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, Physics, Chemistry)

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

SL – Self Learning

OE – Open Elective

L – Laboratory Course

T – Theory

LIT – Laboratory Integrated Theory

TCP – Total Contact Period(s)

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.		Advanced Steel Structures	T	3	0	0	3	3	ES (PC)
2.		Advanced Prestressed Concrete	T	3	0	0	3	3	ES (PC)
3.		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.		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.		Open Elective	---	3	0	0	3	3	OE
5.		Industry Oriented Course II	---	0	0	2	1	1	SD
6.		Practical Training (4 Weeks)	L	0	0	0	0	2	SD
7.		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.		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.		Non-linear Analysis of Structures	3	0	0	3	3
2.		Stability of structures	3	0	0	3	3
3.		Wind and Cyclone Effects on Structures	3	0	0	3	3
4.		Prefabricated Structures	3	0	0	3	3
5.		Advanced Concrete Technology	3	0	0	3	3
6.		Reliability Analysis of Structures	3	0	0	3	3
7.		Design of Formwork	3	0	0	3	3
8.		Maintenance, Repair and Rehabilitation of Structures	3	0	0	3	3
9.		Fiber Reinforced Polymer Composite Materials	3	0	0	3	3
10.		Design of Steel-Concrete Composite Structures	3	0	0	3	3
11.		Design of Masonry Structures	3	0	0	3	3
12.		Design of Industrial Structures	3	0	0	3	3
13.		Advanced Design of Foundation Structures	3	0	0	3	3
14.		Optimization Methods for Structural Engineering	3	0	0	3	3
15.		Structural Health Monitoring	3	0	0	3	3
16.		Design of Offshore Structures	3	0	0	3	3
17.		Performance of Structures with Soil-Structure Interaction	3	0	0	3	3
18.		Design of Bridge Structures	3	0	0	3	3
19.		Design of Shell and Spatial Structures	3	0	0	3	3
20.		Emerging Trends in Structural Engineering	3	0	0	3	3
21.		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