DIT UNIVERSITY
Dehradun

Detailed Course Structure& Syllabus
of
M.TECH. IN CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)
BATCH 2022–24

Approved by the Academic Council at its 20th Meeting

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Structure

Year 1 Semester I

Course Category	Course Code	Course Title	L	T	P	Credit
UC	MA601	Advanced Mathematics	4	0	0	4
DC	CE608	Advanced Structural Analysis	4	0	0	4
DC	CE609	Theory of Elasticity and Plasticity	4	0	0	4
DC	CE601	Advanced Concrete Technology	4	0	0	4
DC	CE604	Advanced Concrete Laboratory	0	0	2	1
DC	CE610	Advanced Steel Design	4	0	0	4
		Total				**21**

Year 1 Semester II

Course Category	Course Code	Course Title	L	T	P	Credit
DC	CE611	Structural Dynamics	4	0	0	4
DC	CE612	Seismic Design of Structures	4	0	0	4
DC	CE605	Finite Element Analysis	4	0	0	4
DE		Elective – I	4	0	0	4
DC	CE613	Computer Aided Design of Structures	0	0	2	1
DC	CE614	Stability of Structures	4	0	0	4
		Total				**21**

Year 2 Semester III

Course Category	Course Code	Course Title	L	T	P	Credit
DE		Elective – II	4	0	0	4
DE		Elective - III	4	0	0	4
DC	CE704	Research Methodology and IPR	2	0	0	2
DC	CE705	Dissertation Phase-I	0	0	12	6
		Total				**16**

Year 2 Semester IV

Course Category	Course Code	Course Title	L	T	P	Credit
DC	CE706	Dissertation Phase-II	0	0	24	12
		Total				**12**

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Elective Basket

Elective -I

S.N.	Course Code	Course Title
1	CE651	Structural Health Monitoring
2	CE652	Theory of Plates and Shells
3	CE653	Advanced Prestressed Concrete
4	CE654	Advanced Foundation Design
5	CE655	Optimization in Structural Design
6	CE656	Advanced Mechanics of Composite Materials

Elective -II

S.N.	Course Code	Course Title
1	CE751	Sustainable Materials and Green Buildings
2	CE752	Soil Structure Interaction
3	CE753	Advanced Reinforced Concrete Design
4	CE754	Design of Masonry Structures
5	CE755	Applied Fracture Mechanics
6	CE756	Maintenance and Rehabilitation of Structures

Elective -III

S.N.	Course Code	Course Title
1	CE761	Design of Advanced Bridges
2	CE762	Design of Industrial Structures
3	CE763	Introduction to Modelling and Simulation
4	CE764	Nonlinear Structural Analysis
5	CE765	Design of Tall Structures

Credit Summary

Year	Semester	Credit	Year Credit
First Year	I	21	42
	II	21	
Second Year	III	16	28
	IV	12	
Total			**70**

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Course Code	MA601	Course Title	Advanced Mathematics					
LTP	4 0 0	Credit	4	Subject Category	UC	Year	1	Semester	I

Course Outline:

COURSE OBJECTIVE:

Detailed Syllabus

UNIT-I
Numerical Techniques
Zeros of Transcendental and Polynomial equation using bisection method, Newton-Raphson method, Rate of convergence of above methods. Interpolation: Finite differences, difference tables, Newton's Forward and Newton's Backward Interpolation, Lagrange's and Newton divided difference formula for unequal intervals. Solution of system of Linear equations, Gauss-Seidal method, Crout method. Numerical Integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule, Solution of ordinary differential (first order, second order and simultaneous) equations by Picard's and Fourth order Runga - Kutta methods

UNIT-II
Partial Differential Equations (PDE)
Formation and Classification of PDE, Solution of One Dimension Wave Equation, and Heat Equation, Two Dimension Heat and Laplace Equation by Separation of variables Method.

UNIT-III
Special Functions
Series solution of ODE of 2^{nd}order with variable coefficient with special emphasis to Legendre and Bessel differential equation, Legendre polynomial of first kind, Bessel Function of first kind and their properties.

UNIT-IV
Statistics:
Elements of statistics, frequency distribution: concept of mean, median, mode, Standard derivation, variance and different types of distribution: Binomial, Poisson and Normal distribution, curve fitting by least square method, Correlation and Regression, Concept of Hypothesis Testing.

UNIT-V
Optimization:
Formulation, Graphical method, Simplex method, Two-Phase simplex method, Duality, Primal-dual relationship, Dual-simplex method.

Text Books:

1. R. K. Jain & S. R. K. Iyenger: Advanced Engineering Mathematics, Narosa publication, 2014.
2. Jain, Iyenger& Jain: Numerical methods for scientific &Engg. Computation, New age, 2003.
3. Gupta S. C., Kapoor V. K.: Fundamentals of Statistics, Sultan Chand & Sons,Eleventh Edition (Reprint) 2014.

Reference Books:

1. E. Kreyszig: Advanced Engineering Mathematics, Wiley publication.
2. B.S. Grewal: Higher Engineering Mathematics, 42nd Edition, Khanna Publication, India, 2012.

School of Engineering & Technology (Civil Engineering)
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Course Code	CE608	Course Title	Advanced Structural Analysis					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1	Semester	I

Course Outcome

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

CO1 Understand the concepts of flexibility and stiffness.

CO2 Analyse statically indeterminate plane structures by flexibility matrix method.

CO3 Calculate the unknown displacements and rotations for various types of plane structures by plane structures.

CO4 Evaluate the forces in the members of pinned jointed space truss by stiffness matrix method and flexibility matrix method.

CO5 Determine the unknown displacements for grid and building frame by stiffness matrix method.

Detailed Syllabus:

UNIT-I **(12 hrs)**

Introduction, Types of loads, Compatibility Conditions, Static and Kinematic indeterminacy, Principle of Superposition, Stiffness and flexibility matrix in single, two and n-co-ordinates, Structures with constrained measurements, Energy Concepts & Transformation of Coordinates and its Application.

NIT-II **(10 hrs)**

Flexibility matrix method applied to statically determinate and indeterminate structures- Choice of redundant, Application to various types of structures, Internal forces due to thermal expansion and lack of fit

UNIT-III **(10 hrs)**

Stiffness matrix method- Basis of stiffness method, force-displacement relationships, Nodal Stiffness, Application to various types of structures, Internal forces due to thermal expansion and lack of fit.

UNIT-IV **(10 hrs)**

Space Truss – Analysis of ***pinned jointed*** space truss by stiffness matrix method and flexibility matrix method.

UNIT-V **(10 hrs)**

Space frame – Analysis of ***rigid jointed*** grid and building frame by stiffness matrix method.

Text Books:

1. Mosche, F., Rubenstein, Matrix Computer Analysis of Structures, Prentice Hall, New York, 1966.
2. Kanchi, Matrix Structural Analysis, Wiley Eastern Ltd., New Delhi, 1981.

References:

1. Pandit G.S. & Gupta, S.P. (2001), Structural Analysis (A matrix approach), Tata McGraw Hill Publishing Ltd.
2. Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India, New Delhi, 2001.
3. Analysis of Structures: D. J. Dawe.
4. Matrix Method of Structural Analysis: C.K. Wang.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering) Batch: 2022-24

Course Code	CE609	Course Title	Theory of Elasticity and Plasticity					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1	Semester	I

Course Objective: The objective of the course is to provide the students in-depth concept in elastic and plastic analyses for design of structures.

Detailed Syllabus:

UNIT-I **(9hrs)**

Analysis of Stress: Traction Vector, State of Stress at a Point, Stress Components on an Arbitrary Plane, Equations of Equilibrium, Transformation of Stress w.r.t. another Coordinate, Principal Stresses in 3D, Stress Invariants, Octahedral Stresses, Mohr's Circle of Stresses, Hydrostatic and Deviatorial Stress components, Equations of Equilibrium Cylindrical Coordinates. Other Special Cases of Stresses

UNIT-II **(9hrs)**

Analysis of Strain: Deformation in the Neighborhoods of a Point, Magnification of a line, Definition of Strain, Strain Tensor, Large and Small Deformations and Strains, Change in Angle between two lines, Principal Strains, Strain Transformation, Dilatation, Different Special Cases, Compatibility Relations, Strain Rossets.

UNIT-III **(6hrs)**

Stress-Strain Relation for Linear Elastic Bodies: General Theory of Constitutive equations; Stress-strain Relations for Linear Elastic Solids, Types of Elastic problems for Isotropic solids. Displacement Equations of Equilibrium

UNIT-IV **(6hrs)**

Torsion: Torsion of thin walled Tubes, Torsion of Noncircular Section: Saint Venanat's Method, Prandtl Stress Function Method, Membrane Analogy, Torsion of Multiply Connected Sections, Centre of Twist and Flexure Centre.

UNIT-V **(12hrs)**

Plasticity: Different plastic behaviours, Basic Concepts, Different Theories of Failure and Yield Criteria, Yield Locus and Yield Surfaces, Bauschinger's Effect, Isotropic and Kinematic Hardening, Flow Rules, Pi- plane, Prandtle-Reuss Equations and other Equations of Plasticity, Elasto-Plastic analysis of Torsion and Bending Problems, Residual Stresses. Axi-symmetric Problems: Thick Walled Cylinders Subjected to Internal and External Pressure, Problems of Spherical and Axial Symmetry, Bending of Curved Beams.

Course Outcome:

The students will be able to:

CO1 develop stress and strain tensors and perform transformations

CO2 analyse stress-strain relationships for materials in elastic state.

CO3 solve problems of linear elasticity using boundary value concept

CO4 analyse problems of plasticity and behaviour of visco-elastic materials using various models

Reference Books

1. Advanced Mechanics of Solids, L.S. Srinath, Tata Mc Graw Hill Pub.Co., New Delhi
2. Solid Mechanics, S M A Kazimi, Tata Mc Graw Hill Pub.Co., New Delhi
3. Advanced Mechanics of Materials, A. P Boresi and R J Schmidt, John Wiley and Sons Inc.
4. Theory of Elasticity, S P Timoshenko and J. H. Goodier, Mc Graw Hill Book Co.,
5. Classical and Computational Solid Mechanics, Y C Fung and P Tong, World Scientific, Singapore.
6. Introduction to the Theory of Plasticity for Engineers, O H Hoffmann, and G Sachs, Mc Graw Hill Book Co. New York.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering) Batch: 2022-24

Course Code	CE601	Course Title	Advanced Concrete Technology					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1	Semester	I

Prerequisite: NIL
Course Objective: The objective of the course is to introduce advance concrete technology.
Detailed Syllabus:

UNIT-I **(10 hrs)**

Concrete as a composite material; Rheological properties of concrete; Microstructure studies in concrete, techniques for measurement of porosity. Reinforcement corrosion: an electrochemical process, techniques for corrosion monitoring, corrosion protection measures, application of coatings on rebar, corrosion inhibitors in concrete

UNIT-II **(10 hrs)**

Use of industrial waste and their influence on physical, mechanical and durability properties of concrete; Fiber reinforced concrete: mechanism of fiber reinforcement, types of fibers, properties of fiber reinforce. High strength concrete: constituents, mix proportioning, properties at fresh and hardened state; Reactive powder concrete; Macro Defect Free (MDF) cement

UNIT-III **(12 hrs)**

Self-compacting concrete; Roller compacted concrete; Ferro cement composites; Polymers in construction, polymer concrete composites; Chemical testing of concrete. Non-destructive evaluation of reinforced concrete by surface hardness techniques, rebound hammer, wave propagation techniques, penetration resistance techniques, electrochemical and electromagnetic techniques.

UNIT-IV **(10 hrs)**

Fracture mechanics of concrete. Repairs and rehabilitation of old concrete.

UNIT-V **(6 hrs)**

Design of High grade concrete mixes by using admixtures.

Course Outcome:
CO1 The student will have understanding of current advances in Concrete technology.

Text Books:
1. P. K. Mehta and P. J. M. Monteiro, Concrete: Microstructure, Properties and Materials, McGraw-Hill, 3rd Ed., 2006.
2. J. Newman and B. S. Choo, Advanced Concrete Technology: Processes, Elsevier, Butterworth-Heinemann, 2003.

Reference Books:
1. A. M., Neville and J. J. Brooks, Concrete Technology, Pearson Education, 4th Indian reprint, 2004.
2. M. S. Mamlouk and J. P. Zaniewski, Materials for Civil and Construction Engineers, Pearson, Prentice Hall, 2nd Ed., 2006.
3. P. C. Aitcin, High Performance Concrete, E &FnSpon, 1998
4. J. Newman and B. S. Choo, Advanced Concrete Technology: Concrete properties, Elsevier, Butterworth-Heinemann,2003.
5. E. G. Nawy, Fundamentals of High-Performance Concrete, John Wiley & Sons Inc., 2nd Ed., 2001.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering) Batch: 2022-24

Course Code	CE604	Course Title	Advanced Concrete Laboratory					
LTP	0 0 2	Credit	1	Subject Category	DC	Year	1	Semester	I

Course Outcome

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

1. Design high grade concrete and study the parameters affecting its performance
2. Conduct non-destructive tests on existing concrete structures.
3. Apply engineering principle to understand behaviour of structural elements.

List of Experiments/Assignments:

1. Design of high-grade concrete using admixture.
2. To experimentally investigate the permeability of concrete.
3. Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rapture.
4. Effect of cyclic loading on concrete.
5. Non-destructive testing of existing concrete members.
6. Behaviour of beams under flexural, shear.

School of Engineering & Technology (Civil Engineering)
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Course Code	CE611	Course Title	Structural Dynamics					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1	Semester	II

Prerequisite: Student should have attended course on structural analysis.
Course Objective: The objective of the course is to provide basics of dynamics in structures.
Detailed syllabus:

UNIT-I **(8hrs)**

Introduction to dynamic load and response, stiffened and damping in series and parallel, Degree of freedom, damped and undamped free vibrations of SDOF, critical damping, logarithmic decrement.

UNIT-II **(10 hrs)**

Response of SDOF to harmonic excitation, frequency response function , half power band method for damping ratio, base isolation, transmissibility, frequency domain analysis for periodic loading, seismic instruments.

UNIT-III **(8 hrs)**

Response of SDOF: response to impulsive and different pulse loads, Duhamel and convolution integrals, numerical methods e. g. Approximation of excitation constant and linear acceleration method, Newmark-Beta method, Wilson-theta method.

UNIT-IV **(12 hrs)**

Multi-degree freedom system, stiffness and flexibility approaches, Lumped-mass matrix, free vibrations fundamental Frequencies and mode shapes, Eigen value problem, Rayleigh quotient, orthogonally of modes, numerical schemes to find mode shapes and frequencies. Multi degree freedom systems, response to dynamic loading, Formulations of equations of motion, normal coordinates, mode superposition method, modal matrix, numerical scheme of Wilson and Newmark.

UNIT-V **(12 hrs)**

Distributed systems: free vibration of uniform bars and beams, BCS in such problems, assumed mode method, Hamilton‘s method, langrage method, generalized parameters. Structural response to earthquake, wind and ground motion characteristics Response spectrum design earth quake, IS code provisions for multi-storey frames.

Course Outcome:

The Student will be able to
CO1 understand basic concepts related to dynamic analysis of structures
CO2 Perform analysis of SDOF and MDOF
CO3 perform dynamic analysis of various structures using numerical methods
CO4 carry out dynamic analysis of base isolated buildings

Reference Books:

1. R. W. Clough:, J. Penzian: Dynamics of Structures
2. J. M. Biggs: Structural Dynamics
3. L. S. Jacobsen R. S. Arye: Engineering Vibrations
4. S. P. Timoshenkoo: Vibration Problems in Engineering
5. G. B. Warburden: The Dynamical Behaviour of Structures

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Course Code	CE612	Course Title	Seismic Design of Structures						
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1	Semester	II

Prerequisite: Student should have attended course on concrete and steel structures.
Course Objective: The objective of the course is to provide basics of earthquake resistant design of structures.

Course Outcome:
At the end of the course, the student will be able to
CO1 Evaluate seismic forces for various structures as per relevant Indian standards
CO2 Design and draw detailing of structures for seismic resistance as per Indian standards
CO3 Apply concepts of repair and rehabilitation of earthquake affected structures
CO4 Understand the concept of ductility Provision in R.C Buildings
CO5 Design steel and timber structures

Detailed Syllabus:

UNIT-I **(10hrs)**

Earthquakes and Ground Motion: Causes and Consequences of Earthquakes, Seismic Waves, Measurement of Ground Motion, Seismic Zoning. Introduction to Dynamics of Structures and Seismic Response: Modelling of Structures, Equation of Motion, Dynamic/Seismic Response of SDOF Structures, Systems with Multi-Degree of Freedom Systems, Periods and Modes of MDOF Systems; Elastic, Inelastic and Design Spectra, Damping.

UNIT-II **(12hrs)**

Earthquake Resistant Planning and Design of Buildings: Functional Planning: Simplicity and Symmetry, Stiffness and Strength, Twisting of Building, Ductility Provisions, Framing Systems, Introduction to IS Codes, Philosophy of Design: Seismic Co-efficient Method, Response Spectrum Method, Introduction to Time- History Method.

UNIT-III **(8hrs)**

Seismic Isolators. Seismic Design of Masonry Buildings: Box Action and Provision of Bands, Restoration and Strengthening Methods. Seismic Design of RC Buildings: Soft and Weak Storeys, Vertical and Horizontal Irregularities, Reinforcement Detailing Requirements.

UNIT-IV **(6hrs)**

Ductility Provision in R.C Buildings, Confining Reinforcements, Design Example, Frame Members Subjected to Bending and Axial Loads.

UNIT-V **(8hrs)**

Design of steel and timber structures. Design considerations for building appurtenance

Text Books:

1. Elements of Earthquake Engineering: Jai Krishna, A.R. Chandrashekaran, Brajesh Chandra, South Asian Publishers Pvt. Ltd., New Delhi
2. Earthquake Resistant Design of Structures: S.K.Dugal, Oxford University Press, New Delhi

References:

1. Earthquake Resistant Design of Structures, P.Agarwal and M. Shrikhande, Prentice Hall, New Delhi.
2. Dynamics of Structures: A.K. Chopra, Prentice hall, Englewood cliffs, New Jersey.
3. Limit State Design of Steel Structures, S K Duggal, Tata Mc Graw Hill, New Delhi.
4. ***S. L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall International Series in Civil Engineering and Engineering Mechanics.***

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Course Code	CE613	Course Title	Computer Aided Design of Structures						
LTP	0 0 2	Credit	1	Subject Category	DC	Year	1	Semester	II

Course Outcome
At the end of the course, the student will be able to
CO1 Design all structural components of framed buildings.
CO2 Draw reinforcement detailing.

List of Experiments/Assignments:
STAAD Pro, ETABS, SAP2000 softwares will be used for the following problems:

1. Analysis and Design of (G+3) residential apartments, reinforcement detailing.
2. Analysis and Design of (G+12) shopping complex, reinforcement detailing.

School of Engineering & Technology (Civil Engineering)
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Course Code	CE614	Course Title	Stability of Structures						
LTP	4 0 0	Credit	4	Subject Category	*DC*	Year	1	Semester	I

Prerequisite: Student should have attended course in structural analysis.
Course Objective: The objective of the course is to provide basics involved in stability of structures.

Course Outcome:
At the end of the course, the student will be able to
CO1 Understand Criteria for Design of Structures
CO2 Understand concept behind Stability of columns and beams
CO3 Perform Mathematical Treatment of Stability Problems
CO4 Understand Torsional Buckling
CO5 Understand Lateral Buckling of Simply Supported Beams

Detailed Syllabus:

UNIT-I **(12 hrs)**

Criteria for Design of Structures: Stability, Strength and Stiffness, Classical concept of stability of discrete and continuous Systems. Linear and non-linear behaviour. Beam Columns: Differential equation for beam columns - Beam column with concentrated loads - Continuous lateral load - Couples - Beam column with built in ends - Continuous beams with axial load.

UNIT-II **(12 hrs)**

Stability of columns and beams: Elastic Buckling of Bars: Elastic buckling of straight columns - Effect of shear stress on buckling - Eccentrically and laterally loaded columns - Energy methods - 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. Inelastic Buckling: Buckling of straight bars-Double modulus theory-Tangent modulus theory. **UNIT-III (6 hrs)**

Mathematical Treatment of Stability Problems: Buckling problem - Orthogonality relation-Ritz method-Timoshenko method and Galerkin method

UNIT-IV **(8 hrs)**

Torsional Buckling: Pure torsion of thin walled bar of open cross section - Non-uniform torsion of thin walled bars of open cross section- buckling by Torsion and Flexure.

UNIT-V **(8 hrs)**

Lateral Buckling of Simply Supported Beams: Beams of rectangular cross section subjected to pure bending. Buckling of Simply Supported Rectangular Plates: Derivation of equation of plate subjected to constant compression in two directions and one direction, finite element method.

Text Books:

1. Stephen P. Timoshenko and James M. Gere., ― Theory of Elastic Stability, McGraw Hill Book company.

References:

1. Blunch- ―Stability of Metallic Structure, Mc Graw Hill.
2. Chem. &Atsute ―Theory of Beam Columns, Vol I Mc Graw Hill.
3. Smitses, ― Elastic Stability of Structures‖, Prentice Hall.
4. Brush and Almorth, ―Buckling of Bars, Plates and Shells , Mc Graw Hill book company.
5. Chajes,A., ― Principles of Structural Stability Theory, Prentice Hall.
6. Ashwini Kumar, ― Stability theory of Structures , Tata Mc Graw Hill Publishing company Ltd, New Delhi.
7. Bleaigh― Elastic Stability, Tata Mc Graw Hill Publishing Company Ltd, New Delhi.

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Course Code	CE655	Course Title	Advanced Foundation Design						
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	II

Course Objectives: To understand the concepts of bearing capacity of soil so as to have deeper understanding in the design of foundations

Course Outcomes:
At the end of the course, the student will be able to
CO1 Understand the concept of evaluation of bearing capacity for shallow foundations
CO2 Evaluate the load carrying capacity of pile and well foundations
CO3 Perform geotechnical analysis of machine foundations
CO4 Understand the concept of liquefaction of soils
CO5 Understand Geotechnical aspects in Earthquake Engineering

Detailed Syllabus:

UNIT-I **(08 hrs)**

Shallow foundations: Terzaghi's bearing capacity equation, General bearing capacity equation, Meyerhof's Vesic theory, Effect of water table, Special footing problems, I.S. Codes, Footing pressure for settlement on sand, Soil pressure at a depth, Boussineq's & Westergaard's methods, Computation of settlements, Inclined and Eccentric Loads.

UNIT-II **(10 hrs)**

Pile foundations: Timber, Concrete, Steel piles, Estimating pile capacity by dynamic formula, by wave equation and by static methods, Point bearing piles, Pile load tests, Negative skin friction, Modulus of sub-grade reaction for laterally loaded piles, Lateral resistance, Pile group considerations, Efficiency, Stresses on underlying strata, Settlement of pile groups, Pile caps, Batter piles, Approximate and Exact analysis of pile groups, I.S. Codes.

UNIT-III **(8 hrs)**

Well Foundations: Types (open end, closed or box, Pneumatic, Drilled), Shapes, Bearing capacity and settlements, Determination of grip length by dimensional analysis, Stability of well foundations by IRC Method, Construction, Tilts & shifts.

UNIT-IV **(6 hrs)**

Machine Foundations: Types, Analysis and design by Barkans method, Determination of coefficient of uniform elastic compression, and Design of a machine foundation, I.S. Method of design.

UNIT-V **(8 hrs)**

Introduction to Geotechnical Earthquake Engineering: Ground Shaking, Liquefaction, Evaluation, Mechanism, Effects of liquefaction. Sheet pile Structures: Types, Cantilever, Anchored sheet, Design by free earth & fixed earth method, Anchored braced sheeting, Cofferdams, Stability of cellular cofferdam, Instability due to heave of bottom.

Text Books:

1. Bowles, Joseph E. , Foundation Analysis and Design, Tata McGraw Hill (2001).
2. Coduto, Donald P., Foundation Design: Principles and Practice, Prentice Hall (2001).
3. Dass, B. M. , Principles of Foundation Engineering, Thomson Learning (2006).

References:

1. Kramer, Steven L., Geotechnical Earthquake Engineering, Pearson Education (2003).
2. Murthy, V.N.S., Advanced Foundation Engineering, C.B.S. Publishers (2007).
3. ***S. L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall International Series in Civil Engineering and Engineering Mechanics.***

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE664	Course Title	Design of Advanced Bridges					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	II

Prerequisite: Student should have attended course on concrete structures at UG level.

Course Objective: The objective of the course is to provide basics in design of bridge structures.

Course Outcome:

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

CO1 Discuss the IRC standard live loads and design the deck slab type bridges.

CO2 Analyse the box culverts for the given loading and detail the box culverts.

CO3 Design T-Beam bridges.

CO4 Understand the stability of piers and abutments.

CO5 Explain the construction of construction joints

Detailed syllabus:

Unit-I **(8 Hrs)**

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project. Site investigation and planning, Scour - factors affecting and evaluation.

Unit-II **(12 Hrs)**

Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures; Superstructure - analysis and design of right, skew and curved slabs. Girder bridges - types, load distribution, design. Orthotropic plate analysis of bridge decks.

Unit-III **(10 Hrs)**

Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R. C. Bridges,

Unit-IV **(8 Hrs)**

Planning and design of flyovers bridges.

Unit-V **(12 Hrs)**

Prestressed concrete bridges and steel bridges Fabrication, Launching & creation. Design and construction of construction joints.

Text Books:

1. D. J. Victor, Essentials of Bridge Engineering, Oxford IBH, 1980.
2. V. K. Raina, Concrete Bridge Practice Analysis Design and Economics, Tata McGraw Hill, 2nd Ed, 1994.
3. ***Indian Standard Codes: IRC:5, IRC:6, IRC:21, SP:16***

References:

1. N. Rajagopalan, Bridge Superstructure, Narosa Publishing House, 2006.
2. W. F. Chen and L. Duan, Bridge Engineering Handbook, CRC press, 2003.
3. B. Bakht and L.G. Jaeger, Bridge Analysis Simplified, McGraw Hill, 1987.
4. E. J. O'Brien, and D. L. Keogh, Bridge Deck Analysis, Taylor and Francis, 1999.
5. H. Eggert and W. Kauschke, Structural Bearings, Ernst &Sohn, 2002.
6. T. Y. Lin and N. H. Burns, Design of Prestressed Concrete Structures, John Wiley and Sons, 1981.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	**CE610**	**Course Title**	Advanced Steel Design						
LTP	**4 0 0**	**Credit**	**4**	**Subject Category**	***DC***	**Year**	**2**	**Semester**	**III**

Perquisites: Student should have attended course in steel structures at undergraduate level.

Course Objectives: To introduce method for design of steel structures with loading standards as per code provisions

Course Outcomes:
At the completion of this course, the student will be able to
CO1 Design plate girders.
CO2 Design various types of steel structures.
CO3 Design gantry girder.
CO4 Design a single-track railway bridge with lattice girders having parallel chords
CO5 Design steel chimney

Detailed Syllabus:

Unit I **(8 Hrs)**
Elements of a plate girder, design of a plate girder, curtailment of flanges, various type of stiffeners

Unit II **(10 Hrs)**
Design of steel foot bridge with parallel booms and carrying wooden decking, using welded joints.

Unit III **(12 Hrs)**
Complete design of an industrial shed including: i) Gantry girder ii) Column bracket iii) Mill bent with constant moment of inertia iv) Lateral and longitudinal bracing for column bent

Unit IV **(12 Hrs)**
Design of single-track railway bridge with lattice girders having parallel chords (for B.G.) i) Stringer ii) Cross girder iii) Main girders with welded joints iv) Portal sway bracings v) Bearing rocker and rollers.

Unit V **(6 Hrs)**
Introduction to design of various industrial steel structure, Design of steel chimney.

Text Books:
1. Limit state design of steel structures: S K Duggal
2. Design of steel structures: N Subramanian
3. ***Indian Standard Codes: IS: 800***

References:
1. Design of steel structures (Vol. 2): Ram Chandra
2. Design of steel structures: L S Negi
3. Design of steel structures (by limit state method as per IS: 800-2007): S S Bhavikatti

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE605	Course Title	Finite Element Analysis					
LTP	4 0 0	Credit	4	Subject Category	DC	Year	1	Semester	II

Course Outcome

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

1. Students will be able to identify mathematical models for the solution of common Engineering problems, formulate simple problems into finite elements, derive element matrix equations by different methods.

Detailed Syllabus:

UNIT- I **(10hrs)**

Introduction, General description of method, FEM vs Classical method, need for studying FEM, Basic equation of elasticity, Equation of equilibrium, strain displacement equations, Linear constitutive laws

UNIT- II **(08 hrs)**

Finite element analysis of bar and trusses, Matrix displacement equations, Solution of Matrix displacement equations

UNIT III **(12 hrs)**

Element- 1,2,3 dimensional, shapes- triangular, rectangular, tetrahedral, nodes, nodal unknowns and coordinate systems- global, local and natural, Discretization of structure, refining mesh, higher order element vs mesh refinement.

UNIT IV **(10 hrs)**

Shape functions, polynomial shape functions, finding shape functions using polynomials and Lagrange polynomials

UNIT V **(12 hrs)**

Finite element analysis of plane stress and plane strain problems, Isoparamatric formulation, Non-plinear analysis.

Text Books:

1. Finite Element analysis: S.S. Bhavikatti, New Age International Publishers
2. Introduction to Finite Elements in Engineering: T.R. Chandrupatla and A.D. Belegundu, Prentice Hall Publishers

Reference books:

1. Finite Element Structural Analysis: T.Y.Yang
2. Concepts and applications of Finite Element Analysis: Robert D. Cook.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE704	Course Title	Research Methodology and IPR					
LTP	2 0 0	Credit	2	Subject Category	DC	Year	2	Semester	III

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

1. Understand research problem formulation
2. Analyse research related information
3. Follow research ethics
4. Understand that today's world is controlled by computer, information technology, but tomorrow world will be ruled by ideas, concept and creativity.
5. Understand that when IPR would take such important place in growth of individuals and nation, it is needless to emphasise the need of information about intellectual property right to be promoted among students in general and engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R&D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Detailed Syllabus:

UNIT I **(12 hrs)**
RESEARCH PROBLEM AND SCOPE FOR SOLUTION
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II **(10 hrs)**
FORMAT
Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT III **(8 hrs)**
PROCESS AND DEVELOPMENT
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT IV **(10 hrs)**
PATENT RIGHTS & NEW DEVELOPMENTS IN IPR
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

UNIT V- **(8 hrs)**

PUBLICATION ETHICS

Publication ethics: definition, introduction and importance. Best practices/standard setting initiatives and guidelines: COPE, WAME. Conflict of interest. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.

Text books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

References:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE651	Course Title	Structural Health Monitoring					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	I

Prerequisite: Student should have attended course on concrete and steel structures.
Course Objective: The objective of the course is to provide details of techniques for health monitoring of structures.
Detailed Syllabus:

UNIT-I **(10 hrs)**
Concept of structural health monitoring, sensor systems and hardware requirements, global and local techniques,

UNIT-II **(8 hrs)**
Computational aspects of global dynamic techniques, experimental mode shapes, Damage localization and quantification

UNIT-III **(8 hrs)**
Piezo-electric materials and other smart materials, Electro-mechanical impedance (EMI) technique, low cost adaptations

UNIT-IV **(16 hrs)**
Fatigue life assessment, Integration of global and EMI techniques, Shear lag models.

UNIT-V **(6 hrs)**
Recent case studies in field of structural health monitoring. Introduction to data accusation, refinement and its application.

Course Outcome: The objective of the course is
CO1 To provide details of techniques used for health monitoring of structures.

Reference Books:
1. Ewins, D. J. (2000), Modal Testing: Theory, Practice and Applications, 2nd edition, Research Studies Press Ltd., Baldock.
2.Inman, D. J., Farrar, C.R., Steffan, V. and Lopes, V. (2005), Damage Prognosis -For Aerospace, Civil and Mechanical Systems, John Wiley & Sons, Ltd., Chichester, UK.
3.Soh, C. K, Yang Y. W. and Bhalla S. (2011), Smart Materials in Structural Health Monitoring, Control and Bio – mechanics, Springer.
4.Hixon, E.L. (1988), ―Mechanical Impedance‖, Shock and Vibration Handbook, edited by C. M. Harris, 3rd ed., Mc Graw Hill Book Co., New York, pp. 10.1-10.46.
5.Ikeda, T. (1990), Fundamentals of Piezoelectricity, Oxford

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE652	Course Title	Theory of Plates and Shells					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	I

Prerequisite: Student should have attended course on structural analysis.
Course Objective: The objective of the course is to make the student learn basics of design of plate and shell structures.
Detailed Syllabus:
UNIT-I **(8hrs)**
Plate: Classification- Thin and thick plates, small and large deflections, Assumptions in theory of thin plates with small deflection, Governing Differential equation in Cartesian coordinates, moment curvature relations, stress resultants.
UNIT-II **(8hrs)**
Rectangular plates: Navier solution for plates with all edges simply supported, Distributes loads. Point loads, rectangular patch load, Green function, Rectangular plates: Levy's method, Distributed load, line load. Energy method: Minimum potential theorem Rayleigh-Ritz approach for simple cases.
UNIT-III **(8hrs)**
Circular Plates: Governing Differential equation in Polar coordinates, Axisymmetric situation, moment curvature relations, simply supported and fixes edge, distributes load, line load, linearly varying load.
UNIT-IV **(10hrs)**
Introduction to thin shell theory, classification on shell geometry, equation to shell surfaces, stress resultants, stress- displacement relations, compatibility Conditions, equilibrium equations, Circular cylindrical shells: Membranes theory, Bending theory for circular-cylindrical shell, design procedure.
UNIT-V **(10hrs)**
Shells of revolution: membrane theory, spherical and conical shells with axisymmetric loading, Simple methods of analysis and design for conoidal and hyperbolic paraboloidal shells.
Course Outcome:
The students will be able to:
CO1 understand the equilibrium theories for analysis of plates and shell structures in civil engineering applications
CO2 perform critical analysis and design of typical shell structures
CO3 understand various methods for analyzing grids for roofs and bridges.

Reference Books:
1. S. P. Timoshemkoo & W. Kriger: Theory of Plates and Shells
2. Jaeger: Theory of Plates
3. Szilard: Theory and Analysis of Plates
4. Flugge: Analysis of Shells
5. G. Ramaswami: Theory and Design of RC Shells

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE653	Course Title	Advanced Prestressed Concrete					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	I

Prerequisite: Student should have attended course on concrete structures.
Course Objective: The objective of the course is to make the student learn basics and design of prestressed concrete and industrial structures.
Detailed Syllabus:

UNIT-I **(10 hrs)**

Anchorage Zone Stresses In Post-Tensioned Members: Introduction to PSC, stress distribution in end block, investigations on anchorage zone stresses, Magnel and Guyon's methods, Comparative analysis, anchorage zone reinforcement. Shear and Torsional Resistance: Shear and principal stresses, ultimate shear resistance, design of shear reinforcement, torsion, design of reinforcement for torsion.

UNIT-II **(12 hrs)**

Composite Beams: Introduction, types of composite beams, analysis for stresses, differential shrinkage, serviceability limit state. Design for flexural and shear strength. Type II and Type III beam, fixed beam, portal frame.

UNIT-III **(10 hrs)**

Tension Members: Introduction, ties, pressure pipes – fabrication process, analysis, design and specifications. Cylindrical containers - construction techniques, analysis, design and specifications.

UNIT-IV **(10 hrs)**

Compression Members: Introduction, columns, short columns, long columns, bi-axially loaded columns, prestressed concrete piles. Slab and Grid Floors: Types of floor slabs, design of one way, two way and flat slabs. Distribution of prestressing tendons, analysis and design of grid floors.

UNIT-V **(10 hrs)**

Precast Elements: Introduction, prestressed concrete poles, manufacturing techniques, shapes and cross sectional properties, design loads, design principles. Railway sleepers classification and manufacturing techniques, design loads, analysis and design principles. Precast bridge girders and segmental constructions. External prestressing.

Course Outcome: It is expected that the Student will able
CO1 to analyse prestressed concrete structures behaviour and design.

Reference Books:

1. Lin T.Y. and H. Burns, Design of Prestressed concrete structures - - John Wiley &Sons, 1982.
2. N. Krishna Raju, Prestressed Concrete- - Tata McGraw-Hill, 3rd edition, 1995.
3. P. Dayaratnam, Prestressed Concrete Structures- - Oxford & IBH, 5th Edition, 1991.
4. G.S. Pandit and S.P. Gupta, Prestressed Concrete-– CBS Publishers, 1993.
5. Guyon, Prestressed concrete, Contractors Record Books, 19636. IS: 1343:1980.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE654	Course Title	Advanced Foundation Design					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	II

Course Objectives: To understand the concepts of bearing capacity of soil so as to have deeper understanding in the design of foundations

Detailed Syllabus:

UNIT-I **(08 hrs)**

Shallow foundations: Terzaghi's bearing capacity equation, General bearing capacity equation, Meyerhof's Vesic theory, Effect of water table, Special footing problems, I.S. Codes, Footing pressure for settlement on sand, Soil pressure at a depth, Boussineq's & Westergaard's methods, Computation of settlements, Inclined and Eccentric Loads.

UNIT-II **(10 hrs)**

Pile foundations: Timber, Concrete, Steel piles, Estimating pile capacity by dynamic formula, by wave equation and by static methods, Point bearing piles, Pile load tests, Negative skin friction, Modulus of sub-grade reaction for laterally loaded piles, Lateral resistance, Pile group considerations, Efficiency, Stresses on underlying strata, Settlement of pile groups, Pile caps, Batter piles, Approximate and Exact analysis of pile groups, I.S. Codes.

UNIT-III **(8 hrs)**

Well Foundations: Types (open end, closed or box, Pneumatic, Drilled), Shapes, Bearing capacity and settlements, Determination of grip length by dimensional analysis, Stability of well foundations by IRC Method, Construction, Tilts & shifts.

UNIT-IV **(6 hrs)**

Machine Foundations: Types, Analysis and design by Barkans method, Determination of coefficient of uniform elastic compression, and Design of a machine foundation, I.S. Method of design.

UNIT-V **(8 hrs)**

Introduction to Geotechnical Earthquake Engineering: Ground Shaking, Liquefaction, Evaluation, Mechanism, Effects of liquefaction. Sheet pile Structures: Types, Cantilever, Anchored sheet, Design by free earth & fixed earth method, Anchored braced sheeting, Cofferdams, Stability of cellular cofferdam, Instability due to heave of bottom.

Course Outcomes:

The students will be able to:

CO1 understand the concept of evaluation of bearing capacity for shallow foundations

CO2 evaluate the load carrying capacity of pile and well foundations

CO3 perform geotechnical analysis of machine foundations • understand the concept of liquefaction of soils

Text Books:

1. Bowles, Joseph E. , Foundation Analysis and Design, Tata McGraw Hill (2001).
2. Coduto, Donald P., Foundation Design: Principles and Practice, Prentice Hall (2001).
3. Dass, B. M. , Principles of Foundation Engineering, Thomson Learning (2006).

Reference Books:

1. Kramer, Steven L., Geotechnical Earthquake Engineering, Pearson Education (2003).
2. Murthy, V.N.S., Advanced Foundation Engineering, C.B.S. Publishers (2007).

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE655	Course Title	Optimization in Structural Design					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	II

Course Objective: To study the fundamentals of simulation as applicable in Civil Engineering structures.

Detailed Syllabus

UNIT-I **(08 hrs)**

Introduction to optimization: Introduction - Historical developments – Engineering applications of optimization - classification of optimization problems - Optimization Techniques. Optimization by calculus - treatment of equality constraints _ Extension to multiple equality constraints - Optimization with inequality constraints - The generalized Newton-Raphson method.

UNIT-II **(12 hrs)**

Linear Programming: Introduction - Applications - standard form of a linear programming- Geometry of linear programming problems - Solution of a system of Linear simultaneous equations - pivotal reduction of a general system of equations - Motivation of the simplex Method - simplex Algorithm

UNIT-III **(12 hrs)**

Non-Linear Programming: Introduction - Unimoial Function - unrestricted search - Exhaustive search - Dichotomous search - Interval Halving method _ Fibonacci method - Golden section method - comparison of elimination methods _ Unconstrained optimization techniques - Direct search methods - Random search methods _ grid search method - Univariate method - Powell's method - simplex method – Indirect search methods - Gradient of a function - steepest descent method - conjugate gradient - Newton's method.

UNIT-IV **(10 hrs)**

Dynamic Programming: Introduction - Multistage decision processes - concept of suboptimization and the principle of optimality - computational procedure in dynamic programming - example illustrating the Calculus method of solution - example illustrating the tabular of solution - conversion of a final value problem into an initial value problem - continuous dynamic programmin.

UNIT-V **(10 hrs)**

Network Analysis: introduction - Elementary graph theory - Network variables and problem types - Minimum-cost route - Network capacity problems - Modification of the directional sense of the network - Application of optimization techniques to Trusses, Beams and Frames.

Course Outcome:

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

CO1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.

Text Books:

1. Optimization: Theory and Applications by S.S. Rao
2. Numerical optimization Techniques for Engineering Design with applications by G.N.Vanderplaats.

References:

1. Elements of Structural Optimization by R.T.Haftka and Z.curdal.
2. Optimum Structural Design by U.Kirsch.
3. Optimum Design of Structures by K.l.Majid.

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE656	Course Title	Advanced Mechanics of Composite Materials					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	2	Semester	III

Course Objective

The Objective of this course is to train a post graduate student for analysis and design of composite material.

Detailed Syllabus

UNIT – I BASIC CONCEPTS AND CHARACTERISTICS: (6 Hrs)

Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosets, Metal matrix and ceramic composites.

UNIT – II MICROMECHANICS: (10 Hrs)

Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties. Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

UNIT – III COORDINATE TRANSFORMATION: (12 Hrs)

Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance. Elastic behavior of unidirectional composites: Elastic constants of lamina, relation ship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

UNIT – IV STRENGTH OF UNIDIRECTIONAL LAMINA: (8 Hrs)

Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micros mechanical predictions of elastic constants.

UNIT – V ANALYSIS OF LAMINATED COMPOSITE PLATES: (4 Hrs)

Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

Course Outcome:

At the end of this course, the student can-

CO1 Understand the basic concept and characteristics of composite materials.

CO2 Apply the micromachines in analysis and design of composited

CO3 Understand the strength and application of laminated plates

Reference Books:

1. Mechanics of Composite Materials/ R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
3. Analysis and performance of fibre Composites/ B. D. Agarwal and L. J. Broutman/ Wiley-Interscience, New York, 1980.
4. Mechanics of Composite Materials/ Second Edition (Mechanical Engineering)/ Autar K. Kaw ,Publisher: CRC
5. Analysis of Laminated Composite Structures/ L. R. Calcote/ Van Nostrand Rainfold, New York, 1969.
6. Advanced Mechanics of Composite Materials/ Vasiliev &Morozov/Elsevier/Second Edition

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE751	Course Title	Sustainable Materials and Green Buildings					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	II

Course Objective:
The objective of this course is to expose the students to the concepts of sustainability in the context of building and conventional engineered building materials, such as Concrete, Bricks, and achieving the same through lower Carbon cements, Superior brick kilns and Recycled aggregate minimizing consumption of natural resources including water. VOC and indoor air quality. Exposing the student to concepts of embodied, Operational and Life Cycle Energy, Minimizing Energy consumption by optimal design, use of BIPV. The course also intend to make student aware of ECBC, LEED, GRIHA etc.

Detailed syllabus:

Unit I **(12 Hrs)**

Introduction, Embodied energy, Operational energy in Building and Life cycle energy. Ecological foot print, Bio-capacity and calculation of planet equivalent, Role of Material: Carbon from Cement, alternative cements and cementitious material, Alternative fuel for cements for reduction in carbon emission. Sustainability issues for concrete

Unit II **(10 Hrs)**

Role of quality, minimization of natural resource utilization, High volume fly ash concrete, geo-polymer concrete etc. concrete with alternative material for sustainability, Reduction in water consumption in concrete, Recycled aggregate, Energy for grinding crushing of cement aggregate etc. and reduction.

Unit III **(10 Hrs)**

Operational energy in building role of materials and thermal conductivity Week 6: Clay Bricks, Types kilns, Comparative energy performance emission performance and financial performance, Indoor air quality

Unit IV **(10Hrs)**

Paints, Adhesive and sealants for use in building, Volatile organic content (VOC) emission issues and indoor air quality for Sustainability and Health hazard Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm Radiation budget, Surface water balance, Effects of trees and microclimatic modification through greening,

Unit V **(8 Hrs)**

Use of Building Integrated Photo Voltaic (BIPV) and other renewable energy in buildings, basic concepts and efficiency, Energy codes ECBC requirement, Concepts of OTTV etc, Green Performance rating, requirements of LEED, GRIHA etc.

Course Outcome:

At the end of this course, the student can-

CO1 Understand the concepts of sustainability in the context of building and conventional engineered building materials, such as Concrete, Bricks, and achieving the same through lower Carbon cements.

Reference Books:

1. Handbook of Green Building Design and Construction, Sam Kubba 2012
2. Sustainability, Energy and Architecture. Ali Sayigh 2013

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	**CE752**	**Course Title**	Soil Structure Interaction						
LTP	**4 0 0**	**Credit**	**4**	**Subject Category**	**DE**	**Year**	**1**	**Semester**	**II**

Course Objective: The aim of the course is to provide the students an understanding of effectively simulating the soil structure interaction problems using computer application and realistic material models.

Detailed Syllabus

UNIT-I **(12 hrs)**

Soil foundation Interaction: Introduction to soil foundation interaction problems, soil behaviour, foundation behaviour, interface behaviour, scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, two parameter elastic model, Elastic Plastic behaviour, Time dependent behaviour.

UNIT- II **(10 hrs)**

Beam on Elastic foundation-soil models:

Infinite beam, two parameters, Isotropic elastic half space, analysis of beams of finite length, classification of finite beams in relation to their stiffness.

UNIT- III **(10 hrs)**

Plate on Elastic medium:

Infinite plate, Winkler, two parameters, isotropic elastic medium, thin and thick plates, analysis of finite plates: rectangular and circular plates, Numerical analysis of finite plates, simple solutions.

UNIT- IV **(10 hrs)**

Elastic analysis of piles:

Elastic analysis of single pile, theoretical solutions for settlement and load distributions, analysis of pile group, interaction analysis, load distribution in groups with rigid cap.

UNIT- V **(10 hrs)**

Laterally loaded pile:

Load deflection prediction for laterally loaded piles, sub-grade reaction and elastic analysis, interaction analysis, pile raft system, solution through influence charts.

Course Outcome:

At the end of the course, the student can :

CO1. At the end of the course students are expected to learn basics of finite difference and finite element analysis and realistic material models for structural materials, soils and interface.

Text Books:

1. Elastic analysis of soil foundation interaction By Selva durai, A.P.S.
2. Pile Foundation Analysis and Design By Poulos, H.G. & Davis E.H.
3. Foundation Analysis By Scott, R.F.
4. Structure Soil Interaction- State of Art Report, Institution of Structural Engineers, 1978, Geotechnical Earthquake Engineering By Kramer, S.L

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE753	Course Title	Advanced Reinforced Concrete Design					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	1	Semester	II

Prerequisite: Student should have attended course on structural analysis.
Course Objectives: To develop the conceptual understanding of the advanced concrete design
Detailed Syllabus:

UNIT-I **(12 hrs)**

Basic Design Concepts: 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 Frame Analysis and Design, Static and dynamic loading of structures.

UNIT-II **(10 hrs)**

Inelastic Behaviour of Concrete Beams, Moment curvature relationship – plastic hinge formation-moment redistribution in continuous beams. Deep Beams and Corbels, Strut and tie method of analysis for corbels and deep beams, Design of corbels, Design of deep beams.

UNIT-III **(8 hrs)**

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.

UNIT-IV **(6 hrs)**

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

UNIT-V **(10 hrs)**

Shear Wall, Analysis and design of shear wall framed buildings 8 Lecture 8. Design of water tank, bunkers and silos.

Course Outcome:
At the end of course, the students are able to-
CO1 Analyse and design the deep beams
CO2 Design shears wall buildings and flat slabs
CO3 Design slender columns, Design of water tanks, bunkers and silos

Text Books:

1. Subramanian. N., (2013), Design of Reinforced Concrete Structures, Oxford University Press, New Delhi.
2. Gambhir.M.L., (2012),Design of Reinforced Concrete Structures, Prentice Hall of India, New Delhi.
3. 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

School of Engineering & Technology (Civil Engineering)
Course Structure & Syllabus for M.Tech. in Civil Engineering (Structural Engineering)Batch: 2022-24

Course Code	CE756	Course Title	Nonlinear Structural Analysis					
LTP	4 0 0	Credit	4	Subject Category	DE	Year	2	Semester	III

Pre-requisite: Basic knowledge of linear structural analysis course.

Course Objective
To understand nonlinear structural behavior and apply knowledge for analysis.

Course Outcome
At the end of this course, the students will be able to
CO1 Understand the importance and use of structural nonlinearity.
CO2 Analyse distributed nonlinearity models
CO3 Understand geometrically nonlinear analysis.
CO4 Perform Nonlinear structural dynamic analysis
CO5 Understand application to hybrid simulation

Detailed Syllabus

Unit-I (10 Hrs)
Introduction to nonlinear structural analysis; Overview, Sources of nonlinearities, types of structural analysis (1st order elastic, 1st order inelastic, 2nd order elastic, and 2nd order inelastic), overview of solution strategies for nonlinear structures Principles of computational plasticity; overview, yield criterion, flow rule, hardening rule, loading/unloading criterion. Some commonly used uniaxial material models; elastic material, elastic-perfectly plastic material, bilinear steel material with kinematic and isotropic hardening, Ramberg-Osgood steel material model, Giuffre-Menegotto-Pinto model with isotropic strain hardening, Kent-Scott-Park concrete material model, Visco-elastic material model, Bouc-Wen model.

Unit-II (12 Hrs)
Member section analysis; fiber section discretization; moment-curvature response; force-deformation response; Material nonlinear beam-column element formulation; lumped plasticity models (beam with hinges formulation), distributed nonlinearity models; displacement-based nonlinear beam-column element; force-based nonlinear beam-column element.

Unit-III (8 Hrs)
Geometrically nonlinear analysis; simplified 2nd order P-Δ analysis, co-rotational formulations of truss and beam elements.

Unit-IV (10 Hrs)
Solution strategies for nonlinear system of equations; incremental single-step methods; Euler method, second-order Runge-Kutta methods, incremental-iterative methods, load control, displacement control, work control, arc-length control; Nonlinear structural dynamic analysis; semi-discrete equations, of motion, explicit time integration, implicit time integration, dissipative integration algorithms, stability and accuracy.

Unit-V (8 Hrs)
Application to hybrid simulation; overview, sub-structuring in hybrid simulation; application to modeling analytical substructures, solution of time discretized equations of motion

Text Books:

1. Bassam A. Izzuddin ―Nonlinear Structural Analysis for Engineers‖, CRC Press, New Delhi, 2013.
2. Leszek Gasinski, Nikolaos S. Papageorgiou ―Nonlinear Analysis‖ Chapman and Hall/CRC, New Delhi, 2005.

References:

1. Crisfield M.A., (1983), 'A fast incremental / iterative solution procedure that handles
2. snap-through', Computers And Structures, 13:55–62
3. Overvelde JTB, Kloek T, D'haen JJA, Bertoldi K., (2015), 'Amplifying the response ofsoft actuators by harnessing snap-through instabilities', The Proceedings of the National Academy ofSciences of the United States of America,112:10863-10868

Riks E. (1979), 'An incremental approach to the solution to the solution of buckling an snapping problems', Int. J. Solids Struct., 15:524–551