ANNA UNIVERSITY, CHENNAI

NON- AUTONOMOUS COLLEGES

AFFILIATED TO ANNA UNIVERSITY

M.E. STRUCTURAL ENGINEERING

REGULATIONS 2025

PROGRAMME OUTCOMES (POs):

PO	PROGRAMME OUTCOMES
1	An ability to independently carry out research/investigation and development work to solve practical problems.
2	An ability to write and present a substantial technical report/document.
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.

PSO	PROGRAMME SPECIFIC OUTCOMES
1	Critically analyze the complex structural engineering problems by applying advanced structural design principles and modern tools to develop sustainable and resilient structures.
2	Engage in research, innovation, and lifelong learning to address complex structural engineering challenges, contribute to industry/ academia, and uphold professional and ethical practices.

ANNA UNIVERSITY, CHENNAI

POSTGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E. Structural Engineering **Regulations:** 2025

Abbreviations:

BS – Basic Science (Mathematics)

ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**)

SL – Self Learning

TCP – Total Contact Period(s)

L – Laboratory Course

T – Theory

LIT – Laboratory Integrated Theory

Semester I										
S. No.	**Course Code**	**Course Title**	**Type**	**Periods per week**			**TCP**	**Credits**	**Category**
				L	**T**	**P**			
1.	MA25C04	Probability, Statistics and Tensor Methods	T	3	0	0	3	3	BS
2.	ST25101	Theory of Elasticity and Plasticity	T	3	0	0	3	3	ES(PC)
3.	ST25102	Structural Dynamics and Earthquake Engineering	T	3	1	0	4	4	ES(PC)
4.	ST25103	Advanced Concrete Structures	T	3	0	0	3	3	ES(PC)
5.	ST25C01	Advanced Construction Engineering and Experimental Techniques Laboratory	L	0	0	4	4	2	ES(PC)
6.	ST25104	Technical Seminar	L	0	0	2	2	1	SD
						TOTAL	**19**	**16**	

Semester - II									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	ST25201	Advanced Steel Structures	T	3	0	0	3	3	ES (PC)
2.	ST25202	Advanced Prestressed Concrete	T	3	0	0	3	3	ES (PC)
3.	ST25203	Finite Element Analysis in Structural Engineering	LIT	3	0	2	5	4	ES (PC)
4.		Programme Elective I	T	3	0	0	3	3	ES (PE)
5.		Industry Oriented Course I	---	1	0	0	1	1	SD
6.	ST25204	Structural Design Studio	L	0	0	4	4	2	ES (PC)
7.		Self Learning Course	---	-	-	-	-	1	-
						Total	**19**	**17**	

Semester - III									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Programme Elective II	T	3	0	0	3	3	ES (PE)
2.		Programme Elective III	T	3	0	0	3	3	ES (PE)
3.		Programme Elective IV	T	3	0	0	3	3	ES (PE)
4.		Programme Elective V	T	3	0	0	3	3	ES (PE)
5.		Industry Oriented Course II	---	0	0	2	1	1	SD
6.	ST25301	Practical Training (4 Weeks)	L	0	0	0	0	2	SD
7.	ST25302	Project Work I	L	0	0	12	12	6	SD
						Total	**25**	**21**	

Semester - IV									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	ST25401	Project Work II	---	0	0	24	24	12	SD
						Total	**24**	**12**	

PROGRAMME ELECTIVE COURSES (PE)

S. No.	Course Code	Course Title	Periods			Total Contact Periods	Credits
			L	T	P		
1.	ST25001	Non-linear Analysis of Structures	3	0	0	3	3
2.	ST25002	Stability of structures	3	0	0	3	3
3.	ST25003	Wind and Cyclone Effects on Structures	3	0	0	3	3
4.	ST25004	Prefabricated Structures	3	0	0	3	3
5.	CN25C01	Advanced Concrete Technology	3	0	0	3	3
6.	ST25005	Reliability Analysis of Structures	3	0	0	3	3
7.	ST25006	Design of Formwork	3	0	0	3	3
8.	ST25C02	Maintenance, Repair and Rehabilitation of Structures	3	0	0	3	3
9.	ST25007	Fiber Reinforced Polymer Composite Materials	3	0	0	3	3
10.	ST25008	Design of Steel-Concrete Composite Structures	3	0	0	3	3
11.	ST25009	Design of Masonry Structures	3	0	0	3	3
12.	ST25010	Design of Industrial Structures	3	0	0	3	3
13.	ST25011	Advanced Design of Foundation Structures	3	0	0	3	3
14.	ST25012	Optimization Methods for Structural Engineering	3	0	0	3	3
15.	ST25013	Structural Health Monitoring	3	0	0	3	3
16.	ST25014	Design of Offshore Structures	3	0	0	3	3
17.	ST25015	Performance of Structures with Soil-Structure Interaction	3	0	0	3	3
18.	ST25016	Design of Bridge Structures	3	0	0	3	3
19.	ST25017	Design of Shell and Spatial Structures	3	0	0	3	3
20.	ST25018	Emerging Trends in Structural Engineering	3	0	0	3	3
21.	ST25019	Strategies for Sustainable Design	3	0	0	3	3

Semester I

MA25C04	Probability, Statistics and Tensor Methods	L	T	P	C
		3	0	0	3

Course Objectives:

- **Understand** the concepts of random variables, correlation, regression, multivariate analysis, and tensor analysis with relevance to engineering applications.
- **Apply** probabilistic and statistical methods to model, analyze, and interpret real-world civil engineering problems such as material strength, traffic flow, and structural reliability.
- **Develop** analytical and computational skills to use tensorial methods in stress-strain analysis and multivariate techniques for data-driven decision-making in civil engineering.

RANDOM VARIABLES: One-dimensional Random Variables, Moments and MGF, Binomial, Poisson, Geometric, Exponential and Normal distributions, Two-dimensional Random Variables, Marginal and Conditional distribution, Covariance and Correlation coefficient, Functions of one-dimensional and two-dimensional Random Variables.

Activities: Problem Solving on beams/columns Failure, Concrete strength Mixture,

CORRELATION AND REGRESSION: Multiple and partial correlation, Method of least squares, Plane of regression, Properties of residuals, Coefficient of multiple correlation, Coefficient of partial correlation, Multiple correlation with total and partial correlations, Regression and partial correlations in terms of lower order co - efficient.

Activities: Regression Analysis in Construction cost, review of competitive exam question papers.

MULTIVARIATE ANALYSIS: Random vectors and matrices, Mean vectors and covariance matrices, Multivariate normal density and its properties, Principal components: Population principal components, Principal components from standardized variables.

Activities: Covariance between rainfall at different stations, Random vector modeling in high-rise structures, Data reduction from satellite images.

Tensor Analysis : Concept of scalars, vectors, and higher-order tensors, Tensor Algebra, Contraction of indices, Symmetric and skew-symmetric tensors, Tensor Calculus: Transformation laws of tensors (Cartesian & curvilinear coordinates), Covariant and contravariant differentiation, Stress and Strain Tensors, Constitutive equations (Hooke's law in tensor form)

Activities: Stress analysis in 2D and 3D continua, Mohr's circle representation, Applications structural mechanics

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

References:

1. **Papoulis, A. & Pillai, S. U.** *Probability, Random Variables and Stochastic Processes*, McGraw Hill.
2. **Johnson, R. A. & Wichern, D. W.** *Applied Multivariate Statistical Analysis*, Pearson.
3. **Timoshenko, S. and Goodier, J.N.** *Theory of Elasticity*, McGraw Hill.
4. **Chadwick, P.** *Continuum Mechanics: Concise Theory and Problems*, Dover Publications

E-resources:

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-041-probabilistic-systems-analysis-and-applied-probability
2. https://nptel.ac.in/courses/111/105/111105041
3. https://www.colorado.edu/engineering/CAS/courses.d/IFEM.d/Tensor.d/Tensor.pdf

	Description of CO	PO	PSO1	PSO2
CO1	**Apply** probability distributions and random variable concepts to model engineering uncertainties.	PO1 (1) PO3 (3)	2	3
CO2	**Analyze** correlation and regression techniques for predictive modeling in civil engineering applications.	PO2 (1) PO3 (3)	1	3
CO3	**Interpret** multivariate data using covariance, correlation matrices, and principal component analysis.	PO1 (2) PO3 (3)	1	3
CO4	**Utilize** tensor analysis for stress-strain representation and elasticity problems in continuum mechanics.	PO1 (1) PO3 (3)	2	2

ST25101	Theory of Elasticity and Plasticity	L	T	P	C
		3	0	0	3

Course Objective: To develop the ability to use the principles of theory of elasticity in engineering problems and to introduce theoretical fundamentals of theory of plasticity.

Elasticity: Analysis of stress and strain, Equilibrium Equations, Compatibility Equations, Stress Strain Relationship. Constitutive Equations

Activity: Poster presentation on constitutive relationship of various materials

2D Stress Strain problems: Plane stress and plane strain, simple two-dimensional problems in cartesian and polar coordinates.

Activity: Problem solving assignment

Torsion of Non-Circular Section: St. Venant's approach, Prandtl's approach, Membrane analogy, Torsion of Thin Walled, Open and Closed sections, Design approach to open web section subjected to torsion, Introduction to Finite Difference Method

Activity: Case study assignments on torsion of sections

Beams on Elastic Foundations: Beams on Elastic foundation, Methods of analysis, Elastic line method, Idealization of soil medium, Winkler model, Infinite beams, Semi-infinite and finite beams, Rigid and flexible, Uniform Cross Section, Point load and UDL, Solution by Finite Differences.

Activity: Quiz on modeling and analysis of beams on elastic foundation

Plasticity: Physical Assumptions, Yield Criteria Failure Theories, Thick Cylinder, Plastic Stress Strain Relationship, Bending and Torsion in Elasto, Plastic Materials, Strain hardening of Materials, Flow hardening properties.

Activity: Review of competitive exam question papers (GATE, IES, etc)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Quiz - 10%
Assignment – 15%
Report preparation from Case study – 10%
Review of Question papers – 15%
Internal Examinations – 50%

References:

1. Ugural, A. C., & Fenster, S. K. (2003). *Advanced strength and applied elasticity*. Prentice Hall Professional Technical Reference.
2. Singh, S. *Elasticity, plasticity, and applied mechanics*.
3. Chakrabarty, J. (2007). *Theory of plasticity*. Elsevier Butterworth-Heinemann.
4. Helena, J. H. (2017). *Theory of elasticity and plasticity*. PHI.
5. Slater, R. A. C. (1977). *Engineering plasticity*. John Wiley and Sons.
6. Timoshenko, S., & Goodier, J. N. (2017). *Theory of elasticity*. McGraw Hill Book Co.

E - Resources

1. NPTEL - Theory of Elasticity, By Prof. Amit Shaw, Prof. Biswanath Banerjee, IIT Kharagpur. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-ce45/
2. NPTEL – Applied Elasticity for Engineers, By Dr. L. Govindaraju, Dr. T.G. Sitharam IISc Bangalore. https://archive.nptel.ac.in/courses/105/105/105105217/#
3. NPTEL – Course name: Advanced Foundation Engineering, Topic: Beams on Elastic Foundation, Dr. Kousik Deb, IIT Kharagpur, https://archive.nptel.ac.in/content/storage2/courses/105106049/lecnotes/mainch11.html

	CO Description	PO Mapping	PSO1	PSO2
CO1	Comprehend the stress, strain, equilibrium, compatibility, and constitutive relationships and apply these principles for linear elastic deformation in both Cartesian and polar coordinates.	PO1 (1) PO3 (3)	3	2
CO2	Analyze and differentiate between plane stress and plane strain conditions, and evaluate solutions to two-dimensional stress–strain problems under both Cartesian and polar coordinate systems.	PO2 (1) PO3 (3)	2	1
CO3	Evaluate the beams resting on elastic foundations, and create solutions for infinite, semi-infinite, and finite beams under point loads and distributed loads.	PO1 (2) PO3 (3)	2	2

ST25102	Structural Dynamics and Earthquake Engineering	L	T	P	C
		3	1	0	4

Course Objective: To make the students understand the basics of structural dynamics and earthquake engineering and to develop the ability to design an earthquake resistant structure.

Dynamic Response of Single Degree of Freedom Systems: Mathematical models of single degree of freedom systems - Free and forced vibration of SDOF systems, Response of SDOF to special forms of excitation, Effect of damping, Evaluation of damping, Transmissibility, Duhamel integral, Fourier transform of non-harmonic forces.

Activity: Case study assignment on DOF of real-time structures

Free Vibration of Multi-Degree of Freedom Systems: Mathematical models of two-degree of freedom systems and multi-degree of freedom systems, free vibrations, Damped and undamped systems, normal modes of vibration, orthogonality of normal modes, applications.

Activity: Review of competitive exam question papers (GATE, IES, etc)

Forced Vibration of Multi-Degree of Freedom Systems: Forced vibrations of multi-degree of freedom systems- damped and undamped, Rayleigh-Ritz method Mode superposition technique, vibration control, Tuned mass damper, Introduction to distributed mass system – Response spectrum analysis, Time-history analysis of structural systems.

Activity: Quiz on free and forced vibrations

Earthquake Ground Motion and Its Effects on Structures: Plate tectonics, Engineering Seismology- Seismic waves and characteristics, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation. Effect of Earthquake on Different Types of Structures - Lessons Learnt from Past Earthquakes - Seismic Zoning of India - Evaluation of Earthquake Forces as per codal provisions - Response Spectra, Design Spectra

Activity: Case study on failure of structures due to earthquake

Earthquake Resistant Design of Masonry and RC Structures: Structural Systems, Types of Buildings - Causes of damage, Planning Considerations, effect of material of construction on the performance of structures, Lateral load analysis of structures- Earthquake Resistant Design of structural and non-structural elements- Earthquake Resistant Design of Masonry Buildings and R.C.C. Buildings, Ductile detailing, Introduction to Capacity based Design.

Activity: Poster presentation on Earthquake Resistant Design of Masonry and RC Structures

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Quiz - 10%
Assignment – 15%
Report preparation from Case study – 10%
Review of Question papers – 15%
Internal Examinations – 50%

References:

1. Chopra, A. K. (2020). *Dynamics of structures*). Pearson Education.
2. Paz, M. (2006). *Structural dynamics: Theory and computation*. Kluwer Academic Publishers.
3. Craig, R. R., Jr., & Kurdila, A. J. (2011). *Fundamentals of structural dynamics*. John Wiley & Sons.
4. Agarwal, P., & Shrikhande, M. (2014). *Earthquake resistant design of structures*. Prentice Hall of India.
5. Relevant IS Codes (*IS 13920, IS 4326,IS 13935),* Bureau of Indian Standards.

e – Resources:

1. NPTEL, NOC: Dynamics of Structures, Manish Kumar, IIT Bombay, https://archive.nptel.ac.in/courses/105/106/105106151/
2. NPTEL, NOC: Dynamics of Structures, P. Banerji, IIT Bombay, https://archive.nptel.ac.in/courses/105/101/105101006/
3. NPTEL, Introduction to Earthquake Engineering, R.S. Jangid, IIT Bombay, https://archive.nptel.ac.in/courses/105/101/105101004/
4. NPTEL, NOC:Earthquake Resistant Design of Foundations, B.K. Maheswari, IIT Roorkee, https://archive.nptel.ac.in/courses/105/107/105107204/

	CO DESCRIPTION	PO MAPPING	PSO1	PSO2
CO1	Explain the free and forced vibration behavior of single-degree and multi-degree of freedom systems, including the effect of damping.	-	-	-
CO2	Analyze the response of structures subjected to earthquake ground motions using response spectra, time-history analysis, and codal provisions.	PO1 (2) PO2 (1) PO3 (3)	3	2
CO3	Design earthquake-resistant masonry and reinforced concrete structures by applying ductile detailing and capacity-based design principles.	PO1 (1) PO3 (2)	2	1

ST25103	Advanced Concrete Structures	L	T	P	C
		3	0	0	3

Course Objective: To make the students familiar with the behaviour of RCC beams and columns and to design special structural members with proper detailing.

Behaviour and design of R.C. Beams: Properties and behaviour of concrete and steel, Behaviour and design of R.C. beams in flexure, shear and torsion, modes of failure - calculations of deflections and crack width as per IS 456, Introduction to strain compatibility methods

Activity: Case-study: Review of real beam failures (flexural vs. shear).

Behaviour and Design of R.C. Columns: Behaviour of short and long columns, behaviour of short column under axial load with uniaxial and bi-axial moments, construction of Pu - Mu interaction curves, Design of slender columns

Activity: Load–deflection behavior of columns (analytical/experimental demo).

Design of special R.C. Elements: Design of RC walls, design of corbels, strut and tie method, design of simply supported and continuous deep beams, analysis and design of grid floors.

Activity: Seminar on Innovative applications of RC special elements in real structures.

Flat Slabs and Yield Line Based Design: Design of flat slabs according to IS method, Check for shear, Design of spandrel beams, Yield line theory and design of slabs, virtual work method, equilibrium method.

Activity: Review of competitive exam question papers (GATE, IES, etc)

Inelastic Behaviour of Concrete Structures: Inelastic behaviour of concrete beams, Moment-curvature curves, moment redistribution, Concept of Ductility, Detailing for ductility, Design of beams, columns for ductility, Design of cast-in-situ joints in frames.

Activity: **Quiz on Inelastic Behaviour of Concrete Structures**

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Quiz - 10%

Assignment – 15%

Report preparation from Case study – 10%

Review of Question papers – 15%

Internal Examinations – 50%

References:

1. Gambhir, M. L. (2012). Design of reinforced concrete structures. Prentice Hall of India.
2. Purushothaman, P. (1986). Reinforced concrete structural elements: Behaviour analysis and design. Tata McGraw-Hill.
3. Pillai, U., & Menon, D. (2020). Reinforced concrete design. Tata McGraw-Hill Publishers.
4. Varghese, P. C. (2020). Advanced reinforced concrete design. Prentice Hall of India.
5. Relevant IS Codes (*IS 456, IS* 13920,*SP 16, SP34),* Bureau of Indian Standards.

E – Resources :

NPTEL, Advanced Reinforced Concrete Design, Prof. S. Suriya Prakash, IIT Hyderabad, https://onlinecourses.nptel.ac.in/noc23_ce109/.

	Description of CO	PO	PSO1	PSO2
CO1	Explain the behavior of reinforced concrete beams and columns under flexure, shear, torsion, and axial loads using IS 456 provisions.	PO1 (1) PO3 (3)	2	2
CO2	Analyze and design special reinforced concrete elements such as walls, corbels, deep beams, flat slabs, and grid floors using codal provisions and advanced methods.	PO1 (2) PO2 (1) PO3 (3)	3	2
CO3	Design ductile reinforced concrete members and joints considering inelastic behavior, moment redistribution, and detailing requirements for seismic performance.	PO1 (2) PO2 (1) PO3 (3)	2	2

ST25C01	Advanced Construction Engineering and Experimental Techniques Laboratory	L	T	P	C
		0	0	4	2

Course Objective:

To provide a thorough knowledge of material selection through the material testing based on specification. To provide a detailed account of modern experimental techniques in construction Engineering research. To introduce the basic working principles, the operational know-how, and the strength and limitations of the techniques.

List of Exercises

1. Mix design of concrete as per BIS methods for high performance concrete.
2. Flow Characteristics of Self Compacting concrete.
3. Workability, strength and durability of concrete made using minerals and chemical admixtures
4. NDT on hardened concrete - UPV, Rebound hammer and core test.
5. RCC Beam two-point flexural testing
6. Permeability test on hardened concrete (RCPT) – Demonstration
7. Density, Mass fraction, tensile strength and modulus of elasticity of modern construction materials – GFRP, CFRP laminates
8. Determination of elastic constants – Hyperbolic fringes
9. Determination of elastic constants – Elliptical fringes
10. Strain gauge meter – Determination of Young's modulus of a metallic wire
11. Ultrasonic interferometer – ultrasonic velocity in liquids
12. Electrical conductivity of metals and alloys with temperature-four probe method
13. Resistivity measurements
14. NDT – Ultrasonic flaw detector
15. Calibration of Proving Ring and LVDT

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

References:

1. Bureau of Indian Standards. (2019). IS 10262: Concrete mix proportioning - Guidelines. Bureau of Indian Standards.
2. American Concrete Institute. (n.d.). ACI 211: Standard practice for selecting proportions for normal, heavyweight, and mass concrete. American Concrete Institute.
3. British Standards Institution. BS EN 206 and BS 8500
4. Bureau of Indian Standards. IS 13311, IS 18256, IS 18255

e - Resources

1. Virtual lab, Smart Structures and Dynamics Laboratory, https://vssd-iitd.vlabs.ac.in/
2. Virtual lab, Concrete Structures lab, https://cs-iitd.vlabs.ac.in/

	CO Description	PO Mapping	PSO1	PSO2
CO1	Illustrate the modern experimental techniques in construction Engineering research.	PO1 (3) PO2 (2) PO3 (1)	2	2
CO2	Integrate the analytical techniques and graphical analysis to interpret the experimental data	PO1 (3) PO2 (2) PO3 (1)	1	3

Semester II

ST25201	Advanced Steel Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the behaviour of members, connections and industrial buildings.

Design Philosophies, Codes, and Structural Systems: Design Philosophies and Design Codes (IS, EC, AISC), Structural Configurations, Functional and Serviceability Requirements, Estimation of wind load as IS code, Global Stability Criteria, Beam, Columns and Frames (Sway and Non-Sway).

Activity: Poster Presentation - Mind map on Design Philosophies.

Analysis and Design of Industrial Buildings: Analysis and design of industrial buildings and PEB, Gantry Girders, Design of Purlins, Louver rails, Gable column, Gable wind girder and beam-columns subjected to combined forces, Earthquake and wind resistant design of industrial buildings.

Activity: Field visit to steel construction sites.

Design of Connections: Types of connections, Welded and Bolted, Design of simple base, Gusseted base and Moment Resisting Base, Flexible Connections, Seated Connections, Unstiffened and Stiffened Seated Connections, Moment Resistant Connections, Clip angle Connections, Split beam Connections.

Activity: Develop models of types of connections

Design Steel-Concrete Composite Elements: Introduction, composite deck slab, profile sheet parallel and perpendicular to the beam, Design using m-k curve, composite beams, propped and unpropped, full composite action, partial composite action, composite columns, concrete filled tubes, concrete encased columns.

Activity: Review of competitive exam question papers (GATE, IES, etc)

Design of Light Gauge Steel Structures: Introduction to Direct Strength Method, Behaviour of Compression Elements, Effective width for load and deflection determination, Behaviour of Unstiffened and Stiffened Elements, Design of webs of beams, Flexural members, Lateral buckling of beams, Shear Lag, Flange Curling, Design of Compression Members, Wall Studs.

Activity: Case study on cold-formed steel buildings

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 15%
Report preparation for field visit – 10%
Review of Question papers – 15%
Internal Examinations – 50%

References:

1. Beedle, L. S. (1997). Plastic design of steel frames. John Wiley & Sons.
2. Narayanan, R., et al. (2000). Teaching resource on structural steel design. INSDAG, Ministry of Steel Publishing.
3. Subramanian, N. (2016). Design of steel structures. Oxford University Press.
4. Yu, W. W. (2019). Design of cold-formed steel structures. McGraw Hill.
5. Duggal, S. K. (2017). Limit state design of steel structures. McGraw Hill.
6. Johnson, R. P., & Wang, Y. C. (2019). Composite structures of steel and concrete: Beams, slabs, columns and frames for buildings. Wiley-Blackwell.

E – Resources:

1. INSDAG STEEL DESIGN MANUAL, https://www.steel-insdag.org, Institute for Steel Development and Growth (INSDAG), Kolkata, West Bengal, India.
2. NPTEL, NOC:Design of connections in steel structures, Prof. Anil Agarwal, IIT Madras, https://archive.nptel.ac.in/courses/105/106/105106216/
3. NPTEL, Design of Steel Structures I, Design of Steel Structures II, Prof. S.R. Satishkumar, Prof. A.R. Shantha Kumar, IIT Madras, https://archive.nptel.ac.in/courses/105/106/105106112/, https://archive.nptel.ac.in/courses/105/106/105106113/

	CO Description	PO	PSO1	PSO1
CO1	Apply national and international steel design codes (IS/EC/AISC) to analyse wind loads, stability criteria, and design basic steel members and frames.	PO1 (1) PO3 (3)	3	2
CO2	Analyse and design industrial steel buildings, including PEB systems, gantry girders, purlins, and beam-columns subjected to combined actions.	PO1 (3) PO3 (3)	3	2
CO3	Design and detail welded/bolted steel connections and develop physical/digital models demonstrating structural behaviour and load transfer mechanisms.	PO1 (2) PO3 (3)	3	2
CO4	Evaluate and design composite and cold-formed steel structural elements using concepts such as effective width, direct strength method, and composite action.	PO1 (3) PO2 (2) PO3(3)	3	3

ST25202	Advanced Prestressed Concrete	L	T	P	C
		3	0	0	3

Course Objective: To develop an understanding of the philosophy of design of prestressed concrete. To be able to design indeterminate prestressed concrete structure. To design the prestressed concrete bridge and composite sections.

Principles of Prestressing: Concepts of Prestressing, Materials and methods of prestressing, Design philosophy- Analysis methods, Time-dependent deformation of concrete and losses of prestress.

Activity: Poster presentation on concepts of prestressing.

Design for Flexure, Shear and Torsion: Behaviour of flexural members, determination of ultimate flexural strength using various Codal provisions - Design for Flexure, Shear, torsion and bond of pre-stressed concrete elements — Transfer of prestress — Box girders - Camber, deflection and crack control.

Activity: Field visit to prestressed concrete construction.

Design of Continuous and Composite Beams: Statically indeterminate structures - Analysis and design of continuous beams and frames– Choice of cable profile - Methods of achieving continuity – concept of linear transformations, concordant cable profile and gap cables – Composite sections of prestressed concrete beam and cast in situ RC slab - Design of composite sections - Partial prestressing - Limit State design of partially prestressed concrete beams

Activity: Real-time structural design of prestressed concrete beams assignment

Design of Tension and Compression Members: Pre-stressed concrete compression and tension members – application in the design of prestressed pipes and prestressed concrete cylindrical water tanks – Design of compression members with and without flexure — its application in the design of piles, flag masts and similar structures — Two way pre-stressed concrete floor systems – Connections for pre-stressed concrete elements.

Activity: Structural design of tanks/pipes/flag mast/other prestressed structure assignment

Design of Prestressed Concrete Bridges: Review of IRC and IRS loadings. Effect of concentrated loads on deck slabs, load distribution methods for concrete bridges. Analysis and Design of superstructures - Design of pre-stressed concrete bridges incorporating long-term effects like creep, shrinkage, relaxation, and temperature effects, Dynamic response of bridge decks.

Activity: Review of competitive exam question papers (GATE, IES, etc)

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 15%

Report preparation for field visit – 10% Review of Question papers – 15% Internal Examinations – 50%

References:

1. Nilson, A. H. (2004). *Design of prestressed concrete*. John Wiley & Sons.
2. Raju, K. (2018). *Prestressed concrete*. Tata McGraw Hill.
3. Lin, T. Y., & Burns, H. (2010). *Design of prestressed concrete structures*. John Wiley & Sons.
4. Rajagopalan, N. (2014). *Prestressed concrete*. Narosa Publications.
5. Sinha, N. C., & Roy, S. K. (1998). *Fundamentals of prestressed concrete*. S. Chand & Co.
6. Victor, D. J. (2019). *Essentials of bridge engineering*. Oxford & IBH Publishing.
7. Nawy, E. G. (2009). *Prestressed concrete: A fundamental approach*. Pearson Education.

E – Resources:

1. NOC: Pre-stressed Concrete Structures, Prof. Devdas Menon, IIT Madras, Prof. Amlan SenGupta, Videos: https://archive.nptel.ac.in/courses/105/106/105106118/

	CO Description	PO	PSO1	PSO2
CO1	Explain the principles, materials, and methods of prestressing.	PO1 (2) PO3 (3)	3	2
CO2	Analyse and design prestressed concrete members for flexure, shear, torsion, and serviceability.	PO1 (3) PO2(2) PO3 (2)	3	2
CO3	Design continuous, composite, and partially prestressed beams using appropriate cable profiles and codal provisions.	PO1 (3) PO3 (3)	3	3
CO4	Apply prestressing concepts to design axial members, tanks, pipes, floor systems, and bridge superstructures considering long-term effects.	PO1 (2) PO3 (3)	3	3

ST25203	Finite Element Analysis in Structural Engineering	L	T	P	C
		3	0	2	4

Course Objective: To make the students understand the basics of the Finite Element Technique, and to cover the analysis methodologies for 1-D, 2-D and 3-D Structural Engineering problems.

Properties of Discrete Elements: Introduction to matrix properties, Structural elements, boundary conditions and degrees of freedom, stiffness equation for discrete elements, Stiffness matrix for truss elements, 2D beam elements and 3D beam elements, Analysis of springs connected in series and parallel.

Activity: Poster Presentation on analysis of truss and spring elements.

Analysis of Beams and Frames using Discrete Elements: Equivalent joint loads, Analysis of continuous beams, sinking of supports and changing cross-sections using beam elements, Transformation matrix, Analysis of trusses and frames.

Activity: Review of competitive exam question papers (GATE, IES, etc).

Introduction to Continua Elements: Introduction, Basic Concepts of Finite Element Analysis, Introduction to Elasticity, Steps in Finite Element Analysis, Finite Element Formulation Techniques, Virtual Work and Variational Principle, Galerkin Method, Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions

Activity: Finite element formulations using virtual work and variational principles.

Analysis of Continua Elements: Natural Coordinates – one dimensional and two dimensional elements-CST and LST elements-Triangular Elements-Rectangular Elements, Shape functions, Formulation of element stiffness matrix, Lagrange and Serendipity Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Solid Elements, Finite Element Formulation of Axisymmetric Element, Numerical Integration: One, Two and Three Dimensional, Problems

Activity: Numerical modelling and analysis of 1D and 2D continuum elements.

Advanced Topics and Case Studies: Geometric and material Nonlinearity - Static Condensation – Substructure technique – Optimizing the bandwidth – Analysis of plate and shell structures using Isoparametric elements.

Activity: Case study on plate and shell structures.

List of Experiments:

1. Finite element analysis of 2D and 3D beam elements to evaluate nodal displacements, reactions, and internal forces considering appropriate degrees of freedom.
2. Finite Element Analysis of a 1D bar or truss element to compute nodal displacements and stresses using the displacement approach and stiffness matrix formulation.
3. FEM analysis of a cantilever beam under static loading using commercial software to study the effect of boundary conditions and mesh refinement.
4. Finite element formulation and analysis of axisymmetric or solid elements.

5. Finite element modelling and analysis of plate and shell structures

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 15%
Report preparation for field visit – 10%
Review of Question papers – 15%
Internal Examinations – 50%

References:

1. Hutton, D. (2017). Fundamentals of finite element analysis. Tata McGraw-Hill Publishing Company Limited.
2. Logan, D. L. (2010). A first course in the finite element method. Thomson Engineering.
3. Zienkiewicz, O. C., & Taylor, R. L. (2013). The finite element method. McGraw-Hill.
4. Chandrupatla, R. T., & Belegundu, A. D. (2015). Introduction to finite elements in engineering. Prentice Hall of India.
5. Moaveni, S. (2020). Finite element analysis: Theory and application with ANSYS. Prentice Hall.

E – Resources:

1. NPTEL, Finite Element Analysis, Prof. B. N. Rao, IIT Madras, https://archive.nptel.ac.in/courses/105/106/105106051/
2. Finite Element Analysis method for vibration and stability analyses, Prof. C.S. Manohar, IISc Bangalore https://archive.nptel.ac.in/courses/105/108/105108141/
3. Open source FE software/ student versions.

	CO Description	PO	PSO1	PSO2
CO1	Apply stiffness formulations to analyse discrete structural elements such as trusses, beams, frames, and spring systems.	PO1 (2) PO3 (3)	3	2
CO2	Analyse beams, trusses, frames, and continuous systems using transformation matrices and equivalent joint loads.	PO1 (3) PO3 (2)	3	2
CO3	*Explain and apply fundamental finite element concepts including variational principles, elasticity, and displacement formulation techniques.*	PO1 (3) PO2(2) PO3 (2)	3	3
CO4	Formulate and analyse 1D, 2D, and 3D continuum elements using shape functions, isoparametric formulations, and numerical integration, including nonlinear and advanced structural cases.	PO1 (3) PO2(2) PO3 (2)	3	3

ST25204	Structural Design Studio	L	T	P	C
		0	0	4	2

Course Objective: To design a structure using modern software tools available like ETABS, STAAD, STRAP, etc. and present it in the form of a complete detailed drawing. Students have to work individually with standard codes, computational tools and software packages for analyzing, designing and detailing a structure. A detailed report on the work done shall be submitted by individual students in the form of a report and presentation.

Analysis and Design of Concrete and Steel Structures

Prepare a design basis report for a project. Develop a model of a structure for analysis. Calculate and apply the loads on the structure as per relevant standards. Analyse the structure. Design the structural elements and connections as per relevant standards. Check for safety and optimization. Prepare a detail structural drawing. Prepare the report.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

E – Resources:

1. Open source structural analysis and design software/ student versions.

	CO Description	PO	PSO1	PSO2
CO1	Develop and analyse structural models by calculating and applying loads as per relevant standards using appropriate computational tools.	PO1 (2) PO3 (3)	3	2
CO2	Design structural elements and connections, check safety/optimization, and prepare detailed structural drawings and reports in accordance with codal provisions.	PO1 (3) PO2 (2) PO3 (3)	3	3

Semester III

ST25301	Practical Training (4 Weeks)	L	T	P	C
		0	0	0	2

Course Objective: To train the students in the field work so as to have first-hand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.

Students are required to undergo a four-week practical training programme during the summer vacation in reputed engineering companies specializing in Structural Engineering. Upon completion of the training, each student must submit a detailed report documenting the work carried out, within ten days from the commencement of the subsequent semester. The performance of the students will be assessed through a viva-voce examination conducted by a panel of internal faculty members.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

	CO Description	PO	PSO1	PSO2
CO1	Apply structural engineering knowledge and industry practices to understand real-time project execution and professional environments.	PO1 (3) PO3 (3)	3	2
CO2	Prepare and present a comprehensive training report and demonstrate effective technical communication during viva-voce.	PO2 (3) PO3 (2)	1	2

ST25302	Project Work I	L	T	P	C
		0	0	12	6

Course Objective: To identify a specific problem for the current need of the society and collect information related to the same through a detailed review of literature. To develop the methodology to solve the identified problem. To train the students in preparing project reports and to face reviews and viva-voce examinations.

The student shall individually undertake a project on a topic approved by a faculty member with expertise in the chosen area of specialization. The topic may be experimental, analytical, or based on case studies, and must be relevant to the student's programme specialization. By the end of the semester, the student must submit a detailed project report that includes a clear statement of the problem, an extensive literature review, and a well-defined methodology for carrying out the work. The evaluation will be based on a viva-voce examination conducted by a panel of examiners, comprising internal faculty and an external examiner.

References:
1. Ganesan, R. (2020). Research methodology for engineers. MJP Publishers. 2. Cooper, D. R., Schindler, P. S., & Sharma, J. K. (2018). Business research methods (12th ed.). Tata McGraw-Hill Education. 3. Holland, C. J. (2007). Intellectual property: Patents, trademarks, copyrights, trade secrets. Entrepreneur Press. 4. Hunt, D., Nguyen, L., & Rodgers, M. (2012). Patent searching: Tools & techniques. Wiley.
E - Resources 1. NOC:Qualitative Research Methods and Research Writing, Prof. Aradhna Malik, IIT Kharagpur, https://archive.nptel.ac.in/courses/127/105/109105115/ 2. NOC: Research Methodology, Prof. Soumitro Banerjee IIT Madras, https://archive.nptel.ac.in/courses/127/106/127106227/

	CO Description	PO	PSO1	PSO2
CO1	Formulate a structural engineering problem through systematic literature review and define clear research objectives aligned with the programme specialization.	PO1 (3) PO3 (3)	3	2
CO2	Develop and document a suitable methodology and present the project findings effectively through a detailed technical report and viva-voce examination.	PO1 (2) PO2 (3) PO3 (2)	2	3

ST25401	Project Work II	L	T	P	C
		0	0	24	12
Course Objective: To solve the identified problem based on the formulated methodology. To develop skills to analyze and discuss the test results, and make conclusions.					
The student shall continue the work initiated in Phase I, following the approved methodology and research plan. By the end of the semester, upon satisfactorily completing the project work to the approval of the supervisor and the review committee, the student must prepare a detailed project report and submit it to the Head of the Department. The evaluation will be based on the quality of the report					

and performance in the viva-voce examination conducted by a panel of examiners, which shall include an external examiner.

References:

1. Cooper, D. R., Schindler, P. S., & Sharma, J. K. (2018). Business research methods. Tata McGraw-Hill Education.
2. Holland, C. J. (2007). Intellectual property: Patents, trademarks, copyrights, trade secrets. Entrepreneur Press.
3. Hunt, D., Nguyen, L., & Rodgers, M. (2012). Patent searching: Tools & techniques. Wiley.

E - Resources

1. NOC:Qualitative Research Methods and Research Writing, Prof. Aradhna Malik, IIT Kharagpur, https://archive.nptel.ac.in/courses/127/105/109105115/
2. NOC: Research Methodology, Prof. Soumitro Banerjee IIT Madras, https://archive.nptel.ac.in/courses/127/106/127106227/

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Execute the research methodology formulated in Phase I and carry out advanced experimental, analytical, or simulation work leading to meaningful findings in the chosen specialization.	PO1 (3) PO3 (3)	3	2
CO2	Prepare a well-structured dissertation and defend the research outcomes effectively through a comprehensive viva-voce examination.	PO1 (2) PO2 (3) PO3 (2)	2	3

PROGRAMME ELECTIVE COURSES

ST25001	Non-Linear Analysis of Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the concept of non-linear behaviour and analysis of elements and simple structures.

Introduction to Non-Linear Analysis: Material non-linearity, geometric non-linearity; statically determinate and statically indeterminate bar systems of uniform and variable thickness.

Activity: Concept map poster presentation

Inelastic Analysis of Flexural Members: Inelastic analysis of uniform and variable thickness members subjected to geometric and material non-linearity; inelastic analysis of bars of uniform and variable stiffness members with and without axial Restraints.

Activity: Inelastic analysis using numerical tools.

Vibration Theory and Analysis of Flexural Members: Vibration theory and analysis of flexural members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading.

Activity: Case study discussion

Elastic and Inelastic Analysis of Plates: Elastic and inelastic analysis of uniform and variable thickness plates.

Activity: Problem solving using numerical tools

Non-Linear Vibration and Instability: Nonlinear vibration and Instabilities of elastically supported beams.

Activity: Nonlinear Response and Stability of an Elastically Supported Beam

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for Case Study – 20%
Internal Examinations – 50%

References:

1. Fertis, D. G. (1999). Non-linear mechanics. CRC Press.
2. Reddy, J. N. (2014). Non-linear finite element analysis. Oxford University Press.
3. Sathyamoorthy, M. (2017). Nonlinear analysis of structures. CRC Press.

E – Resources:

1. NPTEL Advanced Structural Analysis, Prof. Devdas Menon, IIT Madras, https://archive.nptel.ac.in/courses/105/106/105106050/
2. NOC: Elastic Stability of Structures, Prof. Sarat Kumar Panda IIT Kharagpur, https://archive.nptel.ac.in/courses/105/105/105105217/#

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Explain material and geometric nonlinear behavior in structural members.	PO1 (3) PO3 (2)	3	2
CO2	Perform inelastic analysis of flexural members and bars under nonlinear effects.	PO1 (3) PO3 (3)	3	2
CO3	Analyze vibration and hysteretic response of flexural members under cyclic loading.	PO1 (3) PO3 (3)	3	3
CO4	Evaluate elastic and inelastic behavior and instability of plates and beams.	PO1 (3) PO3 (3)	3	3

ST25002	Stability of structures	L	T	P	C
		3	0	0	3

Course Objective: To study the concept of buckling and analysis of structural elements.

Buckling of Columns: States of equilibrium - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis. Governing equation for column buckling - critical load using Equilibrium, Energy methods - Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method.

Activity: Assignment on Buckling of Columns and Stability Analysis

Buckling of Beam-Columns and Frames: Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples - Analysis of rigid jointed frames with and without sway – Use of stability function to determine the critical load.

Activity: Poster presentation on theory of beam column.

Torsional and Lateral Buckling: Torsional buckling – Combined Torsional and flexural buckling - Local buckling - Buckling of Open Sections - Lateral buckling of beams - simply supported and cantilever beams.

Activity: Case study discussion

Buckling of Plate: Governing differential equation - Buckling of thin plates with various edge conditions - Analysis by equilibrium and energy approach – Finite difference method.

Activity: Plate analysis using numerical tools.

Inelastic Buckling: Double modulus theory - Tangent modulus theory - Shanley's model - Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.

Activity: Buckling analysis using numerical tools

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for Case Study – 20%
Internal Examinations – 50%

References:

1. Kumar, A. (2003). Stability theory of structures. Allied Publishers Ltd.
2. Chajes, A. (1974). Principles of structural stability theory. Prentice Hall.
3. Gambhir, M. L. (2013). Stability analysis and design of structures. Springer.
4. Simitser, G. J., & Hodges, D. H. (2006). Fundamentals of structural stability. Elsevier Ltd.

5. Timoshenko, S. P., & Gere, J. M. (2012). Theory of elastic stability. Dover Publications.
6. Cedolin, L., & Bažant, Z. P. (2010). Stability of structures: Elastic, inelastic, fracture and damage theories. World Scientific Publishing Co.

E – Resources:

1. NOC: Elastic Stability of Structures, Prof. Sarat Kumar Panda, IIT Kharagpur, https://archive.nptel.ac.in/courses/105/105/105105217/#
2. NOC:Stability Aspects of Structural Steel Design: Concepts and Applications, Prof. Mahendrakumar Madhavan, IIT Hyderabad. https://nptel.ac.in/courses/105106564

	CO Description	PO	PSO1	PSO2
CO1	Explain and apply stability principles to analyze elastic and inelastic buckling of structural members.	PO1 (3) PO3 (2)	3	2
CO2	Analyze buckling behavior of columns, beam-columns, frames, and plates using analytical and numerical methods.	PO1 (3) PO3 (3)	3	2
CO3	Evaluate torsional, lateral, and local buckling modes in beams and open sections under various loading conditions.	PO1 (3) PO3 (3)	3	3
CO4	Assess inelastic buckling and post-buckling behavior using advanced theories and models.	PO1 (3) PO3 (3)	3	3

ST25003	Wind and Cyclone Effects on Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the concept of wind and cyclone effects for the analysis and design of structures.

Introduction: Introduction - Types of wind - Characteristics of wind - Method of measurement of wind velocity - Variation of wind speed with height, shape factor, aspect ratio, drag and lift effects - Dynamic nature of wind - Pressure and suctions - Spectral studies - Gust factor.

Activity: Concept map poster presentation.

Effect of Wind on Structures: Classification of structures - Rigid and flexible - Effect of wind on structures – Aerodynamics and aeroelasticity - Vortex shedding - Translational vibration of structures - Static and dynamic effects on tall buildings and Chimneys.

Activity: Problem solving assignment

Design of Special Structures: Design of structures for wind loading as per IS, ASCE and NBC code provisions - Design of industrial sheds - Tall buildings - Chimneys - Transmission towers and steel monopoles.

Activity: Real-time structural design assignment

Cyclone Effects: Cyclone effect on: Low rise structures, Sloped roof structures, Tall buildings - Effect of cyclone on claddings - Design of cladding - Use of code provisions in cladding design - Analytical procedure and modeling of cladding.

Activity: Modelling and analysis of claddings

Wind Tunnel Studies: Wind tunnel studies - Types of wind tunnels - Types of wind tunnel models - Modelling requirements - Aero-dynamic and Aero-elastic models - Prediction of acceleration - Load combination factors - Wind tunnel data analysis - Calculation of period and damping value for wind design.

Activity: Field visit to Wind tunnel testing

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for Case Study – 20%
Internal Examinations – 50%

References:

1. Cook, N. J. (1990). The designer's guide to wind loading of building structures. Butterworths.
2. Kolousek, V., Pirner, M., Fischer, O., & Naprstek, J. (1984). Wind effects on civil engineering structures. Elsevier.

3. Lawson, T. V. (1980). Wind effects on buildings (Vols. 1–2). Applied Science Publishers.
4. Sachs, P. (2014). Wind forces in engineering. Pergamon Press.

E – Resources:

1. NPTEL Experimental Gas/Aerodynamics, Topic: Wind tunnels. Prof. Job Kurian, IIT Madras, https://nptel.ac.in/courses/101106040

	CO Description	PO	PSO1	PSO2
CO1	Explain wind characteristics, wind–structure interaction, and associated aerodynamic effects.	PO1 (2) PO3 (2)	2	1
CO2	Analyse wind effects on various structural systems using codal provisions and basic analytical methods.	PO1 (3) PO3 (3)	3	2
CO3	Design wind-resistant structural components and cladding systems, and evaluate performance using modelling or wind-tunnel study concepts.	PO1 (2) PO2 (2) PO3 (3)	3	3

ST25004	Prefabricated Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the design principles, analysis and design of Prefabricated structures.

Design Principles: General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and code provisions, safety factors, material properties, Deflection control.

Activity: Concept map Poster presentation.

Structural Elements and Connections: Prefabricated structures – Analysis of Load bearing and framed structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column, column to column, wall to wall and column to foundation.

Activity: Create models of the connections.

Floors, Stairs and Roofs: Types of floor slabs, analysis and design example of cored and panel types and two-way systems, Design of composite and non-composite slabs, Design analysis for product manufacture-demoulding, handling and erection, staircase slab, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.

Activity: Field visit to prefabricated component manufacturing unit.

Walls: Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, Hoisting and placing, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, Lateral load resistance, Location and types of shear walls, approximate design of shear walls.

Activity: Models of wall panel with joints.

Industrial Buildings and Shell Roofs: Components of single-storey industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing. Cylindrical, folded plate and paraboloid shells, Erection and jointing of components in industrial buildings.

Activity: Field visit to prefabricated structure construction.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%

Assignment – 20% Report preparation for field visit – 20% Internal Examinations – 50%
References: 1. Bachmann, H., & Steinle, A. (2012). Precast concrete structures. 2. Koncz, T. (1971). Manual of precast concrete construction (Vols. I–IV). Bauverlag GmbH. 3. Mokk, L. (2007). Prefabricated concrete for industrial and public structures. Akademiai Kiado. 4. Lewicki, B. (1988). Building with large prefabricates. Elsevier Publishing Company. 5. Society for Studies in the Use of Precast Concrete. (2009). Structural design manual: Precast concrete connection details. Betor Verlag. 6. Elliott, K. S. (2016). Precast concrete structures. CRC Press. 7. Prestressed Concrete Institute. (2017). PCI design handbook: Precast and prestressed concrete.

	CO Description	PO	PSO1	PSO2
CO1	Explain prefabrication design principles and code-based requirements.	PO1 (2) PO3 (2)	2	1
CO2	Analyse and design prefabricated structural elements and their connections.	PO1 (3) PO2 (2) PO3 (3)	3	2
CO3	Evaluate and design wall systems, floors, roofs, and industrial building components used in prefabricated construction.	PO1 (3) PO3 (2)	3	2

CN25C01	Advanced Concrete Technology	L	T	P	C
		3	0	0	3

Course Objective: This course aims to provide students with a comprehensive understanding of the behavior, composition, and performance characteristics of advanced concrete materials. It focuses on modern developments such as chemical and mineral admixtures, high-performance and lightweight concrete, and innovative technologies for sustainable construction.

Concrete Characteristics:

Review of cement chemistry and hydration mechanisms- Properties of fresh and hardened concrete- Microstructure of concrete – ITZ, porosity, permeability - Rheology of concrete and workability measurements- Durability concepts – carbonation, chloride ingress, sulphate attack- Testing methods for strength and durability- Process of manufacturing of concrete - various stages - Batching methods - Mixing methods methods of transportation. Compacting - Curing - Finishing.

Activity: Poster presentation on the concrete production cycle

Admixtures in Concrete

Classification and role of admixtures- Superplasticizers, retarders, accelerators, air entrainers- Mineral admixtures – fly ash, silica fume, GGBS, metakaolin- Compatibility issues between cement and admixtures- Nanomaterials in concrete (nano-silica, carbon nanotubes)- Performance-based mix design with admixtures - Secondary Cementitious Materials –characteristics – effects in fresh concrete – effects in hardened concrete– uses - Metakaolin – application. Advantages – uses.

Activity: Prepare a performance-based mix using superplasticizer and one SCM

Lightweight and High-Performance Concrete

Classification and properties of lightweight concrete- Structural lightweight concrete – aggregates, mix proportioning- Foam concrete and aerated concrete- High-Performance Concrete (HPC) and Ultra-High Performance Concrete (UHPC)- Fiber Reinforced Concrete (FRC) – steel, glass, synthetic fibers- Self-Compacting Concrete (SCC) – design and applications- Applications, Blended cement concrete - Definition - Characteristics – Types.

Activity: Quiz

Sustainable and Green Concrete

Environmental impact of cement and concrete industry- Use of recycled aggregates, construction & demolition waste- Alkali-activated materials and geopolymer concrete - Carbon capture and utilization in concrete - Life Cycle Assessment (LCA) of concrete - IS/ASTM/EN standards for sustainable concrete.

Activity: Case study report on the feasibility of using C&D waste in concrete for a sample project.

Special Concretes and Future Trends High strength concrete, mass concrete - Reactive powder concrete, roller-compacted concrete - Smart concrete – self-healing, piezoelectric, 3D printable concrete - Underwater concrete and shotcrete- Concrete for extreme environments – marine, nuclear, arctic - Trends in AI/ML in concrete mix design and performance prediction. **Activity:** Assignment on special concrete
References: 1. M. Neville – Properties of Concrete, Pearson 2. M.S. Shetty – Concrete Technology, S. Chand 3. Mehta and Monteiro – Concrete Microstructure, Properties, and Materials, McGraw-Hill 4. IS: 456, IS: 10262, ASTM and EN standards Recent journal articles from Cement and Concrete Research, ACI Materials Journal, etc
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology: Poster presentation (10%), Quiz (10%), Assignment (20%), Field visit/Case study report (20%), Internal Examinations (40%)

	CO Description	PO	PSO1	PSO1
CO1	Explain the characteristics, behavior, and performance requirements of various concrete types including HPC, SCC, lightweight, sustainable, and special concretes.	-	-	-
CO2	Analyze the influence of admixtures, SCMs, nanomaterials, and rheological factors on fresh and hardened concrete properties.	PO1 (2) PO3 (3)	3	2
CO3	Design concrete mixes (HPC/UHPC/SCC/lightweight/sustainable) using performance-based, codal, and material-optimized approaches.	PO2 (2) PO3 (3)	3	2
CO4	Evaluate durability, microstructure, and long-term performance of modern and special concretes using advanced testing and characterization methods.	PO1 (2) PO2 (3) PO3(3)	2	3

ST25005	Reliability Analysis of Structures	L	T	P	C
		3	0	0	3

Course Objective: To develop knowledge to solve structural analysis problems using reliability concepts.

Data Analysis: Graphical representation Histogram, frequency polygon, Measures of central tendency- grouped and ungrouped data, measures of dispersion, measures of asymmetry. Curve fitting and Correlation: Fitting a straight line, curve of the form $y = ab^x$, and parabola, Coefficient of correlation.

Activity: Data analysis assignment.

Probability Concepts: Random events-Sample space and events, Venn diagram and event space, Measures of probability- interpretation, probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram, statistical independence, total probability theorem and Baye's theorem.

Activity: Problem solving assignment.

Random Variables: Probability mass function, probability density function, Mathematical expectation, Chebyshev's theorem. Probability distributions: Discrete distributions- Binomial and poison distributions, Continuous distributions, Normal, Log normal distributions.

Activity: Poster presentation on random variables.

Reliability Analysis: Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability Methods-First Order Second Moment Method (FOSM), Point Estimate Method (PEM), and Advanced First Order Second Moment Method (Hasofer-Lind's method).

Activity: Reliability analysis using numerical tools

System Reliability: Influence of correlation coefficient, redundant and non-redundant systems series, parallel and combined systems, Uncertainty in reliability assessments- Confidence limits, Bayesian revision of reliability. Simulation Techniques: Monte Carlo simulation- Statistical experiments, sample size and accuracy, Generation of random numbers, random numbers with standard uniform distribution, continuous random variables, discrete random variables.

Activity: Reliability Assessment of a Structural Beam under Random Load

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Papoulis, A. (2017). Probability, random variables and stochastic processes. McGraw-Hill.
2. Melchers, R. E. (2018). Structural reliability analysis and prediction. John Wiley & Sons.
3. Ditlevsen, O., & Madsen, H. O. (1996). Structural reliability methods. Wiley.
4. Chandrasekaran, S. (2016). Offshore structural engineering: Reliability and risk assessment. CRC Press.
5. Benjamin, J. R., & Cornell, C. A. (2014). Probability, statistics, and decision for civil engineers. Dover Publications.

E – Resources:

1. NOC:Structural Reliability, Prof. Arunasis Chakraborty, IIT Guwahati, Web: https://archive.nptel.ac.in/courses/105/103/105103140/
2. NOC:Structural Reliability, Prof. Baidurya Bhattacharya IIT Kharagpur, Videos: https://archive.nptel.ac.in/courses/105/105/105105209/

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Apply statistical tools to analyze and interpret engineering data.	PO1 (2) PO3 (2)	3	2
CO2	Use probability concepts and distributions to model engineering uncertainties.	PO1 (2) PO3 (2)	3	3
CO3	Evaluate structural reliability using classical and numerical reliability methods.	PO1 (3) PO3 (3)	3	3
CO4	Perform system reliability assessment using simulation and probabilistic techniques.	PO1 (3) PO3 (3)	3	3

ST25006	Design of Formwork	L	T	P	C
		3	0	0	3

Course Objective: To study and understand the detailed planning of formwork, Design of forms for various elements such as foundation, slabs, beams, columns and walls.

Introduction: General objectives of formwork building - Development of a Basic System - Key Areas of cost reduction - Requirements and Selection of Formwork.

Activity: Poster presentation of basic formwork systems

Formwork Materials and Types: Timber, Plywood, Steel, Aluminium, Plastic, and Accessories. Horizontal and Vertical Formwork Supports. Flying Formwork, Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete.

Activity: Concept map poster presentation of the materials of formwork.

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

Activity: Formwork design assignment.

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

Activity: Field visit to construction sites (formwork)

Formwork Failures: Formwork Management Issues – Pre- and Post-Award. Formwork Failures: Causes and Case studies in Formwork Failure, Formwork Issues in Multi story Building Construction.

Activity: Formwork failure Case study discussion

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Peurifoy, R. L. (2010). Formwork for concrete structures. McGraw Hill India.
2. Jha, K. N. (2012). Formwork for concrete structures. Tata McGraw-Hill Education.
3. Bureau of Indian Standards. (1999). IS 14687: False work for concrete structures—Guidelines. BIS.
4. Hurd, M. K. (1996). Formwork for concrete (Special Publication No. 4). American Concrete Institute.
5. Hurst, M. P. (2003). Formwork. Construction Press.

	CO Description	PO	PSO1	PSO2
CO1	Explain formwork objectives, requirements, and selection criteria.	-	-	-
CO2	Identify and compare materials, systems, and types of formwork used in construction.	PO1 (2) PO2 (1)	1	2
CO3	Design formwork systems for structural elements and special structures using relevant standards.	PO1 (3) PO2 (2) PO3 (3)	3	2
CO4	Evaluate formwork failures and propose safe formwork management strategies.	PO1 (2) PO2 (3) PO3 (2)	2	3

ST25C02	Maintenance, Repair and Rehabilitation of Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the damages in structures and suggest appropriate repair and rehabilitation measures

Conditional Assessment of Structure: Quality assurance for concrete based on Strength, Durability and Microstructure of concrete - NDT techniques- Cracks-different types, causes — Effects due to Environment, Fire, Earthquake, Corrosion of steel in concrete, Mechanism, quantification of corrosion damage.

Activity: Concept map Poster presentation

Maintenance and Repair Strategies: Maintenance, Repair and Rehabilitation, retrofit and strengthening, need for rehabilitation of structures- Service life behaviour - importance of Maintenance, causes and effects of deterioration. Non-destructive Testing Techniques.

Activity: Structural Maintenance & Repair Investigation

Repair Materials and Special Concretes: Repair materials-Various repair materials, Criteria for material selection, Methodology of selection, Special mortars and concretes- Polymer Concrete and Grouting materials- Bonding agents -Latex emulsions, Epoxy bonding agents, Protective coatings -Protective coatings for Concrete and Steel, FRP sheets.

Activity: Case study discussion on repair materials

Protection Methods: Concrete protection methods – reinforcement protection methods- cathodic protection - Sacrificial anode - Corrosion protection techniques — Corrosion inhibitors, concrete coatings-Corrosion resistant steels, Coatings to reinforcement, Introduction to Structural health monitoring.

Activity: Case study discussion on corrosion and protection measures

Repair, Retrofitting and Demolition of Structures: Various methods of crack repair, Grouting, Routing and sealing, Stitching, Dry packing, Autogenous healing, Repair to active cracks, Repair to dormant cracks. Repair of various corrosion damaged of structural elements (slab, beam and columns) Jacketing Techniques, Strengthening Methods for Structural Elements. Engineered Demolition -Case studies.

Activity: Field visit to repaired/retrofitted building

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Woodson, R. D. (2012). *Concrete structures: Protection, repair and rehabilitation*. Butterworth-Heinemann/Elsevier.
2. Kominetzky, D. M. S. (2001). *Design and construction failures*. Galgotia Publications.
3. Ravishankar, K., & Krishnamoorthy, T. S. (2004). *Structural health monitoring, repair and rehabilitation of concrete structures*. Allied Publishers.
4. Central Public Works Department, & Indian Buildings Congress. (2008). *Handbook on seismic retrofit of buildings*. Narosa Publishing House.

E - Resources

1. NOC:Maintenance and Repair of Concrete Structures, ProfRadhakrishna Pillai, IIT Madras, Videos: https://archive.nptel.ac.in/courses/105/106/105106202/

	CO Description	PO	PSO1	PSO2
CO1	Identify causes of deterioration and evaluate structural condition using NDT and durability assessment tools.	-	-	-
CO2	Select appropriate repair materials and propose suitable rehabilitation strategies for damaged structures.	PO1 (2) PO3 (2)	3	3
CO3	Apply protection techniques for concrete and reinforcement to enhance structural service life.	PO1 (2) PO2 (3) PO3 (2)	2	3
CO4	Recommend and design suitable repair, retrofitting, and demolition methods for various structural elements.	PO1 (3) PO2 (2) PO3 (3)	3	3

ST25007	Fiber Reinforced Polymer Composite Materials	L	T	P	C
		3	0	0	3

Course Objective: To study the behaviour of composite materials and application of FRP in structures.

Introduction: Introduction to composites - Classification of composite materials - Fiber Reinforced Polymer (FRP) composite: Types of fibers, Properties of fiber, Fabrication methods of fibers, Types of resin, Properties of resin, Interaction of fiber and matrix, Properties of unidirectional long fiber composites and short fiber composites, Methods of fabrication of FRP.

Activity: Concept map composites and its applications Poster presentation.

Macromechanical Behaviour of Lamina: Stress-strain relationship of anisotropic material, orthotropic material and transversely isotropic material - Engineering constants for orthotropic material - Stress-strain relationship for 2D lamina - Engineering constants for 2D Lamina - Strength of orthotropic lamina - Failure criteria for orthotropic lamina.

Activity: Problem solving assignment.

Micromechanical Behaviour of Lamina: Mechanics of material approach to strength and stiffness - Elasticity approach to stiffness - Halpin- Tsai Equation.

Analysis of Laminated Composites: Classical lamination theory - Special cases of laminate - Strength of laminates - Mechanical stress, Hygrothermal stress, Interlaminar stresses - Bending, buckling and vibration of laminated plates - Introduction to fracture mechanics of composites.

Activity: Design of laminated composite plates

Applications And Design Of Frp Composites

Applications of FRP in structural engineering - Properties of FRP rebars - Design of reinforced concrete structures with FRP rebars - Design philosophy of FRP retrofitting – Reuse and recycle of FRP.
Activity: Field visit to FRP construction/retrofit site

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Jones, R. M. (2015). *Mechanics of composite materials*. CRC Press.
2. Agarwal, B. D., Broutman, L. J., & Chandrashekara, K. (2017). *Analysis and performance of fiber composites* (4th ed.). John Wiley & Sons.

3. Hyer, M. W., & White, S. R. (2014). *Stress analysis of fiber-reinforced composite materials*. Destech Publications.
4. Singh, S. B. (2015). *Analysis and design of FRP reinforced concrete structures*. McGraw-Hill Professional.
5. Mukhopadhyay, M. (2022). *Mechanics of composite materials and structures*. Universities Press.

E - Resources

1. NOC:Mechanics of Fiber Reinforced Polymer Composite Structures, Prof. Debabrata Chakraborty, IIT Guwahati, Videos: https://archive.nptel.ac.in/courses/112/103/112103308/
2. NOC:Processing of Polymers and Polymer Composites, Dr. Inderdeep Singh, IIT Roorkee, Videos: https://archive.nptel.ac.in/courses/112/107/112107221/

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Explain the behavior and properties of lamina and laminated FRP composites.	-	-	-
CO2	Analyze stiffness, strength, and failure of composite lamina and laminates using micromechanical and macromechanical models.	PO1 (3) PO3 (3)	3	2
CO3	Design FRP-based structural elements and retrofitting solutions for practical engineering applications.	PO1 (2) PO2 (2) PO3 (3)	3	3

ST25008	Design of Steel-Concrete Composite Structures	L	T	P	C
		3	0	0	3

Course Objective: To develop an understanding of the behaviour and design concrete composite elements and structures.

Basic Concepts: Types of composite constructions - General behaviour of composite beams, slabs, columns and walls - Material properties of concrete and steel under static and fatigue loads - Codes and standards - Serviceability concepts - Fire resistance requirements and design procedure - Construction techniques.

Activity: Field visit to steel-concrete composite construction.

Shear Connectors: Methods of shear connection - Properties of shear connectors - Types - Transfer of shear connector forces in concrete elements - Post-cracking dowel strength - Longitudinal force - Embedment force - Partial interaction and full interaction - Design of shear connectors.

Activity: Poster presentation on Shear connectors.

Design of Composite Beams and Slabs

Moment of inertia of composite beams - Design of composite beams -Propped and unpropped sections- Design of composite profiled slabs and decks - Design of composite beams with composite slabs - Serviceability requirements - Behaviour of box girder bridges.

Activity: Structural design of composite beam/slab assignment.

Design of Composite Columns: Behaviour under pure axial, eccentric axial loads and moments - Short column and long columns - Axial load-moment interaction curves - Design of encased columns - Design of concrete-filled steel columns - Composite trusses.

Design of Joints: Joint configurations - Design of beam-to-beam joints - Design of beam-to-column joints - Column bases - Design of beam and column splices - Design of simple joints and moment-resisting joints.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Oehlers D. J. and Bradford M. A., “Composite Steel and Concrete Structures: Fundamental behaviour”, Revised Edition, Pergamon Press, Oxford, 2013.

2. Johnson R. P. and Y. C. Wang, “Composite Structures of Steel and Concrete: Beams, Slabs, Columns and Frames for Buildings”, Fourth Edition, Wiley Blackwell, 2019.
3. Davison B. and Owens G. W., “Steel Designers Manual”, Seventh Edition, Steel Concrete Institute (UK), Wiley Black, 2016.
4. Narayanan R., “Steel-Concrete Composite Structures: Stability and Strength”, CRC Press, Taylor and Francis Group, 2019.
5. “Guidebook for Steel-concrete Composite Construction - Design procedure of Structural Elements”, Institute for Steel Development and Growth (INSDAG), 2023.

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Understand the behaviour, material properties, and fundamental design concepts of composite structural elements.	-	-	-
CO2	Analyse and design composite beams, slabs, columns, and joints using relevant standards and modern tools.	PO1 (3) PO3 (3)	3	2
CO3	Demonstrate research and technical communication skills through field-based/analytical activities related to composite construction.	PO1 (3) PO2 (2) PO3 (2)	2	3

ST25009	Design of Masonry Structures	L	T	P	C
		3	0	0	3

Course Objective: To design, detail and retrofit a masonry structure.

Introduction: Introduction – Masonry construction – National and International perspective – Historical development, Modern masonry, Material Properties – Masonry units: clay and concrete blocks, Mortar, grout and reinforcement, Bonding patterns, Shrinkage and differential movements.

Activity: Poster presentation on the developments in masonry construction.

Design of Compression Member: Principles of masonry design, Masonry standards: IS 1905 and others - Masonry in Compression – Prism strength, Eccentric loading -Kern distance. Structural Wall, Columns and Plasters, Retaining Wall, Pier and Foundation – Prestressed masonry- design of bed block for beam wall connection.

Design of Masonry Under Lateral Loads: Masonry under Lateral loads – In-plane and out-of-plane loads, Ductility of Reinforced Masonry Members Analysis of perforated shear walls, Lateral force distribution -flexible and rigid diaphragms. Behaviour of Masonry – Shear and flexure – Combined bending and axial loads – Reinforced and unreinforced masonry – Infill masonry.

Activity: Structural design of masonry walls for lateral loads assignment.

Earthquake Resistant Design of Masonry Structures: Structural design of Masonry – Consideration of seismic loads –concepts of confined masonry – Cyclic loading and ductility of shear walls for seismic design -Code provisions- Working and Ultimate strength design – In-plane and out-of-plane design criteria for load-bearing and infills, connecting elements and ties. Modeling Techniques, Static Push Over Analysis and use of Capacity Design Spectra – use of Software.

Activity: Modelling and analysis of masonry structures.

Retrofitting of Masonry: Seismic evaluation and Retrofit of Masonry – In-situ and non-destructive tests for masonry – properties – Repair and strengthening of techniques.

Activity: Case study discussion on retrofit of masonry structures

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Drysdale, R. G. Hamid, A. H. and Baker, L. R, “Masonry Structures: Behaviour & Design”, Prentice Hall Hendry, 1994.

2. A.W. Hendry, B.P. Sinha and Davis, S. R, “Design of Masonry Structures”, E & FN Spon, UK, 2017.
3. R.S. Schneider and W.L. Dickey, “Reinforced Masonry Design”, Prentice Hall, 3rd edition, 1994.
4. Paulay, T. and Priestley, M. J. N., “Seismic Design of Reinforced Concrete and Masonry Buildings”, John Wiley, 1992.
5. A.W. Hendry, “Structural Masonry”, 2nd Edition, Palgrave McMillan Press, 1998.
6. A. S. Arya, Earthquake Disaster Reduction: Masonry Buildings, Design and Construction, Knowledge World International, 2007.

E - Resources

1. NOC:Design of Masonry Structures, Prof. Arun Menon, IIT Madras, Videos: https://archive.nptel.ac.in/courses/105/106/105106197/

	CO Description	PO	PSO1	PSO2
CO1	Describe masonry materials, behaviour, and codal design concepts.	-	-	-
CO2	Analyse and design masonry elements under compression, lateral, and seismic loads.	PO1 (3) PO3 (3)	3	2
CO3	Apply modelling, retrofitting, and technical communication skills in masonry engineering.	PO1 (3) PO2 (3) PO3 (2)	2	3

ST25010	Design of Industrial Structures	L	T	P	C
		3	0	0	3

Course Objective: To disseminate knowledge about planning and design of RCC and Steel Industrial structures.

Planning and Functional Requirements: Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration - Guidelines of Factories Act.

Activity: Concept map on requirements and guidelines for industrial buildings Poster presentation

Industrial Buildings: Steel and RCC - Gantry Girder, Crane Girders - Design of Corbels and Nibs – Design of Staircase.

Activity: Design of Gantry girder/corbels/nib assignment.

Power Plant Structures: Types of power plants – Containment structures - Cooling Towers - Bunkers and Silos - Pipe Rack and supporting structures- Introduction to RCC chimneys – single flue and multi-flue.

Transmission Line Structures and Chimneys: Analysis and design of steel monopoles, transmission line towers – Sag and Tension calculations, Methods of tower testing – Design of self-supporting and guyed chimney, Design of Chimney bases.

Foundation: Foundation for Towers, Chimneys and Cooling Towers –Design of Block foundations for machines - Design of Turbo Generator Foundation.

Activity: Field visit to industrial structure

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, Industrial Buildings: A Design Manual, Birkhauser Publishers, 2004.
2. Santhakumar A.R. and Murthy S.S., Transmission Line Structures, Tata McGraw Hill,1992.
3. Swami saran, Analysis & Design of substructures, Limit state Design second Edition.2018.
4. N.Subramaniyan, Design of Steel Structures, United Press, 2018
5. N. Krishna Raju, Advanced Reinforced concrete Design, 3rd edition 2016.

E - Resources

1. NPTEL, Design of Steel Structures II, Topic: Design of gantry, towers, chimneys. Prof. S.R. Satishkumar, Prof. A.R. Shantha Kumar, IIT Madras, https://archive.nptel.ac.in/courses/105/106/105106113/

	CO Description	PO	PSO1	PSO2
CO1	Explain planning, functional, and safety requirements for industrial buildings and structures.	-	-	-
CO2	Analyse and design industrial structural components such as gantry girders, bunkers, silos, chimneys, and transmission towers.	PO1 (3) PO3 (3)	3	2
CO3	Apply modelling, field-based understanding, and technical communication skills in industrial structural engineering.	PO1 (3) PO2 (3) PO3 (2)	2	3

ST25011	Advanced Design of Foundation Structures	L	T	P	C
		3	0	0	3

Course Objective: To design various types of foundations based on soil data and structural requirements.

Site Investigation and Selection of Foundation: Scope – Objective – Methods of exploration – Penetration tests (SPT and SCPT) – Data interpretation – Evaluation of all geotechnical parameters – Evaluation of liquefaction potential – Selection of foundation based on soil conditions – Bore log report – Location and depth of foundation – Codal provisions.

Activity: Case study discussion on soil reports and identify suitable foundations

Shallow Foundations: Bearing capacity of shallow foundation on homogeneous and layered deposits – Terzaghi's Analysis – Meyerhof's formula – BIS formula – Bearing capacity from in-situ tests (SPT, SCPT) – Allowable bearing pressure – Determination of settlement of foundation in homogeneous and layered deposits – Codal provisions. Structural design and detailing of isolated footing, strip footing, strap footing, rectangular and trapezoidal combined footings and raft foundation for concentric load, eccentric loads and moments.

Activity: Field visit to construction site (foundation construction)

Deep Foundations: Types of Piles- Pile axial capacity evaluation from Insitu tests (SPT, SCPT) – Negative skin friction – Uplift capacity - Settlement of pile group – Interpretation of pile load test -Under reamed pile – codal provision – Lateral load on pile – Brooms method -Structural design of piles and pile caps – undreamed pile foundation – Pile raft – Well foundation – Grip length – Construction of well - Failure and remedial methods - lateral stability – Structural design of well foundation.

Activity: Design of deep foundation assignment

Machine Foundations: Types – General requirements and design criteria – General analysis of machine foundations-soil system – Stiffness and damping parameters – Tests for design parameters – design of foundation for reciprocating engines, impact type machines and rotary type machines.

Special Foundations: Foundations for towers, Chimneys and Silos – design of anchors- Reinforced earth retaining walls. Floating Foundation – Shell foundation – Bucket foundation – Monopile foundation for soil earthquake effects – Codal provisions.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Tomlinson, M.J. and Boorman. R., Foundation Design and Construction, ELBS Longman, Seventh Edition, 2001.
2. Nayak, N.V., Foundation Design manual for Practicing Engineers, Dhanpat Rai and Sons, 2018.
3. Brain J. Bell and M.J. Smith, Reinforced Concrete Foundations, George Godwin Ltd., 1981.
4. Braja M. Das, Principles of Foundations Engineering, Eighth Edition, Thomson Asia (P) Ltd., 2017.
5. Bowels J.E., Foundation Analysis and Design, Fifth Edition, McGraw-Hill International Book Co., 2017.

E - Resources

1. NOC:Geotechnical Engineering, Topic: Pile foundation and Machine Foundations Prof. Dilip Kumar Baidya IIT Kharagpur, Videos: https://archive.nptel.ac.in/courses/105/105/105105185/

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Identify soil properties and select suitable foundations based on site investigation.	PO1 (2) PO3 (3)	3	1
CO2	Design shallow, deep, machine, and special foundations using geotechnical and codal requirements.	PO1 (3) PO3 (3)	3	2
CO3	Apply analytical, modelling, and communication skills to foundation engineering problems.	PO1 (3) PO2 (2) PO3 (2)	2	3

ST25012	Optimization Methods for Structural Engineering	L	T	P	C
		3	0	0	3

Course Objective: To study the optimization methodologies applied to structural engineering.

Basic Principles and Classical Optimization Techniques: Definition – Objective Function; Constraints – Equality and inequality – Linear and non-linear Side, Non-negativity, Behaviour and other constraints – Design space – Feasible and infeasible- Convex and Concave – Active constraint – Local and global optima. Differential calculus – Optimality criteria – Single variable optimization – Multivariable optimization with no constraints- (Lagrange Multiplier method) – with inequality constraints (Khun – Tucker Criteria).

Linear and Non-Linear Programming: Linear programming: Formulation of problems -Graphical solution — Analytical methods- Standard form - Slack, surplus and artificial variables – Canonical form – Basic feasible solution - simplex method – Two phase method – Penalty method- Duality theory – Primal – Dual algorithm, Dual Simplex method. Non-linear programming: One Dimensional minimization methods: Unidimensional - Unimodal function – Exhaustive and unrestricted search – Dichotomous search - Fibonacci Method – Golden section method -Interpolation methods. Unconstrained optimization Techniques.

Activity: Problem solving assignment

Geometric Programming: Polynomial — degree of difficulty — reducing G.P.P to a set of simultaneous equations — Unconstrained and constrained problems with zero difficulty – Concept of solving problems with one degree of difficulty.

Dynamic Programming: Bellman's principle of optimality — Representation of a multistage decision problem- concept of sub-optimization problems using classical and tabular methods.

Activity: Optimization of RC structure assignment

Structural Applications: Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory -Minimum weight design for truss members - Fully stressed design — Optimization principles to design of R.C. structures such as multistory buildings, water tanks and bridges.

Activity: Case studies on structural applications.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Iyengar. N.G.R and Gupta. S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
2. Rao, S.S. "Engineering Optimization: Theory and Practice", Fourth Edition, Wiley Eastern (P) Ltd., 2013.
3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
4. Uri Kirsch, "Optimum Structural Design", McGraw Hill Book Co. 1981.
5. Haftka, R. T. and Gurdal, Z., Elements of Structural Optimization, Springer, 3rd Edition, 1992.

E - Resources

1. NPTEL, Optimzation Methods, Dr. D. Nagesh Kumar IISc Bangalore, Videos: https://archive.nptel.ac.in/courses/105/108/105108127/
2. NPTEL, Optimzation Methods for Civil Engineering, Prof. Rajib Kumar Bhattacharjya, IIT Guwahati, Videos: https://archive.nptel.ac.in/courses/105/103/105103210/

	CO Description	PO	PSO1	PSO2
CO1	Understand basic optimization principles and classical methods for constrained and unconstrained problems.	-	-	-
CO2	Apply linear, non-linear, geometric, and dynamic programming techniques to engineering optimization tasks.	PO1 (3) PO3 (3)	3	2
CO3	Optimise structural systems and components using modern analytical and computational approaches.	PO1 (3) PO2 (2) PO3 (2)	2	3

ST25013	Structural Health Monitoring	L	T	P	C
		3	0	0	3

Course Objective: To make the students familiar with various structural health monitoring tools and techniques.

Introduction to Structural Health Monitoring: Need for SHM, Structural Health Monitoring versus Non-Destructive Evaluation, Methods of SHM- Local & Global Techniques for SHM, Short & Long-Term Monitoring, Active & Passive Monitoring, Remote Structural Health Monitoring- Advantages of SHM - Challenges in SHM- Introduction to non-contact based SHM.

Activity: Concept map on SHMs Poster Presentation.

Sensors and Instrumentation for SHM: Sensors for measurements: Electrical Resistance Strain Gages, Vibrating Wire Strain Gauges, Fiber Optic Sensors, piezoelectric sensors, Temperature Sensors, Accelerometers, Displacement Transducers, Load Cells, Humidity Sensors, Crack Propagation Measuring Sensors, Corrosion Monitoring Sensors, Pressure Sensors, Data Acquisition — Data Transmission - Data Processing — Storage of processed data - Knowledgeable information processing.

Activity: Visit to lab testing facility (sensors and instrumentation)

Static and Dynamic Measurement Techniques for SHM: Static measurement - Load test, Concrete core trepanning, Flat jack techniques, Static response measurement, Dynamic measurement -Vibration based testing- Ambient Excitation methods, Measured forced Vibration-Impact excitation, step relaxation test, shaker excitation method.

Activity: Field visit/ Demo of SHM monitoring

Damage Detection Techniques: Damage Diagnostic methods based on vibrational response- Method based on modal frequency/shape/damping, Curvature and flexibility method, Modal strain energy method, Sensitivity method, Baseline-free method, Cross-correlation method, Damage Diagnostic methods based on wave propagation Methods-Bulk waves/Lamb waves, Reflection and transmission, Wave tuning/mode selectivity, Migration imaging, Phased array imaging, Focusing array/SAFT imaging.

Activity: Problem solving assignment

Data Processing and Case Studies: Advanced signal processing methods - Wavelet, Hilbert-Huang transform, Neural networks, Support Vector Machine Principal component analysis, Outlier analysis. Applications of SHM on bridges and buildings, case studies of SHM in Civil/ Structural engineering.

Activity: Case study discussion on SHM in structures.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Daniel Balageas, Peter Fritzen, Alfredo Guemes, Structural Health Monitoring, John Wiley & Sons,2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components Methods with Applications, Wiley Publishers, 2007
3. Hua-Peng Chen, Structural Health Monitoring of Large Civil Engineering Structures, Wiley Publishers, 2018
4. Ansari, F Karbhari, Structural health monitoring of civil infrastructure systems, V.M,Woodhead Publishing, 2009
5. J. P. Ou, H. Li and Z. D, “Duan Structural Health Monitoring and Intelligent Infrastructure”, Vol1, Taylor and Francis Group, London, UK, 2006.
6. Victor Giurglutiu, “Structural Health Monitoring with Wafer Active Sensors”, Academic Press Inc, 2007.

E - Resources

1. NOC:Structural Health Monitoring, Prof. Srinivasan Chandrasekaran, IIT Madras, Videos: https://archive.nptel.ac.in/courses/114/106/114106046/

	CO Description	PO	PSO1	PSO2
CO1	Explain SHM concepts, monitoring methods, and types of sensors used in structural assessment.	-	-	-
CO2	Apply static, dynamic, and vibration-based techniques for structural monitoring and damage detection.	PO1 (3) PO3 (3)	3	2
CO3	Use data processing, analytical tools, and case studies to interpret SHM results and support engineering decisions.	PO1 (3) PO2 (3) PO3 (2)	2	3

ST25014	Design of Offshore Structures	L	T	P	C
		3	0	0	3

Course Objective: To impart knowledge about the concept of wave theories, forces, offshore foundation, analysis and design of jacket towers, pipes and cables.

Introduction to Offshore Environment: Ocean winds - Waves - Wave parameters - Introduction to Airy's wave theory and its applications - Brief introduction about ocean currents - Tides, ice-sea interactions - Need for offshore structures - Introduction to environmental loads - Wind, wave, current and ice loads - Introduction to API and DNV code provisions.

Activity: Concept map on Offshore environments

Types and Components of Offshore Structures: Types of offshore structures - Functional and structural requirements of an offshore platform - Components of a fixed jacket steel platform, steel jack-up platform, concrete gravity platform, semi-submersible platform and ship structures.

Activity: Poster presentation on types of offshore structures

Loads on Offshore Structures: Introduction: Permanent load, Operating load, Construction and Installation loads - Lifting force - Load-out force - Transportation force - Lifting and upending force - Accidental loads - Wind force - Wave and current force - Drag force and inertia force on vertical-horizontal-arbitrarily oriented structure (cylindrical/tubular members) - Morison equation - Ice loads on vertical and arbitrarily oriented structure (cylindrical/tubular members), Earthquake loads and wave force on large diameter structure.

Activity: Case study discussion on load calculation in offshore structures

Analysis and Design of Jacket Platforms: Design considerations - Codes and provisions - Typical preliminary design - Minimum embedment length of piles (of columns) - Top deck analysis for imposed loads - Analysis and design of deck framing members - Truss structures in the top deck - Reassessing sufficiency of vertical column below the top deck - Tubular members in jacket structure - Miscellaneous considerations for jacket platform.

Activity: Modelling and analysis of Jacket platform

Analysis and Design of Concrete Gravity Platforms: Introduction and design environmental conditions - Analysis and design aspects of gravity platform - Salient features to be considered in analysis and design - Bearing capacities of gravity platform foundation - Requirements in design - Drained and undrained bearing capacity of foundation soil - Sliding resistance of foundation soil - Ultimate capacities of shallow foundations - Static deformation of gravity platform foundation - Immediate or short-time deformations - Primary and secondary consolidation (as per API code) - Regional subsidence - Analysis and design of gravity platform subjected to wind and wave loads - Assumptions made in simplified analysis - Additional considerations for dynamic behaviour of platform components.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%

Report preparation for field visit – 20%

Internal Examinations – 50%

References:

1. Graff W. J., “Introduction to Offshore Structures”, Gulf Publ. Co.,1981.
2. Dawson T. H., “Offshore Structural Engineering”, Prentice Hall, 1983.
3. B. C. Gerwick Jr., “Construction of Marine and Offshore Structures”, CRC Press, Florida, 2000.
4. Clauss G., Lehmann E. and Ostergaard C., “Offshore Structures”, Vol. 1 & 2, Springer-Verlag, 1992.
5. Reddy D. V. and Arockiasamy M., “Offshore Structures” Vol. 1 & 2, Kreiger Publ. Co., 1991.
6. Morgan N., “Marine Technology Reference Book”, Butterworths, 1990.
7. McClelland B. and Reifel M. D., “Planning and Design of fixed Offshore Platforms”, Van Nostrand, 1986.
8. “PI RP 2A - Planning, Designing and Constructing Fixed Offshore Platforms”, API, 2000.

E - Resources

1. NOC:Design of Offshore Structures, Prof. S. Nallayarasu, IIT Madras, Videos: https://archive.nptel.ac.in/courses/114/106/114106011/

	CO Description	PO	PSO1	PSO2
CO1	Describe offshore environmental conditions, loads, and relevant code provisions.	-	-	-
CO2	Analyse types, components, and functional requirements of offshore structural systems.	PO1 (2) PO3 (3)	3	2
CO3	Apply the concepts and design offshore platforms using environmental load calculations and modern analytical tools.	PO1 (3) PO2 (2) PO3 (3)	3	3

ST25015	Performance of Structures with Soil Structure Interaction	L	T	P	C
		3	0	0	3

Course Objective: To study the concept of soil-structure – interaction in the analysis and design of structures.

Soil-Structure Interaction: Introduction to Soil – Foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, soil-foundation interaction analysis, soil response models, Elastic continuum, Winkler, Two parameter elastic models, Elastic – plastic behavior, Time dependent behavior.

Activity: Poster presentation on SSI problems

Beam on Elastic Foundation: Soil Models: Infinite beam subjected to various loading conditions, semi-infinite beam, beams with finite length and various end conditions, Continuity among the foundation soil layers, Two-parameters models, Isotropic elastic half space model, - beam with variable EI and subgrade modulus, combined footings.

Plates on Elastic Continuum: Thin and thick rafts, rectangular and circular Plates on Elastic Foundation (rectangular and circular), Elastic and elasto-plastic analyses of raft foundations - Analysis of finite plates, Numerical analysis of finite plates.

Activity: Problem solving assignment

Pile Foundations: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Load distribution in groups with rigid cap, Pile cap-pile-soil interaction - Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system- uplift capacity of piles and anchors.

Practical Application: Seismic soil structure interaction analysis in time domain for buildings and bridges. Analysis of high-rise building with fixed base and flexible base- Computer program based solution of different interaction problems - Examples and Case studies.

Activity: Real-time case study discussions

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. John P. Wolf, Soil-structure interaction, Prentice Hall, 1987.
2. Bowels, J.E., “Analytical and Computer methods in Foundation” McGraw Hill Book Co., New York., 1974

3. Desai C.S. and Christian J.T., “Numerical Methods in Geotechnical Engineering” McGraw Hill Book Co. New York,1977.
4. Soil Structure Interaction, the real behaviour of structures, Institution of Structural Engineers, 1989.
5. A.P.S. Selvadurai, Elastic Analysis of Soil Foundation Interaction, Developments in Geotechnical Engg.vol-17, Elsevier Scientific Publishing Co., 1979.
6. Prakash, S., and Sharma, H. D., “Pile Foundations in Engineering Practice.”John Wiley & Sons, New York, 1990.
7. Rolando P. Orense, Nawawi Chouw & Michael J. Pender – Soil-Foundation-Structure Interaction, CRC Press, Taylor & Francis Group, London, UK, 2010

E - Resources

1. NOC:Soil Structure Interaction, Prof. Koushik Deb, IIT Kharagpur, Videos: https://archive.nptel.ac.in/courses/105/105/105105200/

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Explain soil–foundation interaction concepts, soil models, and behaviour under various loading conditions.	-	-	-
CO2	Analyse beams, plates, piles, and pile–raft systems on elastic foundations using theoretical and numerical methods.	PO1 (3) PO3 (3)	3	2
CO3	Apply SSI principles, modelling tools, and case studies to evaluate real-world structural–soil interaction problems.	PO1 (3) PO2 (3) PO3 (2)	3	3

ST25016	Design of Bridge Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the loads, forces on bridges and design principles of several types of bridges.

Introduction: Introduction-Selection of Site and Initial Decision Process - Classification of Bridges- General Features of Design- Standard Loading for Bridge Design as per different codes - Road Bridges — Railway Bridges - Design Codes - Working Stress Method- Limit State Method of Design.

Activity: Poster presentation on various codes and criteria for bridge design

Analysis of Superstructures: Selection of main bridge parameters, design methodologies -Choices of superstructure types - load distribution techniques - Grillage analysis - Different types of superstructure (RCC and PSC); Longitudinal Analysis of Bridge - Transverse Analysis of Bridge.

Activity: Design of superstructure component - Problem solving assignment

Bridge Design Principles: Analysis and Design of RCC solid slab culverts -Design of RCC Tee beam and slab bridges - Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges — Arch bridges — Box culverts — Segmental bridges–Design principles only.

Activity: Field visit to bridge construction/structure site

Substructure, Bearings and Deck Joints: Pier - Abutment - Wing walls - Importance of soil-structure interaction - Types of foundations - Open foundation - Pile foundation - Well foundation - Different types of bridge bearings and expansion joints - Design of bearings and joints

Prestressed Concrete Bridges & Steel Bridges: Design principles of PSC bridges – PSC girders –Design principles of steel bridges - Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

Activity: Case study discussion on real-time design of bridges

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%
Assignment – 20%
Report preparation for field visit – 20%
Internal Examinations – 50%

References:

1. Jagadeesh T. R. and Jayaram M. A., “Design of Bridge Structures”, Second Edition, Prentice Hall of India Pvt. Ltd., 2009.
2. Johnson Victor D., “Essentials of Bridge Engineering”, Sixth Edition, Oxford and IBH Publishing Co., New Delhi, 2019.
3. Ponnuswamy S., “Bridge Engineering”, Third Edition, Tata McGraw Hill, 2017.

4. Raina V. K. “Concrete Bridge Practice”, Tata McGraw Hill Publishing Company, New Delhi, 2014.
5. Richard M. Barker & Jay A. Puckett, “Design of Highway Bridges”, John Wiley & Sons Inc., 2021.
6. N. Krishna Raju, “Design of Bridges”, Fifth Edition, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, 2018.

E - Resources

1. NOC:Bridge Engineering, Prof. Piyali Sengupta, IIT Kharagpur, Videos: https://archive.nptel.ac.in/courses/105/105/105105216/

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Explain types of bridges, design codes, and standard loading for bridge structures.	-	-	-
CO2	Analyse and design bridge superstructures and substructures using RCC, PSC, and steel.	PO1 (3) PO3 (3)	3	2
CO3	Apply bridge design principles, field observations, and case studies to real-world bridge engineering problems.	PO1 (3) PO2 (2) PO3 (2)	2	3

ST25017	Design of Shell and Spatial Structures	L	T	P	C
		3	0	0	3

Course Objective: To study the behaviour and design of shells, folded plates, space frames and application of FORMIAN software.

Design of Shell Structures: Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31.

Activity: Create models of shells

Design of Folded Plates: Folded Plate structures, structural behaviour, types, design by ACI - ASCE Task Committee method – pyramidal roof- Prismoidal roof.

Activity: Create models of folded plates

Introduction to Space Frame: Space frames - configuration - types of nodes - Design Philosophy – Behaviour -Introduction of tensegrity structures.

Activity: Create models of space frames

Analysis and Design of Space Frames: Analysis of space frames – Design of Nodes – Pipes - Space frames – Introduction to Computer- Aided Design.

Activity: Modelling and analysis of space frames

Special Methods

Application of Formex Algebra, FORMIAN for generation of configuration.
Activity: Develop various configuration of space truss in FORMIAN

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Assignment – 25%
Report preparation for activities – 25%
Internal Examinations – 50%

References:

1. Billington. D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, ASCE Manual No.31, Design of Cylindrical Shells,1982.
2. Varghese. P.C., Design of Reinforced Concrete Shells and Folded Plates, PHI Learning Pvt. Ltd., 2010.
3. Subramanian. N,” Space Structures: Principles and Practice”, Multi-Science Publishing Co. Ltd. 2008.
4. Ramasamy, G.S., “Analysis, Design and Construction of Steel Space Frames”, Thomas Telford Publishing, 2002.
5. Wilby. C “Concrete Folded Plate Roofs”, Elsevier, 1998.
6. IS 2210: 1998 (2003), Criteria for Design of Reinforced Concrete Shell Structures and Folded Plates, Bureau of Indian Standards, New Delhi 110002.

	CO Description	PO	PSO1	PSO2
CO1	Understand types, behaviour, and design principles of shell and folded plate structures.	-	-	-
CO2	Analyse and design space frames, nodes, and tensegrity structures using theoretical and computational methods.	PO1 (3) PO3 (3)	3	2
CO3	Apply modelling tools and special methods to develop and evaluate complex structural configurations.	PO1 (3) PO2 (2) PO3 (2)	2	3

ST25018	Emerging Trends in Structural Engineering	L	T	P	C
		3	0	0	3

Course Objective: To understand the potential developments happening in structural engineering and to acquire the skills to leverage latest technologies in design, construction and maintenance of structures.

AI & ML for Engineering: Introduction: Introduction - Understanding AI Fundamentals - Machine Learning, reinforcement learning, supervised learning, unsupervised learning, Deep Learning, Neural Networks, AI Algorithms and Engineering Applications – Internet of Things.

Activity: Poster presentation on various types of NN

AI & ML for Structural Engineering: Implementation of AI in Structural Engineering: Procedures, Training and Testing Data Sets, Training an AI Model, Specialized AI Software for Structural Engineering.

Activity: Case study discussion on application of AI in structural Engineering

AI & ML for Structural Engineering : Case Studies: Applications of AI in Structural Engineering: Design Optimization, Analysis, SHM & Predictive Maintenance, Digital Twins; AI for Smart Infrastructure and Construction- Case Studies of Successful AI Implementations in Structural Engineering-Challenges and Future Trends of AI in Structural Engineering.

Activity: GA based optimization problem assignment

Smart Materials: Introduction to Smart Materials & Structures (SMS): Historical developments and potential applications, Piezoelectric materials, sensors, and actuators, Electrostrictive materials, sensors, and actuators, Magnetostrictive and magnetoelectric materials, sensors, and actuators, Magnetorheological and electrorheological fluid devices, Shape memory alloys and polymers: properties and devices.

Activity: AI application in construction – case study/real-time discussion

Smart Material Systems: Applications In Structural Engineering: Smart Materials for Structural Engineering: Structural Health Monitoring (SHM), Vibration Control, Energy Harvesting, Characterization of smart materials, Design and Optimization of Smart Material Systems using CAD and FEA software packages.

Activity: IOT application in structural engineering - Assignment

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology:

Poster Presentation - 10%

Assignment – 20%

Report preparation for field visit – 20%

Internal Examinations – 50%

References:

1. Charles R. Farrar, Keith Worden, Structural Health Monitoring: A Machine Learning, John Wiley & Sons, Ltd, 2013.
2. Ian Smith, Artificial Intelligence in Structural Engineering, Information Technology for Design, Collaboration, Maintenance, and Monitoring, Springer, 1998.
3. Russell and Norvig. Artificial Intelligence: A Modern Approach, Pearson Education India, 2015.
4. Gandhi and Thompson, B.S. Smart Materials and Structures, Chapman and Hall, 1992.
5. Banks, H. T., Smith, R. and Wang, Y., Smart Materials and Structures: Modeling, Estimation and Control, Wiley, 1996.
6. Clark, R., Saunders, W and Gibbs, B., Adaptive Structures: Dynamics and Control, Wiley, 1998.
7. Leo, DJ. Smart Material Systems: Analysis, Design, and Control, John Wiley & Sons, 2006.

E - Resources

1. NPTEL “Machine Learning, ML” by Prof. Carl Gustaf Jansson, KTH, The Royal Institute of Technology. https://onlinecourses.nptel.ac.in/noc25_cs50/
2. NPTEL “Smart Material, Adaptive Structures and Intelligent Mechanical Systems”, Dr. Nachiketa Tiwari, Dr. Bishakh Bhattacharya, IIT Kanpur, https://nptel.ac.in/courses/112104173.

	CO Description	**PO**	**PSO1**	**PSO2**
CO1	Explain AI, ML, and smart material fundamentals and their applications in structural engineering.	-	-	-
CO2	Apply AI and ML techniques for structural analysis, optimization, SHM, and predictive maintenance.	PO1 (3) PO3 (3)	3	2
CO3	Use smart materials and computational tools for designing, monitoring, and controlling structural systems.	PO1 (3) PO2 (2) PO3 (2)	2	3

ST25019	Strategies for Sustainable Design	L	T	P	C
		3	0	0	3

Course Objective: To develop an understanding of the concepts of sustainability and energy efficiency and to design sustainable and energy efficient structures.

Sustainability, Climatology and Heat Transfer in Buildings: Overview of Sustainability and Green buildings, SDGs', Selection of site – preservation and planning, Influence of climate on buildings, Basics of climatology, Earth – Sun relationship, Solar angles and sun path diagram, Design of shading systems. Basics of Thermodynamics, Convection/radiation heat transfer, Heat gain through various elements of a building – Thermal comfort – Indoor air quality – Visual Comfort – Integral approach.

Activity: Design of building for thermal and visual - assignment

Sustainable Materials for Reduction in Carbon Emission: Embodied energy, Operational energy in Building and Life cycle energy. Ecological foot print, Bio-capacity and calculation of planet equivalent - Sustainability issues for concrete: Carbon from Cement - Alternative fuel for cements. – strategies for minimization of natural resource utilization and water consumption in concrete - bricks and building blocks - Energy performance emission performance and financial performance - Volatile organic content (VOC) emission of Paints, Adhesive and sealants - green product certifications, Features of sustainable building materials and sustainable alternatives.

Activity: Calculation of Carbon emission of construction materials in a construction project

Operation Energy Efficiency of Buildings: Operational energy reduction and net zero building - Optimization through use of Evolutionary genetic algorithm - Energy management system – lighting and renewable energy and Energy Audit. Water Efficiency – Planning and design of water management system, Treatment and reuse. Waste management – Types of waste and its treatment methods, Construction and demolition waste management, Waste management in residential, commercial buildings, healthcare facilities.

Activity: Energy audit of a small building -assignment

Energy Ratings of Buildings: Life cycle assessment and its types – Modelling and Analysis, Greenhouse gas emission. Different phases of Green building project management. Green building rating systems- LEED, BREEAM and others, Indian Green building rating systems – IGBC & GRIHA, IGBC criteria for certification.

Activity: Real-time case studies on energy ratings of buildings

Sustainable Buildings - Case Studies and Analysis: Smart Buildings - Building Automation Systems - Case Studies in Smart Building Implementation - Overview of Building Energy Codes - Compliance Requirements for Energy-Efficient Buildings - Case Studies in Code Compliance - Real-World Examples of Energy-Efficient

Buildings - Lessons Learned from Successful Projects - Economic and Environmental Benefits - Overcoming Implementation Challenges. **Activity:** Group discussion on challenges and future of sustainable construction
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%
Assessment Methodology: Poster Presentation - 10% Assignment – 20% Report preparation for field visit – 20% Internal Examinations – 50%
References: 1. Majumdar, M. (Ed), Energy efficient Buildings in India, Tata Energy Research Institute, Ministry of Non Conventional Energy Sources, 2002. 2. Tyagi, A. K.(Ed), Handbook on energy audits and management, Tata Energy Research. 3. M.S. Sodha, N.K. Bansal et al., Solar Passive: Building Science and Design, Pergamon Press (1986). 4. Brown, G.Z. and DeKay, M., Sun, Wind and Light Architectural Design Strategies,John Wiley and Sons Inc, 2001. 5. Chilogioji, M.H., and Oura, E.N., Energy Conservation in Commercial and Residential Buildings, MarcelDekker Inc., New York and Basel, 1995. 6. Dubin, F.S. and Long, C.G., Energy Conservation Standards For Building Design, Construction and Operation McGraw Hill Book Company 1990.Institute, 2000.
E - Resources 1. NPTEL Energy Efficient Buildings, Mrs. Vandana Chandrakar & Mrs. Purvi Chandrakar Chhattisgarh Swami Vivekanand Technical University (CSVTU), Bhilai. https://onlinecourses.swayam2.ac.in/nou24_ge85/ 2. NPTEL United Nations Sustainable Development Goals (UN SDGs) by Prof. Shiva Ji, IIT Madras 3. NPTEL Sustainable Materials and Green Buildings, by Dr. B. Bhattacharjee, IIT Delhi

	CO Description	PO	PSO1	PSO2
CO1	Explain sustainability concepts, climatology, and heat transfer principles in building design.	-	-	-
CO2	Evaluate and select sustainable materials, energy-efficient systems, and water/waste management strategies for buildings.	PO1 (3) PO3 (3)	3	2
CO3	Apply green building rating systems, case studies, and optimization techniques for energy-efficient and smart building designs.	PO1 (3) PO2 (3) PO3 (2)	2	3