing House, 2008

References:

1. The Finite Element Method, Lewis P. E. and WardJ. P., Addison-Wesley Publication Co.
2. The Finite Element Method, Desai and Able, CBS Publication.

Analytical and Numerical Methods for Structural Engineering

COURSE CODE: 26MSE1002

L	T	P	C
4	0	0	4

1. To solve the algebraic and transcendental equations, using different numerical method.
2. To Estimate the unknown function.
3. To estimate the value of derivatives, evaluate the definite integrals using different numerical methods
4. Calculate the numerical solution of an ordinary differential equation i.e. IVP.
5. To solve linear system of equations by Numerical Methods.

COURSE OUTCOMES
On completion of this course, students should be able

1. Solve the algebraic and transcendental equations by identifying suitable numerical methods.
2. Estimate the value of dependent variable for a particular x by deducing the unknown function y = f(x) for an evenly or unevenly spaced points.
3. Estimate the value of derivatives, evaluate the definite integrals using different numerical methods.
4. Solve the IVP using different numerical methods.
5. Solve linear system of equations by LU –Factorization, Matrix Inverse, Gauss seidal Method, Tridiagonalization and QR Factorization.

SYLLABUS:
UNIT-I
Numerical solutions of Algebraic and Transcendental Equations:
Introduction-The Bisection Method – The Method of False Position – The Iteration Method – Newton-Raphson Method.

UNIT-II
Interpolation: Introduction –Finite differences- Forward Differences – Backward differences – Central differences – Symbolic relations and separation of symbols-Differences of a polynomial – Newton's formulae for interpolation – Interpolation with unevenly spaced points– Lagrange's Interpolation formula.

UNIT-III
Numerical Differentiation and Integration: Numerical Differentiation using finite differences – Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule.

UNIT-IV
Solution of Ordinary Differential equations: Solution by Taylor's series – Picard's Method of successive Approximations – Euler's and Modified Euler's Method – Runge – Kutta Methods – Predictor – Corrector Methods – Milne's Method.

UNIT-V

Numerical Methods in Linear Algebra: LU –Factorization, Matrix Inverse, Gauss seidal Method, Tridiagonalization and QR-Factorization.

Text Books:

1. Higher Engineering Mathematics, 42nd edition, 2012 - B. S. Grewal, Khanna Publishers, New Delhi.
2. Introductory Methods of Numerical Analysis- Sastry, S.S, Prentice-Hall, 2nd Edition, 1992.

Reference Books:

1. Mathematical Methods, 6th edition, 2011, Dr. T. K.V.Iyengar& others S. Chand Publications.
2. Numerical Methods by E. Balaguruswamy, Tata Mc Grewal
3. An introduction to numerical analysis, Atkinson K.E., J. Wiley and sons, 1989

Design of Pre Stressed Concrete Structures

COURSE CODE: 26MSE1003

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

Students will learn to

1. study about historic development, methods and systems of prestressed concrete and IS code provisions.
2. study about loss of prestress in pre-tensioned and post-tensioned members due to various causes like elastic shortage of concrete, shrinkage of concrete, creep of concrete etc,
3. study analysis of sections for flexure with straight, concentric, eccentric, bent and parabolic tendons.
4. study about design of various sections for flexure and Shear and analysis of end blocks which include Guyon's method and Mugnel method
5. study the deflections and continuous beams.

COURSE OUTCOMES:

Students will get ability to

1. Describe general principles and various methods of pre-stressed concrete.
2. Identify the losses of the prestresses due to various causes.
3. Analyze sections for flexure with straight, concentric, eccentric, bent and parabolic tendons.
4. Design of Sections for Flexure and Shear, analyze the end blocks by different methods.
5. Compute Deflections and analyze continuous beams of Pre-stressed Concrete.

UNIT – I

Introduction: Principles of pre-stressing- pre-tensioning and post tensioning – Materials – High strength concrete and high Strength steel- I.S. 1343 provisions, Pre-tensioning and post tensioning methods - Different systems of pre-stressing (Hoyer System, Magnel System, Freyssinet system and Gifford – Udall System).

UNIT – II

Losses of Pre-stress: Loss of prestress in pre-tensioned and post-tensioned members- elastic shortage of concrete- shrinkage of concrete- creep of concrete-Relaxation of steel-slip in anchorage bending of member-frictional losses.

UNIT – III

Analysis of Flexural members: Elastic analysis of concrete beams prestressed with straight, concentric, eccentric, bent and parabolic tendons.

UNIT – IV

Design for Flexure and Shear: Design as per I.S. 1343 – simple rectangular and I-section and principal stresses – Kern lines, cable profile.

Analysis of End Blocks: Guyon's method and Mugnel method, Anchorage zone stresses – As per IS 1343 – Anchorage zone reinforcement – Transfer of prestress pre-tensioned members.

UNIT – V

Deflections of Prestressed Concrete Beams: Control of deflections –Influencing factors– short term & long term deflections of uncracked members

Continuous beams: P-line, C-line – primary & secondary moments – analysis and design of continuous beams

Text Books:

1. Prestressed Concrete by Krishna Raju; - Tata Mc.Graw Hill Publications 2018
2. . Design of Prestressed concrete structures (Third Edition) by T.Y. Lin & Ned H.Burns, John Wiley & Sons.
3. Prestressed Concrete by Ramamrutham; Dhanpat rai Publications 2016.

References:

1. Pre-Stressed Concrete byMuttu & Janarthan

Codes: Code of Practice for IS 1343 - 1980

Note: Code book is permitted to the examination

Theory of Thin Plates and Shells
(Elective-1)

COURSE CODE: 26MSE1E11

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:
Students will have

1. To study Derivation of plate equation for -in plane bending and transverse bending effects, Rectangular Plates.
2. Plates under various loading conditions like sinusoidal loading, uniformly distributed load and hydrostatic pressure.
3. To study Circular plates, symmetrically loaded, circular plates under various loading conditions, annular plates.
4. To study Equations of Equilibrium, Derivation of stress resultants, Principles of membrane theory and bending theory.
5. To study Cylindrical Shells, Derivation of the governing DKJ equation for bending theory, details of Schorer's theory. Application to the analysis and design of short and long shells.

COURSE OUTCOMES:
Students will get ability

CO-1 To study Derivation of plate equation for -in plane bending and transverse bending effects, Rectangular Plates,
CO-2 Plates under various loading conditions like sinusoidal loading, uniformly distributed load and hydrostatic pressure.
CO-3 To study Circular plates, symmetrically loaded, circular plates under various loading conditions, annular plates.
CO-4 To study Equations of Equilibrium, Derivation of stress resultants, Principles of membrane theory and bending theory.
CO-5 To study Cylindrical Shells, Derivation of the governing DKJ equation for bending theory, details of Schorer's theory. Application to the analysis and design of short and long shells.

UNIT-I
Derivation of plate equation for cylindrical bending of rectangular plates – analysis of UDL rectangular plates with simply supported edges and fixed edges – stain Energy in pure bending.

UNIT-II
Small Deflection theory thin Rectangular Plates: Plates under various loading conditions like sinusoidal loading, uniformly distributed load Navier and Levy's type of solutions for various boundary conditions and hydrostatic pressure**.**

UNIT-III

Circular plates: Symmetrically loaded, circular plates under various loading conditions, Annular plates.

UNIT-IV

Equations of Equilibrium: Derivation of stress resultants, Principles of membrane theory and bending theory.

UNIT-V

Cylindrical Shells: Derivation of the governing DKJ equation for bending theory, details of Schorer's theory. Application to the analysis and design of short and long shells. Use of ASCE Manual coefficients for the design.

Text Books:

1. Theory of plates and shells – Timoshenko and Krieger, McGraw-Hill book company, INC, New Yark.
2. A Text Book of Plate Analysis – Bairagi, K, Khanna Publisher, New Delhi.
3. Design and Construction of Concrete Shell Roofs – Ramaswamy, G.S, Mc Graw – Hill, New Yark.

References :

1. Theory of plates by Chandrasekhar, University press

Stability of Structures
(Elective-1)

COURSE CODE: 26MSE1E12

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Students will have

1. To study Beam columns, Differential equation for beam columns, Beams column with concentrated loads continuous lateral load, Beam column with built in ends, continuous beams with axial load.
2. To study Elastic buckling of bars, Elastic buckling of straight columns, Sway & Non Sway mode, Energy methods.
3. To study Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads, Effect of shear force on critical load Buckling of frames.
4. To study Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling.
5. To study Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.

COURSE OUTCOMES:

Students will get ability

1. To learn Beam columns, Differential equation for beam columns, Beams column with concentrated loads continuous lateral load, Beam column with built in ends, continuous beams with axial load.
2. To learn Elastic buckling of bars, Elastic buckling of straight columns, Sway & Non Sway mode, Energy methods.
3. To learn Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads, Effect of shear force on critical load Buckling of frames
4. To learn Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling.
5. To learn Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.

UNIT-I

Beam-columns: Differential equation for beam columns – Beams-column with concentrated loads – continuous lateral load – couples – Beam-column with built in ends – continuous beams with axial load – application of Trigonometric series – Determination of allowable stresses.

UNIT-II

Elastic buckling of bars: Elastic buckling of straight columns – Effect of shear stress on buckling – Eccentrically and laterally loaded columns –Sway & Non Sway mode - Energy methods.

UNIT-III

Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads – Buckling of bars with change in cross section – Effect of shear force on critical load – Built up columns – Effect of Initial curvature on bars – Buckling of frames – Sway & Non Sway mode.

UNIT-IV

Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling.

UNIT-V

Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.

Text Book :

1. Theory of Elastic stability by Timshenko & Gere-Mc Graw Hill

References:

1. Stability of Metal Structures by Bleinch – Mc Graw Hill
2. Theory of beam columns Vol I by Chem. & Atsute Mc. Graw Hill.
3. Theory of Stability of Structures by Alexander Chases.

Advanced Concrete Technology
(Elective-1)

COURSE CODE: 26MSE1E13

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Students will have to

1. To study Materials- Cement, Aggregates, mixing water soundness of aggregate, Fresh and hardened concrete, Admixtures, types of admixtures, purposes of using admixtures- chemical composition.
2. To study Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms, Acoustical emission methods- Corrosion activity measurement, Impact echo methods- Ultrasound pulse velocity methods
3. To study Repair and rehabilitation of structural elements, Analysis, and design, Material requirement, Surface preparation- Reinforcing steel cleaning, repair and protection
4. To study Strengthening and stabilization, design considerations, Beam shear capacity strengthening- Shear Transfer strengthening, Column strengthening, flexural strengthening.
5. To study Fibre reinforced concrete, Properties of constituent materials, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes.

COURSE OUTCOMES:

Students will be able to

1. To learn Materials- Cement, Aggregates, mixing water soundness of aggregate, Fresh and hardened concrete, Admixtures, types of admixtures, purposes of using admixtures- chemical composition.
2. To learn Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms, Acoustical emission methods- Corrosion activity measurement, Impact echo methods- Ultrasound pulse velocity methods
3. To learn Repair and rehabilitation of structural elements, Analysis, and design, Material requirement, Surface preparation- Reinforcing steel cleaning, repair and protection
4. To learn Strengthening and stabilization, design considerations, Beam shear capacity strengthening- Shear Transfer strengthening, Column strengthening, flexural strengthening.
5. To learn Fibre reinforced concrete, Properties of constituent materials, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes.

UNIT-I

Materials- Cement, Aggregates, mixing water soundness of aggregate- Fresh and hardened concrete: Admixtures- types of admixtures- purposes of using admixtures- chemical composition- effect of admixtures on fresh and hardened concretes- Natural admixtures.

UNIT-II

Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods- Corrosion activity measurement- chloride content – Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests

UNIT-III

Repair and rehabilitation of structural elements: Analysis, strategy and design- Material requirement- Material selection- Surface preparation- Reinforcing steel cleaning, repair and protection- Bonding repair materials to existing concrete- placement methods.

UNIT-IV

Strengthening and stabilization- Techniques- design considerations- Beam shear capacity strengthening- Shear Transfer strengthening- stress reduction techniques- Column strengthening- flexural strengthening- Connection stabilization and strengthening Crack stabilization

UNIT-V

Fibre reinforced concrete- Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes.

Text Books:

1. Concrete Technology by M S Shetty.
2. Concrete Technology by Neville & Brooks.
3. Special Structural concrete by Rafat Siddique.
4. Concrete repair and maintenance illustrated by Peter H Emmons.

Reference Books:

1. Job Thomas., " Concrete Technology", Cenage learning,
2. R. Santhakumar „ Concrete Technology", Oxford Universities Press, 2006

Advanced Solid Mechanics
(Elective-2)

COURSE CODE: 26MSE1E21

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To study Elasticity, Displacement, stress and strain fields, components of stess and strain, Equations of elasticity.
2. To study differential Equation of Equilibrium, concepts of stress and strain, Principle stress strain and principle axes.
3. To study stress strain relations, strain displacement relations and compatibility relations, Boundary conditions and boundary value problems.
4. To study Solve simple problems of Two Dimensional problems in Plane stress and Plane strain, Airy's stress Function and Polar Coordinates.
5. To study Saint Venent's Method, Homogeneous Torsion of Prismatic Bars, Membrane Analogy, Torsion of Rectangular Bars and Thin tubes.

COURSE OUTCOMES:

After successful completion of this course, students will be able to

CO 1: To learn Elasticity, Displacement, stress and strain fields, components of stess and strain, Equations of elasticity.
CO 2: To learn differential Equation of Equilibrium, concepts of stress and strain,Principle stress strain and principle axes.
CO 3: To learn stress strain relations, strain displacement relations and compatibility relations, Boundary conditions and boundary value problems.
CO 4: Solve simple problems of Two Dimensional problems in Plane stress and Plane strain, Airy's stress Function and Polar Coordinates.
CO 5: To learn Saint Venent's Method, Homogeneous Torsion of Prismatic Bars, Membrane Analogy, Torsion of Rectangular Bars and Thin tubes.

UNIT-I

Introduction to Elasticity – Notation for Forces and Stresses – Components of Stresses – Components of Strain, Stress – Strain Fields, Displacements, Cartesian Tensors and Equations of Elasticity.

UNIT-II

Stress – Strain Fields – Elementary Concept of Stress and Strain, Principle Stress, Strain and Principle Axes, Compatibility Conditions, Stress at a Point, Strain at a point, Stress components on an Arbitrary Plane, Differential Equations of Equilibrium.

UNIT-III

Equations of Elasticity – Equations of Equilibrium, Stress – Strain Relations, Strain – Displacement Relations and Compatibility relations, Boundary Conditions and boundary value problems and Homogeneous Deformations.

UNIT-IV

Two - Dimensional Problems of Elasticity – Plane Stress and Plane Strain Problems, Airy's Stress Function, Two Dimensional Problems in Rectangular and Polar Coordinates.

UNIT-V

Torsion of Bars – saint Venant's Method, Membrane Analogy, Torsion of Rectangular Bars, Torsion of Prismatic Bars and Torsion of Thin Tubes.

TEXT BOOKS:

1.Theory of Elasticity – Sadhu Singh, Khanna Publishers, 2003.
2.Advance Mechanics of Solids – L S Srinath., McGraw Hill, 3rd Edition, 2000.
3.Theory of Elasticity- Timoshenko S & Goodier J.N., McGraw Hill,3rd Edition,2010.

REFERENCES:

1.Theory of Elasticity and Plasticity – H. Jane Helena., PHI Learning private Limited,2017.
2.Theory of Elasticity and Plasticity – E.M.Lifshitz, A.M.Kosevich, L.P.Pitaevskii., Science Direct, 3rd Edition,1986.

AR 26 – M. Tech. – SE **M. Tech., I Semester**

Structural Health Monitoring
(Elective-2)

L	T	P	C
3	0	0	3

COURSE CODE: 26MSE1E22

COURSE OBJECTIVES:

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

1. To study Diagnosis the distress in the structure understanding the causes and factors.
2. To study Suggest Various Measures for Structural Health Monitoring.
3. To study Diagnosis the Structural health investigation.
4. To study Assess the health of structure using static field methods.
5. To study Assess the health of structure using dynamic field tests.

COURSE OUTCOMES:

1. To learn Diagnosis the distress in the structure understanding the causes and factors.
2. To learn Suggest Various Measures for Structural Health Monitoring.
3. To learn Diagnosis the Structural health investigation.
4. To learn Assess the health of structure using static field methods.
5. To learn Assess the health of structure using dynamic field tests.

UNIT – I:

Structural Health: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance.

UNIT – II:

Structural Health Monitoring: Concepts, Various Measures, Structural Safety in Alteration

UNIT – III:

Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures

UNIT – IV:

Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.

UNIT – V:

Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring

Reference Books:

1. Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2006.
2. Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007.
3. Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan, Taylor and Francis Group, London, UK, 2006.
4. Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc, 2007.

AR 26 – M. Tech. – SE **M. Tech., I Semester**

Structural Optimization
(Elective-2)

COURSE CODE: 26MSE1E23

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Students will have

1. To study the need and scope for optimization, historical development, objective function and its surface design variables, constraints and constraint surface, classification of optimization problems.
2. To study classical optimization techniques, multi variable optimization by method of constrained variation and Lagrange multipliers, Khun-Tucker conditions of optimality.
3. To study non-liner programming methods having constrained minimization such as Cutting plane method- Zoutendjik's method- penalty function methods.
4. To study non-liner programming methods having unconstrained minimization such as Fibonacci, Quadratic and cubic interpolation methods for a one dimensional minimization and univariate method, Powel's method, Newton's method, Davidon Fletcher Powell's method for multivariable optimization.
5. To study linear programming including definitions and theorems, Simplex method, Duality in Linear programming, Plastic analysis and Minimum weight design and rigid frame.

COURSE OUTCOMES:

Students will get ability

1. Describeneed and scope for optimization, Historical development, Objective function and its surface design variables, constraints and constraint surface, Classification of optimization problems.
2. ExplainClassical optimization techniques, multi variable optimization by method of constrained variation and Lagrange multipliers, Khun-Tucker conditions of optimality
3. Explain non-liner programming methods having constrained minimization such as Cutting plane method- Zoutendjik's method- penalty function methods.
4. Discuss non-liner programming methods having unconstrained minimization such as Fibonacci, Quadratic and cubic interpolation methods for a one dimensional minimization and univariate method, Powel's method, Newton's method, Davidon Fletcher Powell's method for multivariable optimization.
5. Explain linear programming, definitions and theorems, Simplex method, Duality in Linear programming, Plastic analysis and Minimum weight design and rigid frame.

UNIT-I

Introduction: Need and scope for optimization- Historical development – statements of optimization problems- Objective function and its surface design variables- constraints and constraint surface- Classification of optimization problems.

UNIT-II

Classical optimization techniques: Differential calculus method, multi variable optimization by method of constrained variation and Lagrange multipliers and Khun-Tucker conditions of optimality.

UNIT-III

Non-Linear programming: Constrained minimization- Cutting plane method- Zoutendjik's method- penalty function methods.

UNIT-IV

Non-Linear programming: Unconstrained minimization- Fibonacci, golden search, Quadratic and cubic interpolation methods for a one dimensional minimization, Powel's method, Newton's method and Davidson Fletcher Powell's method for multivariable optimization.

UNIT-V

Linear programming: Definitions and theorems- Simplex method- Duality in Linear programming- Plastic analysis and Minimum weight design and rigid frame.

Text Books:

1. Optimization Theory and Applications – S.S. Rao, Wiley Eastern Limited, New Delhi
2. Optimum structural design- Theory and applications- R H Gallergher and O C Zienkiewiez3

References:

1 Elements of Structural Optimization, Haftka, Raphael T.,Gürdal, Zafer,Springer.
2 Variational methods for Structural optimization, Cherkaev Andrej,Springer

Advanced Concrete Technology Lab

COURSE CODE: 26MSE1101

L	T	P	C
0	0	4	2

COURSE OUTCOMES:

Students will get ability

1. To practice Tests study of stress strain curve of high strength concrete and Corrolations in between cube and cylinder.
2. To practice Aggregate Crushing and Impact value, Workability Tests on Fresh self compacting concrete, Air Entrainment Test on fresh concrete.
3. To practice Marsh cone test, Permeability of Concrete and effect of cyclic loading on steel.
4. To practice Non Destructive Testing of Concrete, Accelerated Curing of Concrete and behavior of beams under flexure, shear and torsion.
5. To practice Influence of W/C ratio on strength and Aggregate / Cement ratio on workability and Strength, Influence of Different Chemical Admixtures on concrete.

SYLLABUS:

1. Stress – strain response of High Strength Concrete
2. Correlation between cube strength and Cylinder strength
3. Split Tensile strength and Modulus of rupture of Concrete
4. Understanding Cyclic loading on steel reinforcement
5. Workability Tests on Fresh self compacting concrete
6. Air Entrainment Test on fresh concrete.
7. Marsh cone test.
8. Determination of Permeability of Concrete.
9. Non Destructive Testing of Concrete.
10. Accelerated Curing Test of Concrete.
11. Behaviour of RC Beams under Flexure & Shear

Add On Experiments

1. Aggregate Crushing and Impact value
2. Influence of W/C ratio on strength and workability of Concrete
3. Study on Influence of Chemical Admixtures on concrete.

Structural Design Lab

COURSE CODE: 26MSE1102

L	T	P	C
0	0	4	2

COURSE OUTCOMES:

Students will get ability to

1. develop the knowledge in design of one story building by staad pro
2. develop the knowledge in design of multistory building by staad pro
3. prepare drawing of the reinforcement details of beam element of the building by autocad and manual
4. Prepare drawing of the reinforcement details of footing with column elements of the building by autocad and manual.
5. Prepare drawing of the reinforcement details of slab, column and beam elements of the building by autocad and manual.

SYLLABUS:

1. Design of Single storey building by STAAD Pro v8i
2. Design of multi storey building by STAAD Pro v8i
3. Drawing of beam reinforcement detailing by AutoCAD and Conventional method
4. Drawing of footing and column reinforcement detailing by AutoCAD and Conventional method
5. Drawing of slab reinforcement detailing by AutoCAD and Conventional method
6. Drawing of the column, beam joints by AutoCAD and Conventional method

SOFTWARES :-

1. AUTOCAD

2. STAAD Pro v8i

English for Research Paper Writing

(Audit Course)

COURSE CODE: 26MAC1001

L	T	P	C
2	0	0	0

Course Objectives

1. To develop students' ability to plan and organize academic writing by mastering word order, sentence structure, paragraph development, conciseness, and techniques for avoiding ambiguity and redundancy.
2. To enable learners to present ideas clearly and responsibly through skills such as clarifying agency (who did what), highlighting findings, using hedging and criticism appropriately, and avoiding plagiarism through effective paraphrasing.
3.To train students in the structure and components of a research paper by understanding and producing well-organized abstracts, introductions, literature reviews, methods, results, discussions, and conclusions.
4.To enhance students' competence in writing key academic sections—including titles, abstracts, introductions, and literature reviews—using appropriate academic style, coherence, and logical progression.
5.To equip learners with practical skills for drafting, revising, and finalizing research papers by applying section-specific writing strategies and conducting a thorough final check for clarity, accuracy, and academic integrity.

Course Outcomes

1.Students will be able to plan and organize academic texts effectively by applying correct word order, clear sentence and paragraph structure, and techniques for conciseness while avoiding ambiguity and redundancy.
2.Students will be able to present information clearly and ethically by clarifying agency (who did what), highlighting key findings, using appropriate hedging and criticism, and avoiding plagiarism through accurate paraphrasing.
3.Students will be able to write and evaluate major sections of a research paper such as literature reviews, methods, results, discussions, conclusions, and perform a final check for coherence and accuracy.
4.Students will be able to construct effective titles, abstracts, and introductions and develop logically organized reviews of literature using accepted academic writing conventions.
5.Students will be able to apply section-specific writing skills to produce well-structured methods, results, discussion, and conclusion sections that meet academic and research communication standards.

UNIT-I

Planning and preparation, Word order, Breaking up long sentences, Structuring paragraphs and sentences. Being concise and removing redundancy, Avoiding ambiguity and vagueness

UNIT-II

Clarifying who did what, Highlighting findings. Hedging and criticizing. Paraphrasing and plagiarism, Sections of a paper, Abstracts, Introduction

UNIT-III

Review of the Literature. Methods, Results, Discussion, Conclusions, Final check

UNIT-IV

Key skills needed when writing a title. An abstract, An introduction and a review of the Literature

UNIT-V

Skills needed when writing methods, Results, Discussions and Conclusion.

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TEXT BOOKS

1. Goldbort R (2006). Writing for Science. Yale University Press.
2. Day R (2006). How to Write and Publish a Scientific Paper. Cambridge University Press.
3. Highman N (1998). Handbook of Writing for the Mathematical Sciences. SIAM. Highman's book.

Disaster Management

(Audit Course)

Course Code: 26MAC1002

L	T	P	C
2	0	0	0

Course Objectives:

The primary objectives of this course are:

1. To provide basic concepts and terminologies related to hazards and disasters.
2. To highlight the critical importance and role of disaster management in the contemporary world.
3. To enhance awareness of institutional processes, policies, and management strategies used to mitigate disaster impacts.
4. To analyze the various dimensions of vulnerability and their contribution to disaster risk.
5. To equip knowledge regarding emergency management for manmade and technological threats.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Define and classify different types of disasters and distinguish them from hazards.
2. Evaluate the nature of vulnerability and assess the impacts of disasters on different communities.
3. Explain the components of the Disaster Management Cycle, including mitigation, preparedness, response, and recovery.
4. Discuss the institutional frameworks and legislations available for disaster risk management at national and international level.
5. Identify specific threats related to industrial accidents and security, and understand the necessary emergency response mechanisms.

Unit 1: Introduction and Basic Concepts: Understanding Fundamental Concepts: Definitions of Hazards and Disasters. Classification: Disaster types and causes including Geophysical, Hydrological, Meteorological, Biological, Atmospheric, and Human-made. Distinguishing between natural hazards and manmade disasters

Unit 2: Dimensions of Disasters and Vulnerability: Global Trends: Analysis of global trends in disasters. Impact analysis: Physical, Social, Economic, Political, Environmental, and Psychosocial impacts of disasters. Understanding Vulnerability: Defining and analyzing Physical Vulnerability, Economic Vulnerability, and Social Vulnerability

Unit 3: The Disaster Management Cycle and Risk Reduction: Detailed study of the components of DM Cycle: Response and recovery, Risk assessment, Mitigation and prevention, Preparedness planning, Prediction and warning. Disaster Risk Reduction (DRR): Concepts of DRR and Community based disaster risk reduction strategies.

Unit 4: Institutional Frameworks and Initiatives: National Context: Disaster Risk Management in India; related policies, plans, programs, and legislation. Global Context: International strategies for disaster reduction and other global initiatives. Agencies: Role of agencies NIDM, NDRF.

Unit 5: Emergency Management and Emerging Threats: Technological and Industrial Disasters: Explosions, Industrial accidents, Nuclear, Transport, and Mining accidents. Environmental Emergencies: Spills (Oil and Hazardous material). Security Threats: Bomb threats, terrorist attacks, stampedes, and conflict situations.

Textbooks:

1. Sharma, S.C., Disaster Management, Khanna Book Publishing. Latest Edition
2. Singh, R. B. (ed.), Natural Hazards and Disaster Management: Vulnerability and Mitigation, Rawat Publications, New Delhi. Latest Edition
3. Modh, S., Managing Natural Disaster: Hydrological, Marine and Geological Disasters, Macmillan, Delhi. Latest Edition

Reference Books:

1. **Carter, N.**, Disaster Management: A Disaster Management Handbook, Asian Development Bank, Manila. Latest Edition
2. **Clements, B. W.**, Disasters and Public Health: Planning and Response, Elsevier Inc. Latest Edition
3. **Dunkan, K., and Brebbia, C. A. (Eds.)**, Disaster Management and Human Health Risk: Reducing Risk, Improving Outcomes, WIT Press, UK. Latest Edition
4. **Ramkumar, Mu**, Geological Hazards: Causes, Consequences and Methods of Containment, New India Publishing Agency, New Delhi. Latest Edition

Constitution of India

(Audit Course)

COURSE CODE: 22MAC1003

L	T	P	C
2	0	0	0

Course Objectives

1. To provide students with a comprehensive understanding of the historical background and salient features of the Indian Constitution, including Fundamental Rights, Duties, and Directive Principles of State Policy.
2. To familiarize learners with the structure and functioning of local self-government institutions and the importance of grassroots democracy in India.
3. To develop awareness of the parliamentary system of government in India, including the roles and powers of the President, Prime Minister, Cabinet, and Judiciary.
4. To explain the nature of Indian federalism and the legislative procedures and privileges of Union and State legislatures.
5. To enable students to understand the role and functioning of constitutional and statutory bodies such as parliamentary committees, Election Commission, CAG, Finance Commission, NITI Aayog, and political parties.

Course Outcomes

1. Students will be able to **explain the origin, structure, and key features of the Indian Constitution,** including Fundamental Rights, Fundamental Duties, and Directive Principles.
2. Students will be able to **describe the organization and functions of local administration,** including Panchayati Raj Institutions and municipal bodies, and appreciate the value of participatory democracy.
3. Students will be able to **analyze the working of the parliamentary system** and the emergency provisions, and understand the relationship between the executive, legislature, and judiciary.
4. Students will be able to **interpret the principles of Indian federalism** and explain Union–State relations and the legislative process in Parliament and State Legislatures.
5. Students will be able to **evaluate the role of constitutional and non-constitutional bodies** and recognize their contribution to democratic governance and accountability in India.

UNIT-I

Introduction: Historical perspective of the constitution of India -Salient features of The Indian Constitution-Features: Fundamental Rights (Article 12 to 35), Duties (31 A-1976 emergency) and Directive principles (Article 30 to 51) of State Policy - Articles 14 to 18 Articles 19-Article 21-Amendment Procedure of The Indian Constitution: 42nd amendment (Mini Constitution)-44th amendment (1978-Janatha Govt.)

UNIT-II

Local Administration: District's administration head: Role and Importance, Municipalities Introduction, Mayer and role of elected representative, CEO of municipal corporation, Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of elected and appointed officials, Importance of grass root democracy.

UNIT-III

Parliamentary form of Govt. In India: President of India- Emergency provisions- National Emergency Article 352 President Rules- Article 356 Financial Emergency- Article 360 Prime Minister and Cabinet- Supreme Court of India (Indian Judiciar).

UNIT-IV

Indian Federalism: Union State relations, Legislative, Administrative and Financial relations. Lok Sabha, Rajya Sabha, Vidhan Sabha & Vidhan Parishad-Composition, Speaker, Chairman, Privileges, Legislative procedure.

UNIT-V

Parliamentary Committees: Public Accounts Committee- Estimates Committee- Committee on Public Undertakings- Election commission of India (Article -324) -Comptroller and Auditor General (CAG) of India (Article 148 to 150) Finance Commission (Article-280)-Neethi Aayog (Planning Commission) and Political Parties.

TEXT BOOKS

1 DD Basu-Indian Constitution
2 Dr. D. Surannaida - Indian Politica ISystem.
3 Madhav Khosla- The Indian Constitution

REFERENCES BOOKS

1. The Constitution of India. 1950 (Bare Act), Government Publication
2. M. P. Jain, Indian Constitution Law, 7th Edn, Lexis Nexis, 2014

FINITE ELEMENT ANALYSIS

COURSE CODE: 26MSE1004

L	T	P	C
4	0	0	4

COURSE OUTCOMES:
Students will get ability

1. To study A brief history of F.E.M. Need of the method, Equations of equilibrium, Compatibility, Strain displacement relations.
2. To study and use Theory relating to the formulation of the finite element method, Element Stiffness Matrix and Element Load Vector.
3. To study Application to Structural Elements, Galarkin Method, Interpolation Functions.
4. To study isoparametric formulation, different types of elements and its interpolation functions.
5. To study solve continuum problems using finite element methods into CST,Rectangular and Quadrilateral elements.

COURSE OUTCOMES:
Students will get ability

CO 1: To learn A brief history of F.E.M. Need of the method, Equations of equilibrium, Compatibility, Strain displacement relations.

CO 2: To learn and use Theory relating to the formulation of the finite element method, Element Stiffness Matrix and Element Load Vector.

CO 3: To learn Application to Structural Elements, Galarkin Method, Interpolation Functions.

CO 4: To learn isoparametric formulation, different types of elements and its interpolation functions.

CO 5: To solve continuum problems using finite element methods into CST,Rectangular and Quadrilateral elements.

UNIT-I

Introduction - A brief history of F.E.M. minimum Potential Energy Principle, Direct Stiffness method, Equilibrium Equations, Assembly of Global Stiffness Matrix, Elements Stress and Strains.

UNIT-II

Beam elements – Element Stiffness Matrix, Element Load Vector and Theory relating to the formulation of the finite element method, Matrix boundary conditions – All with reference to trusses under axial forces.

UNIT-III

Method of Weighted Residuals – Galerkin Finite Element Method, applications to Structural Elements, Compatibility and completeness Requirements, Polynomial Forms and Applications.

UNIT-IV

Types of Elements – Different Types of elements and its shapes with Interpolation functions, Triangular Elements, Rectangular Elements, Three – Dimensional Elements, Isoparametric formulations.

UNIT-V

Application to Solid Mechanics – Plane Stress, Plane Strain, CST Element, Rectangular Element, Iso parametric formulation of the Quadrilateral element.

TEXT BOOKS:

1. Finite Element Method in Engineering, Belegundu A.D., Chandrupatla, T.R., Prentice Hall India, 1991.
2. Finite Element Analysis , P. Seshu., PHI Learning Private Limited, Delhi, 2013..
3. Finite Element Methods in Engineering, Singiresu S. Rao, ELSEVIER, 5th Edition.
4. Finite element Method by R D Cook

REFERENCES

1. A First Course in the Finite Element Method,Daryl L. Logan, Cengage Learning,5th Edition, 2012.
2. An Introduction to Nonlinear Finite Element Analysis, J N Reddy, Oxford University Press, 2nd Edition, 2015.

Structural Dynamics

COURSE CODE: 26MSE1005

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

Students will have

1. To study Objectives, Importance of Vibration Analysis, Nature of ExcitingForces, Mathematical Modeling of Dynamic Systems.
2. To study Degrees of Freedom of continuous system, Oscillatory motion, Simple Harmonic Motion, Free Vibrations of Single Degree of Freedom (SDOF) systems, Undamped and Damped, Critical damping, Logarithmic decrement, Forced vibrations of SDOF systems Harmonic excitation, Dynamic magnification factor, Band width.
3. To study rigid base excitation, Formulation of equations of motion for SDOF and MDOF Systems, Earthquake response analysis of single and multi-storyed buildings, Use of response spectra.
4. To study Free and Forced Vibration with and without Damping-Response to Harmonic Loading- Response to General Dynamic Loading using Duhamel's Integral- Fourier Analysis for Periodic Loading, State Space Solution for Response.
5. To study Selection of the Degrees of Freedom – Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion - Undamped free vibrations – Solution of Eigen value problem for natural frequencies and mode shapes – Analysis of dynamic response - Normal coordinates

COURSE OUTCOMES:

Students will get ability

1. To learn Objectives, Importance of Vibration Analysis, Nature of ExcitingForces, Mathematical Modeling of Dynamic Systems.
2. To learn Degrees of Freedom of continuous system, Oscillatory motion, Simple Harmonic Motion, Free Vibrations of Single Degree of Freedom (SDOF) systems, Undamped and Damped, Critical damping, Logarithmic decrement, Forced vibrations of SDOF systems Harmonic excitation, Dynamic magnification factor, Band width.
3. To learn rigid base excitation, Formulation of equations of motion for SDOF and MDOF Systems, Earthquake response analysis of single and multi-storyed buildings, Use of response spectra
4. To learn Free and Forced Vibration with and without Damping-Response to Harmonic Loading- Response to General Dynamic Loading using Duhamel's Integral- Fourier Analysis for Periodic Loading, State Space Solution for Response.
5. To learn Selection of the Degrees of Freedom, Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion - Undamped free vibrations Solution of Eigen value problem for natural frequencies and mode shapes, Analysis of dynamic response, Normal coordinates.

UNIT-I

Introduction: Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modeling of Dynamic Systems.

UNIT-II

Elements of a Vibratory system: Degrees of Freedom of continuous systems, Oscillatory motion, Simple Harmonic Motion, Free Vibrations of Single Degree of Freedom (SDOF) systems, Undamped and Damped, Critical damping, Logarithmic decrement, Forced vibrations of SDOF systems, Harmonic excitation, Dynamic magnification factor, Band width.

UNIT-III

Dynamic Analysis: Introduction, Rigid base excitation, Formulation of equations of motion for SDOF and MDOF Systems, Earthquake response analysis of single and multi-storyed buildings, Use of response spectra

UNIT-IV

Single Degree of Freedom System: Free and Forced Vibration with and without Damping- Response to Harmonic Loading- Response to General Dynamic Loading using Duhamel's Integral- Fourier Analysis for Periodic Loading, State Space Solution for Response.

UNIT-V

Multiple Degree of Freedom System (Lumped parameter): Selection of the Degrees of Freedom – Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion - Undamped free vibrations – Solution of Eigen value problem for natural frequencies and mode shapes – Analysis of dynamic response - Normal coordinates

REFERENCES:

1. Dynamics of Structures by Claugh&Penzien.
2. Structural Dynamics A K Chopra
3. Vibration of Structures - Application in Civil Engineering Design, Smith J. W., Chapman and Hall.
4. Structural Dynamics - Theory and Computation, Paz Mario, CBSPublication. Dynamics of Structures, Hart and Wong

Design of Formwork

COURSE CODE: 26MSE1006

L	T	P	C
4	0	0	4

Course Objectives:
At the end of the course, students will be learning to

1. Requirements and Selection of Formwork.
2. Select proper formwork, accessories and material.
3. Design the form work for Beams, Slabs, columns, Walls and Foundations.
4. Design the form work for Special Structures.
5. Understand the working of flying formwork.

Course Outcomes:
At the end of the course, students will be able to
1. Requirements and Selection of Formwork.
2. Select proper formwork, accessories and material.
3. Design the form work for Beams, Slabs, columns, Walls and Foundations.
4. Design the form work for Special Structures.
5. Understand the working of flying formwork.

UNIT-I
Introduction: Definition of Form Work, Difference between Form Work and False Work, Requirements and Selection of Formwork, Difficulties while Erection

UNIT-II
Formwork Materials- Timber, Plywood, Steel, Aluminum, Plastic, and Accessories. Horizontal and Vertical Formwork Supports.

UNIT-III
Formwork Design: Concepts, Formwork Systems and Design for Foundations, Walls, Columns, Slab and Beams.

UNIT-IV
Formwork Design for Special Structures: Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Bridges.

UNIT-V
Flying Formwork: Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete, Formwork Management Issues –Pre- and Post-Award.

Reference Books:

1 Formwork for Concrete Structures, Purify, Mc Graw Hill India, 2015.
2 Formwork for Concrete Structures, Kumar Neeraj Jha, Tata McGraw Hill Education, 2012.
3 IS 14687: 1999, false work for Concrete Structures - Guidelines, BIS.

Advanced Steel Design
(Elective-3)

COURSE CODE: 26MSE1E31

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Students will have

1. To study Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Upper lower bound theorems. Redistribution of moments.
2. Various types of connections
3. Plastic method of structural analysis
4. General principle in the design of steel structures
5. Analysis and design of industrial structures

COURSE OUTCOMES:

Students will get ability

1. To learn Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Upper lower bound theorems. Redistribution of moments.
2. Analyze various types of connections like bearing type joints - unstiffened & stiffened seat connections -moment resisting connection -bolted and welded-semi-rigid connections.
3. Analyze & Application of Theory of plastic bending - Plastic hinge concept.
4. Analyze General principle in the design of steel structures
5. Analyze Industrial buildings, Gable frames with gantry girder industrial frames-Fire resistant design-Fatigue resistant design.

UNIT I

Limit analysis of steel structures: Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Limit load, Coplanar load, Upper lower bound theorems. Redistribution of moments continuous beams: Relevant or irrelevant mechanisms, Types of mechanisms method for performing moment check.

UNIT II-CONNECTIONS

Properties of Steel: Mechanical Properties, Hysteresis, Bearing type joints - unstiffened and stiffened seat connections -moment resisting connection of brackets-bolted and welded-semi-rigid connections, Location of Beam Column, Column Foundation, Splices.

UNIT III-PLASTIC ANALYSIS

Hot Rolled Sections: compactness and non-compactness, slenderness, residual stresses.

Design of Steel Structures: Theory of plastic bending –Shape Factor- Plastic hinge concept Inelastic Bending Curvature, Plastic Moments, Design Criteria Stability, Strength, Drift.

UNIT IV-GENERAL PRINCIPLES

Ductility, Beams subjected to biaxial bending - Built-up Purlins - Various types and Design - Design of Wind girders-Beam-columns - With various support Conditions-Design of foundations-with lateral forces.

UNIT V-INDUSTRIAL BUILDINGS

Industrial buildings-braced and unbraced - Gable frames with gantry girder industrial frames-Fire resistant design-Fatigue resistant design.

Text Books:

1. N.Subramanian, "Design of Steel Structures: Theory and Practice",Oxford university Press, U.S.A, Third Edition, 2011
2. Duggal.S.K, "Design of Steel Structures", McGraw Hill New Delhi,2010
3. Dayaratnam P. "Design of Steel Structures,"S. Chand Limited, NewDelhi. 2008
4. Neal. B.G., "Plastic Method of Structural Analysis", Taylor &Francis,Third Edition, 1985
5. Edwin.H.Gaylord, Charles.N.Gaylord, James. E. Stallmeyer, "SteelStructures", McGraw Hill, New Delhi, 1980.
6. Ramchandra, "Design of Steel Structures", Vol I & II Standard BookHouse, Delhi, 1975
7. Plastic Methods of Structural Analysis, Neal B. G., Chapman and Hall London.

Reference Books:

1. John E. Lothers, "Structural Design in Steel", Prentice Hall, 1999.
2. Neal. B.G., "Plastic Method of Structural Analysis", Taylor &Francis,Third Edition, 1985
3. Arya.S and Ajmani.J.L, "Design of Steel Structures", Nem Chand &Bros, Roorkee.
4. The Steel Skeleton- Vol. II, Plastic Behaviour and Design - Baker J. F., Horne M. R., Heyman J., ELBS.
5. IS 800: 2007 – General Construction in Steel - Code of Practice,2007.
6. SP – 6 - Handbook of Structural Steel Detailing, BIS,1987.

REPAIR AND REHABILITATION OF STRUCTURES
(Elective-3)

COURSE CODE: 26MSE1E32

L	T	P	C
3	0	0	3

Objectives:
The objective of this course is to enable the students to
- Understand different maintenance and repair strategies and their importance.
- Understand different repair materials, grouting materials.
- Know the factors effecting durability and strength of structures.
- Understand various repair protection & retrofitting of structure.
- Conductfieldmonitoringandnon-destructiveevaluationofconcretestructures.

Outcomes:
At the end of the course the students are expected to
1. Apply the different strategies of repair and maintenance of structures
2. Apply the strength and durability of concrete
3. Evaluate various repair and rehabilitation methods
4. Evaluate and explain various non-destructive methods
5. Evaluate the methods for strengthening the components of a structure

UNIT-I
Maintenance and Repair Strategies: Maintenance, Repair and Rehabilitation, facets of maintenance, importance of maintenance, various aspects of inspection, assessment procedure for evaluating a damaged structure, causes of deterioration.

UNIT-II
Repair materials Various repair materials, Criteria for material selection, Methodology of selection, Health and safety precautions for handling and applications of repair materials
Special mortars and concretes Polymer Concrete and Mortar, Quick setting compounds.
Grouting materials: Gas forming grouts, Salfoalumate grouts, Polymer grouts, Acrylate and Urethane grouts.
Bonding agents: Latex emulsions, Epoxy bonding agents.
Protective coatings Protective coatings for Concrete and Steel. FRP sheets.

UNIT-III
Strength and Durability of Concrete:
Quality assurance and quality control on concrete, Strength, durability, thermal properties of concrete. Cracks different type, causes, effects due to climate, temperature, corrosion, effects of cover thickness.

UNIT-IV
Techniques for Repair and Protection Methods: Non-Destructive testing techniques, Epoxy injection, Shoring, Underpinning, Corrosion protection techniques, corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection.

UNIT-V

Repair, Rehabilitation and Retrofitting of Structures: Strengthening of beams, strengthening of columns, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Demolition techniques, Engineered demolition methods, Jacketing and fiber raping, Case studies.

Text Books:

1. AllenR.T.& EdwardsS.C,RepairofConcreteStructures,BlakieandSons,UK,1987
2. Denison Campbell, Allenand HaroldRoper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical UK, 1991

Reference Books:

1. Shetty M.S., "Concrete Technology, Theory andPractice",S.ChandandCompany,2008
2. DovKominetzky.M.S.,"Designandconstructionfailures,GalgotiapublicationsPvtLtd., 2001
3. "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill.

Web References:

1. https://easyengineering.net/ce6021-repair-and-rehabilitation-of/
2. https://www.academia.edu/4519837/MaintenanceandRehabilitationof Structures

E-TextBooks:

1. https://books.google.co.in/books?isbn=0784470294
2. https://books.google.co.in/books?isbn=0128111844

BRIDGE ENGINEERING
(Elective-3)

COURSE CODE: 26MSE1E33

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Students will have

- To explain the basic Components of a Bridges
- To explain of R.C.C. Culverts and T-Beam Bridges.
- To discuss various types of steel bridges
- To discuss the Pier and Abutments.
- To explain the Importance of bearings, concrete girder and box girder bridges.

COURSE OUTCOMES:

After completion of this course students will be able to

1. Understand the basic Components of a Bridges.
2. Design of R.C.C. Culverts and T-Beam Bridge.
3. Design of various types of steel bridges.
4. Illustrate the Pier and Abutments.
5. Understand the Importance of bearings and design of concrete girder and box girder bridges.

UNIT I

Introduction and Investigation for Bridges: Components of a Bridge, Classification, Standard Specifications, Need for Investigation, Selection of Bridge Site, Preliminary Data to be Collected, Preliminary Drawings, Determination of Design Discharge, Economical Span, Location of Piers And Abutments, Vertical Clearance Above HFL, Scour Depth, Choice of Bridge Type, Importance of Proper Investigation.

UNIT II

Design Consideration of RCC bridges: Various types of bridges (brief description of each type), Design of R.C.C. Culverts and T-Beam Bridges.

UNIT III

Design Consideration of steel bridges: Various types of steel bridges (brief description of each type), Design of welded plate girder bridge. Design Principles of continuous bridges and box girder bridges.

UNIT IV

Sub Structure for Bridges: Pier and Abutments Caps; Materials for Piers and Abutments, Design of Pier, Design of Abutment, Backfill behind Abutment, Approach Slab.

UNIT V

Bearings for Bridges: Importance of bearings, bearings for slab bridges, bearings for girder bridges, expansion bearings, fixed bearings, design of elastomeric pad bearing. Foundations for bridges, Scour at abutments and piers, grip length, types of Foundations. Analysis and design of concrete girder and box girder bridges considering only primary torsion, Design of end block, Theory on open web girder.

Text Book(s)

1. Krishna Raju N., Design of Bridges, 4/e, Oxford & IBH Publishing, 2008.
2. Jagadish. T.R and Jayaram. M.A, Design of Bridge Structures, 2/e, PHI Learning Pvt. Ltd., 2009.

Reference Book(s):

1. D.Johnson Victor, Essentials of Bridge Engineering, 6/e, Oxford & IBH Publishing Co. Pvt. Ltd., 2007.
2. Ponnuswamy.S, Bridge Engineering, 2/e, Tata McGraw Hill Education, 2007.

Design of Advanced Concrete Structures
(Elective-4)

COURSE CODE: 26MSE1E41

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Students will have to

CO-1 Explain various loads on the structures, Partial Safety factors and provisions of Indian codes.

CO-2 Explain long term and short term deflections as per the provisions of Indian codes.

CO-3 Explain redistribution of moments as per IS code provisions with Moment-curvature (M – ψ), Relation of reinforced concrete sections.

CO-4 Explain Deep beams and corrbels

CO-5 Explain of shear walls with different cases.

COURSE OUTCOMES:

Students able to

CO-1 Illustrate various loads on the structures, Partial Safety factors and provisions of Indian codes.

CO-2 Calculate long term and short term deflections as per the provisions of Indian codes.

CO-3 Analyze redistribution of moments as per IS code provisions with Moment-curvature (M – ψ), Relation of reinforced concrete sections.

CO-4 Design Deep beams and corrbels

CO-5 Design of shear walls with different cases.

SYLLABUS:

UNIT-I : Loads and Material characteristics: Dead Loads, imposed loads, loads due to imposed deformations, Characteristic Imposed loads, Partial Safety factors for loads, Provisions for Live loads, Wind loads on structures, Indian Code for wind loads and wind load combination.

UNIT-II: Deflection: Short term & Long Term Deflections of beams, Calculation of Deflection as per the provisions of IS 456.

Crack width: Factors affecting crack-width in beams, Mechanism of Flexural Cracking, Calculations of Crack width as per provisions of IS 456.'

UNIT-III: Moment Redistribution: Introduction, Redistribution of moments in fixed beam, Positions of points of contra flexure, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, IS code provisions- Moment-curvature (M - ψ), Relation of reinforced concrete sections.

UNIT-IV: Design of RC deep beams & Corbels: Strut-and-tie Mechanism,Minimum thickness, Steps of designing deep beams, Design of deep beams and Corbels by IS 456, Check for local failures.

UNIT-V: Design of shear walls: Classification of shear walls, Loads in shear walls, Design of rectangular shear wall, Design of Flanged shear walls, Derivation of formula for moment resistance of rectangular shear wall.

Text Books:

1. "Advanced Reinforced Concrete" P.C. Varghese vol:2 Prentice Hall of INDIA Private Ltd. 2008.
2. "Reinforced Concrete Design" CK Wang

Reference Books:

1. "Design of Reinforced Concrete Structures" by N.Subramanian, Oxford University Press.
2. "Reinforced Concrete Design" S. Unnikrishna Pillai & Devdas Menon; Tata Mc. Graw-Hill Publishing Company Ltd. New Delhi 2010.
3. Reinforced concrete structural elements – behaviour, Analysis and design by P. Purushotham, Tata Mc.Graw-Hill, 1994.
4. Design of concrete structures – Arthus H. Nilson, David Darwin, and Chorles W. Dolar, Tata Mc. Graw-Hill, 3rd Edition, 2005.
5. Reinforced Concrete design by Kennath Leet, Tata Mc. Graw-Hill International, editions, 2nd edition, 1991.
6. "Design Reinforced Concrete Foundations" P.C. Varghese Prentice Hall of INDIA Private Ltd.
7. IS 456-2000 10. SP 16 11. SP 34, IS 13920-2016

Advanced Design of Foundations
(Elective-4)

COURSE CODE: 26MSE1E42

L	T	P	C
3	0	0	3

Course Objectives:
Students will have

1. To Decide the suitability of soil strata for different projects.
2. To Design shallow foundations deciding the bearing capacity of soil..
3. To Analyze and design the pile foundation.
4. To Understand analysis methods for well foundation.
5. To Compute Pressure around Tunnels.

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

1. Decide the suitability of soil strata for different projects.
2. Design shallow foundations deciding the bearing capacity of soil.
3. Analyze and design the pile foundation.
4. Understand analysis methods for well foundation.
5. Compute Pressure around Tunnels.

UNIT-I: Planning of Soil Exploration for Different Projects, Methods of Subsurface Exploration, Methods of Borings along with Various Penetration Tests.

UNIT-II: Shallow Foundations, Requirements for Satisfactory Performance of Foundations, Methods of Estimating Bearing Capacity-Terzaghi,meyarhoff,vesic and IS methods, Settlements of Footings.

UNIT-III: Pile Foundations, Methods of Estimating Load Transfer of Piles, Settlements of Pile Foundations, Pile Group Capacity and Settlement, Pile Load Tests, Analytical Estimation of

Load- Settlement Behavior of Piles. Pile caps

UNIT-IV: Well Foundation, IS and IRC Code Provisions, Elastic Theory and Ultimate Resistance Methods.

UNIT-V: Tunnels and Arching in Soils, Pressure Computations around Tunnels.

Reference Books:

1. Foundation Analysis and Design, J. E. Bowles, Tata McGraw Hill New York
2.Design of foundation system, N.P. Kurian, Narosa Publishing House.
3. Analysis and Design of Substructures, Sawmi Saran, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi

Design of Industrial Structures
(Elective-4)

COURSE CODE: 26MSE1E43

L	T	P	C
3	0	0	3

Course Obectives:

Students will have

1. To analyze and design steel gantry girders.
2. To design portal frame with hinge base, design of portal frame with fixed base, gable structures and lightweight structures.
3. To design square bunker using Jansen's and Airy's theories and is code provisions, cylindrical silo.
4. To design chimneys and its foundation.
5. To design rectangular riveted steel water tank and its foundation.

Course Outcomes:

Students will get ability

1. Analyze and design steel gantry girders.
2. Design portal frame with hinge base, design of portal frame with fixed base, Gable Structures and Lightweight Structures.
3. Design square bunker using Jansen's and Airy's theories and IS Codeprovisions, cylindrical silo.
4. Design chimneys and its foundation.
5. Design rectangular riveted steel water tank and its foundation.

UNIT-I

Steel Gantry Girders : Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.

UNIT-II

Portal Frames : Design of portal frame with hinge base, design of portal frame with fixed base - Gable Structures –Lightweight Structures.

UNIT-III

Steel Bunkers and Silos : Design of square bunker, Jansen's and Airy's theories, IS Code provisions, Design of side plates, Stiffeners, Hooper ,Longitudinal beams Design of cylindrical silo ,Side plates, Ring girder ,stiffeners.

UNIT-IV

Chimneys : Introduction, dimensions of steel stacks, chimney lining, breech openings andaccess ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.

UNIT-V

Water Tanks: Design of rectangular riveted steel water tank ,Tee covers, Plates, Stays ,Longitudinal and transverse beams ,Design of staging – Base plates – Foundation and anchor bolts.

Textbook Books:

- Design of Steel Structures, Subramaniyam
- Design of Steel Structures, Ram Chandra, 12th Ed., Standard Publishers, 2009.
- Design of Steel Structure, Punmia B. C., Jain Ashok Kr., Jain Arun Kr., 2nd Ed., Lakshmi Publishers, 1998.

Reference Books:

- "Fundamentals of Structural Analysis" by Jakkula & Stephenson, Von Nostrand, East West Press.
- "Design of Steel Structures" by Arya & Ajmani, Nemchand Publishers

Analytical and Numerical Methods for Structural Engineering Lab

COURSE CODE: 26MSE1103

L	T	P	C
0	0	4	2

Course Objectives: At the end of the course, students will be learn to

1. To develop basic knowledge on usage of MAT LAB to solve engineering problems.
2. Find Roots of non-linear equations by Bisection method and Newton's method.
3. Do curve fitting by least square approximations
4. Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jorden Method
5. To Integrate Numerically Using Trapezoidal and Simpson's Rules

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

1. To develop basic knowledge on usage of MAT LAB to solve engineering problems.
2. Find Roots of non-linear equations by Bisection method and Newton's method.
3. Do curve fitting by least square approximations
4. Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jorden Method
5. To Integrate Numerically Using Trapezoidal and Simpson's Rules

Exercises:

1. Write a MAT LAB Code for finding the Roots of Non-Linear Equation Using Bisection Method.
2. Write a MAT LAB Code for finding the Roots of Non-Linear Equation Using Newton's Method.
3. Write a MAT LAB Code for solving the Curve Fitting by Least Square Approximations.
4. Write a MAT LAB Code for solving the System of Linear Equations Using Gauss - Elimination Method.
5. Write a MAT LAB Code for solving the System of Linear Equations Using Gauss - Seidal Iteration Method.
6. Write a MAT LAB Code for solving the System of Linear Equations Using Gauss - Jorden Method.
7. Write a MAT LAB Code to Integrate numerically using Trapezoidal Rule. Integrate numerically using Simpson's Rules.
8. Write a MAT LAB Code for finding Numerical Solution of Ordinary Differential Equations by Euler's Method.
9. Write a MAT LAB Code for finding Numerical Solution of Ordinary Differential Equations by Runge - Kutta Method.

TEXT BOOKS:

1. Introduction to Numerical Methods, A MAT LAB Approch, Abdelwahab Kharab, Ronald B Guenther, Chapman & CRC Press.
2. Simulink User Manual, Mathworks Corporation.
3. MAT LAB Toolboxes Introduction, Mathworks Corporation

REFERENCE BOOKS:

Chapman S.J. Essentials of MAT LAB Programming (CENGAGE Leaning, 2nd ed., 2008

Research Methodology and IPR

COURSE CODE: 22MCC1001

L	T	P	C
2	0	0	2

Course Objectives :

1. Formulate research problems with clarity and develop strong analytical skills.
2. Apply structured research methodology, literature review techniques, and ethical practices to academic work.
3. Interpret research data effectively and master the mechanics of technical report writing.
4. Gain a comprehensive understanding of Intellectual Property Rights (IPR) and the legalities of the patenting process.
5. Understand the global landscape of patent rights, technology transfer, and emerging trends in IP.

COURSE OUTCOMES

CO 1 Summarize the fundamental concepts, types, and systematic processes of scientific research.

CO 2 Formulate a well-defined research problem by applying systematic selection techniques

CO 3 Construct a comprehensive literature review and theoretical framework while maintaining high ethical standards.

CO4 Execute data interpretation and produce high-quality technical reports and oral presentations.

CO 5 Navigate the legalities of Intellectual Property Rights, including patent filing, licensing, and emerging IP trends.

UNIT-I: Introduction to Research Methodology

Meaning, objectives, and motivation in research. **Research Taxonomy:** Types of research (Descriptive vs. Analytical, Applied vs. Fundamental, and Quantitative vs. Qualitative). **Methodology:** Research approaches, significance of research, and the distinction between Research Methods vs. Methodology. **Scientific Rigor:** Research and the scientific method; Importance of understanding the research process from inception to completion.

UNIT-II: Defining the Research Problem

Quality Standards: Criteria of good research; Common problems encountered by researchers in India. **Problem Formulation:** The art of defining the research problem; Necessity and importance of a well-defined problem. **Techniques:** Step-by-step process of
identifying and selecting a research problem. **Application:** Practical illustrations and the logic of narrowing down a broad area into a researchable topic.

UNIT-III: Literature Review and Research Ethics

Strategic Review: Place of literature review in research; Bringing clarity and focus to the problem; improving methodology and broadening knowledge base. **Execution:** Searching existing literature, reviewing selected literature, and contextualizing findings. **Frameworks:** Developing theoretical and conceptual frameworks for the study. **Integrity:** Writing about the literature reviewed; **Analysis of Plagiarism** and adherence to **Research Ethics**.

UNIT-IV: Interpretation and Report Writing

Data Synthesis: Meaning and techniques of interpretation; Precautions to take during data interpretation. **Technical Communication:** Significance of report writing; Different steps and layout of a formal research report. **Formatting & Mechanics:** Types of reports, oral presentation skills, and the mechanics of writing a research report. **Quality Control:** Precautions for writing effective and accurate research reports.

UNIT-V: Nature of Intellectual Property and Patenting

IP Fundamentals: Nature of Intellectual Property: Patents, Designs, Trademarks, and Copyrights. **The Patent Lifecycle:** From technological research and innovation to development; Procedure for grant of patents. **Global Framework:** International cooperation on IP; Patenting under the **Patent Cooperation Treaty (PCT)**. **Rights & Trends:** Scope of patent rights; Licensing and transfer of technology; Patent databases. **Emerging Areas:** Geographical Indications (GI), Traditional knowledge case studies.

TEXT BOOKS

1. Kothari, C. R(1990). Research methodology, 2nd edition, New Age International Publishers.
2. Kothari, C. R., & Garg, G. (2024). Research methodology: Methods and techniques (5th ed.). New Age International Publishers.
3. Ramappa, T. (2021). Intellectual property rights under WTO (3rd ed.). S. Chand Publishing.

REFERENCE BOOKS

1. Chawla, D., & Sondhi, N. (2016). Research methodology: Concepts and cases (2nd ed.). Vikas Publishing House.
2. Cornish, W., Llewelyn, D., & Aplin, J. (2025). Intellectual property: Patents, copyright, trade marks and allied rights (10th South Asian ed.). Sweet & Maxwell. Available at Bharat Law House.
3. Controller General of Patents, Designs and Trade Marks. (2024). Manual of patent practice and procedure. IP India Official Website.
4. World Intellectual Property Organization. (2024). PCT – The International Patent System. WIPO.