COEP Technological University

(Unitary Public University of Government of Maharashtra)

Wellesley Road, Shivajinagar, Pune - 411005

Department of Civil Engineering

Curriculum

(Structure, Evaluation Scheme and Course Content)

For

Post Graduate Program

Master of Technology

In

Structural Engineering

With Effect From

Academic Year 2025-2026

Master of Technology

Structural Engineering

Program Educational Objectives (PEOs)

I. Graduate will work as an expert in the field of Structural Engineering by acquiring advanced knowledge in the area of analysis and design of structural systems.

II. Graduate will analyze and solve complex problems of Structural engineering systems.

III. Graduate will exhibit professionalism, ethical approach, communication skills, and team work in their profession and adapt to modern trends by engaging in lifelong learning.

Program Outcomes (POs)

The student will:

PO1. Apply knowledge of science, mathematics, and engineering principles for developing problem solving attitude.

PO2. Write and present a substantial technical report/document.

PO3. Demonstrate a degree of mastery in Structural Engineering. (The mastery at a level higher than the requirements in the appropriate bachelor program.).

PO4. Gain knowledge/skill in integrating Structural Engineering concepts for collaborative multidisciplinary solutions, carry out planning and management of projects considering economic and financial factors as a member and as a leader of the team.

PO5. Recognize the need for and have ability in lifelong learning independently for professional advancement, demonstrate professional ethics, work culture and understanding of responsibility to contribute to community for sustainable development of society.

Correlation between the PEOs and the POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**
PEO 1	3	2	3	2	2
PEO 2	2	1	3	3	2
PEO 3	2	3	2	3	3

Master of Technology

Structural Engineering Curriculum Structure

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5
PSBC	Programme Specific Bridge Course	1	3	3.75
PCC + LC	Programme Core Course + Laboratory Course	8	24	30
PEC	Programme Elective Course	3	9	11.25
OJT	On Job Training	1	3	3.75
OE	Open Elective	1	3	3.75
LLC	Liberal Learning Course	1	1	1.25
SLC	Self-Learning Course	2	6	7.5
RM	Research Methodology	1	3	3.75
AEC	Ability Enhancement Course	1	2	2.5
Project	Project	2	22	27.5
	Total	**22**	**80**	**100**

M. Tech. Civil- Structural Engineering

NEP Curriculum Structure: 2025-26

Semester I

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PSMC	<tbd>	Numerical Methods in Structural Engineering	3	1	-	1	4	30	20	50	-	-
2	PSBC	<tbd>	Advanced Analysis of Structures	3	-	2	1	4	30	20	50	50	50
3	PCC	<tbd>	Solid Mechanics	3	-	-	1	3	30	20	50	-	-
4	PCC	<tbd>	Structural Dynamics	3	-	-	1	3	30	20	50	-	-
5	PCC	<tbd>	Advanced Design of RC Structures	3	-	-	1	3	30	20	50	-	-
6	PCC	<tbd>	Structural Engineering Laboratory - I	-	-	4	-	2	-	-	-	50	50
7	PEC-1	<tbd>	*Program Specific Elective Course – I* 1. Advanced Design of Steel Structures 2. Design of Special structures 3. Structural Health Monitoring 4.Computer Aided Design of Structures	3	-	-	1	3	30	20	50	-	-
8	RM	<tbd>	Research Methodology	2	1	-	1	3	30	20	50	-	-
			Total Credits	**25**									

Legends:
L-Lecture, **T**-Tutorial, **P**-Practical, **S**-Self Study, **Cr**-Credits, **ISE**: In-Semester-Evaluation, **ESE**: End-Semester-Evaluation, **MSE**: Mid-Semester Evaluation, **TA**: Teacher's Assessment, **CIE**: Continuous-Internal-Evaluation

Semester II

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	OE	<tbd>	Open Elective	3	-	-	1	3	30	20	50	-	-
2	PCC	<tbd>	Finite Element Method	3	-	2	1	4	30	20	50	50	50
3	PCC	<tbd>	Structural Design of Foundations	3	-	-	1	3	30	20	50	-	-
4	PCC	<tbd>	Earthquake Analysis and Design of Structures	3	-	-	1	3	30	20	50	-	-
5	PEC-2	<tbd>	*Program Specific Elective Course – II* 1.High Rise Structures 2. Bridge Engineering 3. Theory of Thin Plates and Shells 4. Structural Optimization	3	-	-	1	3	30	20	50	-	-
6	PEC-3	<tbd>	*Program Specific Elective Course – III* 1.Design of Prestressed Concrete Structures 2. Mechanics of Composite Materials 3. Advanced Concrete Technology 4.Application of Artificial Intelligence and Machine Learning in Structural Engineering	3	-	-	1	3	30	20	50	-	-
7	PCC	<tbd>	Structural Engineering Laboratory – II	-	-	4	-	2	-	-	-	50	50
8	AEC	<tbd>	Technical Communication Skills	1	-	2	1	2	50	50	-	100	-
9	LLC	<tbd>	Liberal Learning Course	-	-	2	2	1	-	-	-	100	-
			Total Credits			**24**							

- The department offers “MATLAB for Engineers” as Open Elective for students of other departments
- Exit option to qualify for PG Diploma in Civil: Structural Engineering:
- Eight weeks domain-specific industrial internship in the month of June-July after successfully completing the first year of the program

Semester III

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	SLC	<tbd>	Massive Open Online Course –I	3	-	-	1	3	-	-	100	-	-
2	SLC	<tbd>	Massive Open Online Course –II	3	-	-	1	3	-	-	100	-	-
3	OJT	<tbd>	Internship	-	-	-	-	3	-	-	100	-	-
4	Project	<tbd>	Dissertation Phase–I	-	-	22	12	11	-	-	-	70	30
			Total Credits	**20**									

Semester IV

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
2	Project	<tbd>	Dissertation Phase– II	-	-	22	12	11	-	-	-	70	30
			Total Credits	**11**									

SEMESTER I

Numerical Methods in Structural Engineering

Course Code: CSE-25001	**Credit: 4**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 1	TA: 20
Self-Study: 1	ESE: 50

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

1. Apply various iterative techniques to find the roots of non-linear algebraic and transcendental equations, and solve simultaneous linear and non-linear systems
2. Evaluate definite integrals and derivatives of functions using appropriate numerical methods
3. Compute the dominant eigenvalues and corresponding eigenvectors of matrices using iterative methods
4. Develop mathematical models for given experimental data by applying curve fitting techniques
5. Formulate and solve Ordinary and Partial Differential Equations (ODEs and PDEs) using appropriate numerical schemes and utilize computational software to analyze practical engineering and structural problems.

Unit 1: Solution of Non-Linear Algebraic and Transcendental Equations and Simultaneous Equations [9 Hrs]

Roots of nonlinear equations, multiple roots, Solution of Linear and Nonlinear Simultaneous Equations

Unit 2: Numerical Differentiation and Integration: [9 Hrs]

High Accuracy Differentiation Formulas, Derivatives of Unequal Spaced Data. Newton-Cotes formulae, Integration with unequal segments, multiple integration, Gauss Quadrature rule

Unit 3: Eigen Values and Eigen Vectors [9 Hrs]

Power method, Relaxation Method, Diagonalization method.

Unit 4: Curve Fitting: [9 Hrs]

Interpolation by Newton's Formulae, Lagrange Interpolating Polynomials, Spline Interpolation

Unit 5: Finite Difference Method [12 Hrs]

Solution of Ordinary and Partial Differential Equations, initial and boundary value problems, Applications to beam bending, beam vibration, plate bending, column buckling problems

Unit 6: Self-Study

Fundamentals of numerical methods Error analysis, Engineering Systems, Physical and Mathematical Modelling, Error Analysis Approximations and round off and Truncation errors, Eulers method, Improvement of Eulers method, Runge-Kutta Method, Applications of the above Numerical methods for different Structural Engineering problems using software such as EXCEL/MATLAB

Reference Books:

[1] Chapra S C and Canale R P, Numerical Methods for engineering. Mcgraw-HillInc, 8th Edition, 2021.

[2] Scheid F, Theory and problems of Numerical analysis. New York. McGraw Hill Book Co.(Shaum Series), 2nd Edition 1988

[3] Sastry S S, Introductory Methods of Numerical Analysis. Prentice-Hall of India, 5th Edition, 2012.

Web Resources:

[1] Numerical Methods for Engineers, IIT by Prof. Niket Kaisare, Madras (NPTEL) https://nptel.ac.in/courses/127106019

[2] Numerical Methods in Civil Engineering, by Dr. A. Deb, IIT Kharagpur (NPTEL) https://nptel.ac.in/courses/105105043

[3] Numerical Methods And Simulation Techniques for Scientists and Engineers, by Prof. Saurabh Basu, IIT Guwahati https://nptel.ac.in/courses/115103114

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	1	1
CO2	3	1	3	1	1
CO3	3	1	3	1	1
CO4	3	1	3	1	1
CO5	3	1	3	2	2

1 – Slightly; 2 – Moderately; 3 – Substantially

Advanced Analysis of Structures

Course Code: CSE-25002	**Credit: 4**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Lab: 2	TA: 20
Self-Study: 1	ESE: 50

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

1. Analyse indeterminate structures using Flexibility method.
2. Develop member stiffness matrices for Framed structures.
3. Analyse pin-jointed trusses using Stiffness method.
4. Analyse Beams and Frames using Stiffness method.
5. Analyze Framed structures using computer programs.

Unit 1: Basic Concepts of Structural Analysis: [8 Hrs]

Types of Framed Structures, Deformations in Framed Structures, Actions and Displacements, Equilibrium, Compatibility, Static and Kinematic Indeterminacy, Principle of Virtual Work, Principle of Minimum Potential Energy, Castigliano's Theorem, Action and Displacement Equations.

Unit 2: Flexibility Matrix Methods: [8 Hrs]

Flexibility Method, Temperature Changes, Pre-strains, and Support Displacements, Joint Displacements, Member End-Actions, and Support Reactions, Flexibilities of Prismatic Members.

Unit 3: Stiffness Matrix Method: [8 Hrs]

Stiffness Method Temperature Changes, Pre-strains and Support Displacements, Stiffness of Prismatic Members, Formalization of the Stiffness Method.

Unit 4: Direct Stiffness Method: [8 Hrs]

Rotation of Axes in Two Dimensions, Application to Plane Truss Members, Rotation of Axes in Three Dimensions, Plane Frame Member Stiffnesses, Analysis of Plane Frames, Analysis of Grids, Analysis of Space Trusses, Analysis of Space Frames.

Unit 5: Introduction to Finite Element Method: [8 Hrs]

Introduction, Stresses and Strains in Continua, Virtual-Work Basis of Finite Element Method, One-Dimensional Elements, Weighted residual formulation.

Unit 6: Self-Study

Loads between Joints, Oblique Supports, Elastic Supports, Elastic Connections.

Reference Books:

[1] Madhu Kanchi, "Matrix Methods of Structural Analysis", New Age Publications, 2016

[2] William Weaver and James Gere, "Matrix Analysis of Framed Structures", Van Nostrand, 1990

[3] William McGuire, Richard Gallagher and Ronald Ziemian, "Matrix Structural Analysis", Bucknell Publications, 2000.

[4] Devdas Menon, "Advanced Structural Analysis", Alpha Science International, 2009.

[5] Igor Karnovsky and Olga Lebed, "Advanced Methods of Structural Analysis", Springer Publications, 2010.

[6] Mohamed Abdel-Rohman, "Analysis of Structures", BookSurge Publishing, 2011

Web Resources:

[1] Matrix Methods of Structural Analysis, Prof. Amit Shaw and Prof. Biswanath Banergy, IIT Kharagpur, (NPTEL) https://nptel.ac.in/courses/105105180

[2] Structural Analysis, by Dr. R. S. Jangid, Dr. Siddharth Ghosh, IIT Bombay (NPTEL) https://nptel.ac.in/courses/105101085

[3] Advanced Structural Analysis, Dr. Devesh Punera, IIT Bhubaneshwar (NPTEL) https://nptel.ac.in/courses/105105690

Suggested List of Lab Assignment:

[1] Flexibility Analysis of Truss Structures
[2] Flexibility Analysis of Beams and Frames
[3] Analysis of Continuous Beams
[4] Analysis of 2-D Truss Structures
[5] Analysis of 2-D Frame Structures
[6] Analysis of Grid Structures
[7] Analysis of Space Truss Structures
[8] Analysis of Space Frame Structures

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	1	1
CO2	3	1	3	1	1
CO3	3	2	3	2	1
CO4	3	3	3	2	2
CO5	3	2	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Solid Mechanics

Course Code:	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 0	TA: 20
Self-Study: 1	ESE: 50

Course Outcomes: At the end of the course, the students demonstrate the able to:
1. Understand Principles of 3D Elasticity to be used for the analysis of structures.
2. Solve simple elasticity problems.
3. Apply above principles to solve complex problems of mechanics.
4. Solve the problem of non-circular sections subjected to torsion.
5. Apply the concept of theories of failure to mechanic's problems.

Unit 1: Introduction **[8 Hrs]**
Review of Strength of Materials, Concept of state of stress at a point, Analysis of principal planes and principle stress in 2D using analytical and graphical methods and Introduction to 3D Theory of Elasticity and Indicial Notation.

Unit 2: Stress **[8 Hrs]**
Introduction to stress tensor in 3D, Stress Transformation, Principal Stresses, Stress Invariant, Max Shear Stress., Differential Equations of Equilibrium in cartesian and cylindrical co-ordinate systems.

Unit 3: Strain **[8 Hrs]**
Introduction to strain tensor in 3D, Strain-Displacement Relationships, Strain Transformation, Strain Compatibility conditions.

Unit 4: Constitutive Relations **[8 Hrs]**
Generalized Hooke's Law for Homogeneous Isotropic material, Orthotropic Material and Anisotropic Material. Generalized Hook's Law for advanced materials.

Unit 5: Applications **[8 Hrs]**
Airy's Stress function approach for plane stress and plane strain conditions, application to Beam Bending problems, Torsion of Cylindrical Bars and Non-Circular Prismatic Bars.

Unit 6: Self-Study (Theories of Failure)
Plastic deformations, Yield Criteria, Theories of Failure, Application of theories of Failure. Stress-Strain relation for plastic deformation

Reference Books:

[1] L S Srinath," Advance Mechanics of Solid", Tata Mc-Graw Hill Publications, 2009.
[2] Mohammed Ameen," Computational Elasticity", Narosa Publishing House, 2005.
[3] Mrtin H. Sadd, "Elasticity", Academic Press – Elsevier, 2005.
[4] Carl T. Herakovich, "A Concise Introduction to Elastic Solids", Tata Mc-Graw Hill Publications, 2008.
[5] Boresi A. P., Richard J. Schmidt., "Advanced Mechanics of Materials", (Sixth Edition) Wiley Publishing, 2003.
[6] Arvind Kumar Singh., "Mechanics of Solids", Prentice Hall of India, 2007.

Web Resources:

[1] Mechanics of Solid, by Prof. Priyanka Ghosh, IIT Kanpur (NPTEL)
https://onlinecourses.nptel.ac.in/noc22_ce46/preview

[2] Solid Mechanics, by Prof. Ajeet Kumar, IIT Delhi (NPTEL)
https://onlinecourses.nptel.ac.in/noc24_me97/preview

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	1	2
CO2	3	1	3	1	1
CO3	3	1	3	2	2
CO4	3	1	3	1	2
CO5	3	1	3	1	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Structural Dynamics

Course Code: CSE-25001	**Credit: 03**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 0	TA: 20
Self-Study: 0	ESE: 50

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

1. To apply the fundamental theory of structural dynamics and equation of motion to field problems.
2. To find the response of the single and multi-degree-of-freedom systems.
3. To evaluate vibration characteristics of distributed parameter systems.
4. To interpret and apply the response spectrum method to solve structural dynamics problems.
5. To apply structural dynamics concepts for response control of structures.

Unit 1: Introduction and Single Degree of Freedom Systems (SDOF) [8 Hrs]

Objectives of study, Importance of vibration analysis, difference between static and dynamic loading. Nature of exciting forces, Mathematical modeling of dynamic systems, Development of equation of motion for lumped mass system. Free and forced vibration with and without damping, Response to harmonic loading, Response to general dynamic loading using Duhamel's integral. Numerical solutions to response of linear and non-linear systems using Newmark β method**.**

Unit 2: Multi Degree of Freedom (MDOF) System (Lumped parameter) [8 Hrs]

Multi Degree of Freedom System (up to 3 DOF). Formulation of mass, stiffness and damping matrices. Determination of natural frequencies and mode shapes. Dynamic response by modal superposition method. Dynamic analysis of beams. Time history response of MDOF systems using Newmark β method.

Unit 3: Multi Degree of Freedom (MDOF) System (Distributed parameter) [8 Hrs]

Development of equation of motion, Single span beams, free and forced vibration response, Natural frequencies and mode shapes of uniform beams.

Unit 4: Response Spectra Method [8 Hrs]

Theory and development of response spectra, Codal provisions, tripartite response spectra, Simple Problems

Unit 5: Applications of structural dynamics [8Hrs]

Introduction to techniques of vibration response control. Base isolation of SDOF.

Unit 6: Self Study [8Hrs]

Duhamel's Integral, Fourier analysis for periodic loading, Dynamic analysis of plane frames, tripartite response spectra problems, base isolation of 2-DOF system, Introduction to machine foundation, 3 DOF, Response spectra.

Reference Books:

[1] Anil K. Chopra, “Dynamics of Structures – Theory and Applications to Earthquake Engineering”, Pearson, 3rd Edition, 2011

[2] Gary Hart and Kevin Wong, “Structural Dynamics for Structural Engineers”, John Wiley and Sons, 2000

[3] J. W. Smith, “Vibration of Structures. Application in Civil Engineering Design”, Chapman and Hall, 1988

[4] Mario Paz and William Leigh, “Structural Dynamics - Theory and Computation, Updated
With Sap 2000”, 5thEdition, Kluwer Academic Publishers.

[5] Clough and J. Penzien, “Dynamics of Structures”, Computers & Structures, Inc., University
Ave, Berkeley, USA, 1995.

[6] Leonard Meirovitch, “Fundamentals of Vibrations”, Tata Mc Graw Hill, 2001

[7] IS 1893(2016) Criteria for Earthquake Resistant design of buildings (Part I): General provisions and Building – Code of Practice (Sixth Revision), Bureau of Indian Standards, New Delhi.

[8] IS 1893(2022) Criteria for Earthquake Resistant Design of Structures - Part 6 Base Isolated Buildings.

Web Resources:

[1] Structural Dynamics (NOC) by Prof. Ramancharala Pradeep Kumar, IIIT Hyderabad (NPTEL) https://nptel.ac.in/courses/105106151.

[2] Vibration and Structural Dynamics by Prof. Mira Mitra, IIT Kharagpur (NPTEL) https://onlinecourses.nptel.ac.in/noc21_ae15/preview.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	1	2
CO2	3	1	3	2	2
CO3	3	1	3	2	2
CO4	3	2	3	2	3
CO5	3	2	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Advanced Design of RC structures

Course Code: CSE-25001	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 1	TA: 20
Self-Study: 1	ESE: 50

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

1. Analyze the structural behavior and design principles of complex systems like grid floors and flat slabs.
2. Design storage structures for granular and liquid materials, including bunkers, silos, and water tanks, considering relevant pressure theories and stability requirements.
3. Analyze and design special structural elements such as deep beams, curved beams, domes, and spherical shells using appropriate theories.
4. Design ground-supported and elevated water-retaining structures, incorporating hydrostatic, hydrodynamic, and membrane action principles.
5. Explain modern formwork systems and apply best practices for efficient, safe, and economical construction.

Unit 1: Grid Floors and Flat Slabs **[8 Hrs]**

Analysis and design of grid floors. Direct Design and Equivalent Frame Methods for flat slabs. Design for shear and moment transfer. Detailing requirements as per IS 456.

Unit 2: Water Storage Structures: **[8 Hrs]**

Design of ground resting reservoirs and reservoirs resting below ground- Sump,

Unit 3: Elevated service reservoirs (ESR) **[8 Hrs]**

Design, Drawing and detailing of ESR

Unit 4: Deep and Curved Beams: **[8 Hrs]**

Design of deep beams using strut-and-tie methodology or IS 456 provisions. Design of beams curved in plan for bending, torsion, and shear.

Unit 5: Shell Structures: **[8 Hrs]**

Analysis and design of spherical domes with and without rings under various loading conditions. Design of conical bottom for Intze tanks.

Unit 6: Self-Study:

Basics of Formwork Objectives and requirements of formwork. Types of formworks (conventional, modular flying forms, tunnel forms).

Detailed design report/case study

Any prevailing advanced topic as suggested by the course coordinator

Textbooks:

[1] Varghese, P.C., *Advanced Reinforced Concrete Design*, 2nd ed., Prentice Hall of India.

[2] Krishna Raju, N., *Advanced Reinforced Concrete Design*, 3rd ed., CBS Publishers & Distributors.

[3] Punmia, B.C., *Reinforced Concrete Structures*, 7th ed., Laxmi Publications.

[4] *IS 456:2000 *Plain and Reinforced Concrete - Code of Practice**.

[5] IS 2210:1988 *Criteria for Design of Reinforced Concrete Bunkers and Silos*.

[6] *IS 3370 (Parts 1-4):2009 *Code of Practice for Concrete Structures for Storage of Liquids**.

Reference Books/Codes:

[1] Varghese, P.C., *Advanced Reinforced Concrete Design*, 2nd ed., Prentice Hall of India.
[2] Krishna Raju, N., *Advanced Reinforced Concrete Design*, 3rd ed., CBS Publishers & Distributors.
[3] Punmia, B.C., *Reinforced Concrete Structures*, 7th ed., Laxmi Publications.
[4] Teng, J.G., *Design of Concrete Silos*, Springer.
[5] Timoshenko, S. and Woinowsky-Krieger, S., *Theory of Plates and Shells*, McGraw-Hill.
[6] *IS 456:2000 *Plain and Reinforced Concrete - Code of Practice**.
[7] IS 2210:1988 *Criteria for Design of Reinforced Concrete Bunkers and Silos*.
[8] *IS 3370 (Parts 1-4):2009 *Code of Practice for Concrete Structures for Storage of Liquids**.
[9] *SP 16:1980 Design Aids for Reinforced Concrete to IS 456:1978*.
[10] *SP 34:1987 Handbook on Concrete Reinforcement and Detailing*.

CO-PO Articulation matrix:

	Program Outcomes (POs)				
Course Outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	2	1
CO2	3	1	3	2	1
CO3	3	1	3	2	1
CO4	3	1	3	2	1
CO5	2	3	2	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Structural Engineering Laboratory – I

Course Code: CSE (PE)2500	**Credit: 2**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Practical: 4	MSE: 50
Tutorial : 0	ESE: 50
Self-Study: 1	

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

1. Use different software tools to analyze and design the structure.
2. Analyse the structure for gravity and lateral load.
3. Function as team member for laboratory work.
4. Handle appropriate equipment and tools.
5. Design simple experiments related to structural systems

Part A

Laboratory Experiments using commercially available structural software's such as STAAD. Pro, ETABS, SAP2000 and MIDAS GEN:

Training software:

a) Analysis and Design of Steel Structures

- Analysis of plane frames for lateral loading
- Analysis of industrial shed for gravity and lateral load

b) Analysis and Design of RCC structures

- Analysis of RCC frame
- Analysis and design of RCC building for lateral loading

Part B

a) Laboratory Experiments:

- Estimation of compressive strength of concrete using Rebound Hammer
- Estimation of compressive strength of concrete using UPV
- Corrosion prediction and analysis for RC member
- Free vibration response of Steel Beam
- Free vibration response of Frames

Part C

Site Visits (Minimum Two)

Reference Books:

[1] Subramanian, N, Steel Structures: Design and Practice. India, Oxford University Press, 2016.

[2] Duggal, S. K, Limit State Design of Steel Structures, Tata McGraw Hill, 2017.

[3] N. Krishna Raju, Advanced Reinforced Concrete Design, 4 th edition, CBS Publishers.

[4] P.C. Varghese, Advanced Reinforced Concrete Design, 2nd edition, Prentice Hall of India

[5] M. Paz and W. Leigh, Integrated Matrix analysis of Structures, Kluwer Academic, 2001.

[6] M. Paz and W. Leigh, Structural Dynamics Theory and Computation, Kluwer Academic, 2004.

[7] V. M. Malhotra and N. J. Cariano, Handbook of Non-destructive Testing of Concrete, CRC Press, 2003

BIS codes: IS800-2007, IS 456-2000, IS875-1987-Parts I, II, IS875-2016-Parts III, IS 1893.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	3	2	3	2	2
CO3	1	2	1	3	1
CO4	1	1	1	2	2
CO5	3	3	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Advanced Design of Steel Structures

Course Code: CSE (PE)-25001	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 0	TA: 20
Self-Study: 1	ESE: 50

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

1. Apply plasticity concepts to steel members.
2. Demonstrate the connection design.
3. Design steel frames for torsion.
4. Design the plate girder.
5. Design of the gantry girder.

Unit 1: Plastic Characteristics of structural steel: [8 Hrs]

Introduction to various geometric forms of structures- Loads on engineering structures, Failure analysis, Material properties of structural steel under normal and high temperature. Plastic behaviour of structures- shape factor- Moment curvature relationships. Plastic design of structures.

Unit 2: Connection Design: [8 Hrs]

Design of rigid, semi-rigid and flexible connections, Design of splices, Haunched connections.

Unit 3 Torsion: [8 Hrs]

Design of laterally supported beam, Lateral torsional bucking of beams, Beam columns: Design for torsion, elastic torsional buckling, Buckling of columns and frames.

Unit 4: Transfer Girder design [8 Hrs]

Plate girder design -shear buckling, Design methods, End panel design, Load carrying stiffeners, Intermediate web stiffeners, Bearing stiffeners, Diagonal stiffeners, Tension stiffeners, Torsional stiffeners.

Unit 5: Gantry Girder Design [8 Hrs]

Introduction, Fatigue effects on gantry girders, forces in the flange due to torsion

Unit 6: Self-Study

Introduction to Pre-engineered Buildings. Design of industrial shed considering gravity and wind loads.

Reference Books:

[1] Subramanian, N.. Steel Structures: Design and Practice. India, Oxford University Press, 2016.
[2] Duggal, SK, Limit State Design of Steel Structures, Tata McGraw Hill, 2017.
[3] Edwin H. Gaylord, Charles N. Gaylord, James E. Stallmeyer ,Design of Steel Structures. McGraw Hill, 3rd Edition
[4] John Baker and Jacques Heyman, Plastic design of frames: Fundamentals, Cambridge University press, 2024.
[5] Baker, Horne and Heyman, "The steel skeleton: Plastic behaviour and design", (Vol II), Cambridge University press, 1956.
[6] N.S. Trahair, M.A. Bradford, D.A. Nethercot, and L. Gardner, The Behavior and Design of Steel Structures to EC3, 4th edition, Taylor and Francis

BIS codes: IS800-2007, IS875-1987-Parts I, II, IS875-2016-PartsIII, SP:6– Part 1 to 6

Web Resources:

[1] Advanced design of steel structures by Prof. Srinivasan Chandrasekaran, IIT Madras (NPTEL) https://onlinecourses.nptel.ac.in/noc22_oe02/preview
[2] Design of Connections in Steel Structures by Prof. Anil Agarwal, IIT Hyderabad (NPTEL) https://onlinecourses.nptel.ac.in/noc25_ce65/preview
[3] Design of Steel Structures by Prof. Damodar Maity, IIT Kharagpur (NPTEL) http://www.digimat.in/nptel/courses/video/105105162/L01.html

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	1	2
CO2	3	2	3	2	2
CO3	3	1	3	1	2
CO4	3	2	3	2	2
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Design of Special Structures

Course Code:	**Credit: 3**
Teaching Scheme:3 Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: -	TA: 20
Self-Study: 1	ESE: 50

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

CO1: To understand the design philosophy of blast resistant design of structures.
CO2: To understand the fundamental concepts of precast concrete design.
CO3: Apply the principles of modular planning, standard specifications, and finishing requirements for precast building systems.
CO4: To acquire knowledge of design of offshore structures
CO5: To develop the ability to apply computational tools, interaction methods, and modern design concepts for practical structural engineering problems, including self-directed project work.

Unit 1 — Introduction to Blast Resistant Design and Loading (8 hrs)
Factors affecting blast resistant structures, Blast wave and its propagation, Factors affecting blast load, Structural Analysis for Impulsive Loading, Analysis methods to predict behaviour of blast load, Material behaviour under High Strain-Rate of Loadings, Response of the structures to blast load.

Unit 2 — Blast Resistant Design and Detailing (8 hrs)
Design Procedure, Performance-Based Blast Design, Structural detailing, Anti-Terrorism Planning and Design of Facilities, Blast Retrofitting techniques for Building Structure.

Unit 3 — Introduction to Precast concrete and its Elements (8 hrs)
Definition and necessity of precast, Advantages and disadvantages, Materials used, Study of Precast Structural Building components, Non-structural precast concrete elements, IS specifications, casting tolerances, fabricating systems, joints, storage and transportation, Testing of Precast components.

Unit 4 —Precast Buildings (8 hrs)
Concept and Benefits of Prefabricated Construction, Prefabricated Construction Process. Precast load bearing and non-load bearing wall panels, floor systems, Material characteristics, Plans & Standard specifications, concept of modules, modular grids and finishes. Prefab systems and its classification, structural schemes. Joints – requirements of structural joints and their design considerations for above elements. Manufacturing, storage, curing, transportation and erection of above elements, equipment needed.

Unit 5 — Introduction to Offshore Structures (8 hrs)
Introduction, Loads on Offshore Structures Wind Loads; Wave and Current Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth; Fatigue Load Definition and Joint Probability distribution; Seismic Loads.

Unit 6 — Self-Study / Project-Based Learning
Students to undertake a mini-project applying RC or steel design principles to a chosen structural problem based on syllabus

Reference Books:

1. S. Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design, 3rd Edition, 2009, Tata Mcgraw Hill
2. J. Wight and J.G. MacGregor, Reinforced Concrete - Mechanics & Design, 6th Edition, Prentice-Hall, 2011
3. A Nilson, D Darwin, C Dolan Design of Concrete Structures, McGraw-Hill Education; 14 edition (16 August 2009), 816 pages.
4. TM-5-1300, UFC 3-340-02, Impact by Werner Goldsmith
5. Dawson, T. H., Offshore Structural Engineering, Prentice Hall, 1983.
6. McClelland, B & Reifel, M. D., Planning & Design of fixed Offshore Platforms, Van Nostrand, 1986.
7. B.C Gerwick, Jr. Construction of Marine and Offshore Structures, CRC Press, Florida, 2000.
8. Hydrodynamics of Offshore Structures by S.K. Chakrabarti, Springer Verlag

Web Resources:

Blast and Impact Resistant Structures by Prof. Hrishikesh Sharma, Indian Institute of Technology, Guwahati Blast and Impact Resistant Structures - Course

Ocean Engineering by Dr. S. Nallayarasu, Department of Ocean Engineering, IIT Madras
https://onlinecourses.nptel.ac.in/noc25_ce132/preview

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	2	3
CO2	2	1	3	2	2
CO3	3	2	3	3	2
CO4	3	1	3	2	3
CO5	3	3	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Structural Health Monitoring

Course Code: CSE-25008 **Credit: 3**

Teaching Scheme: Hrs/Week **Examination Scheme:**

Lectures:	3	MSE:	30
Tutorial:	0	TA:	20
Self-Study:	1	ESE:	50

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

CO 1: Observe the status of structure from Visual observation and NDT Test

CO 2: Conduct structural audit.

CO 3: Suggest repairing methods and or retrofitting technique for strengthening of structural member and or structure.

Unit 1: Introduction **[8 Hrs]**

Need of structural Health Monitoring (SHM): Factors affecting health of structures, cau distress, load variation, material variations, Structural health monitoring. Various mea regular maintenance, Advantages of SHM.

Unit 2: **[8 Hrs]**

Visual Inspection of structure, techniques. Different types of NDT tests.

Unit 3: **[8 Hrs]**

Structural audit, Role of Engineer, Purpose, survey of structural defects, Guidelines for str audit, Case studies. Cracks in structural members, types, measurements of cracks. Performa structure for different loading, failure of structures, different techniques for repairs of crack

Unit 4: **[8 Hrs]**

Carbonation of concrete, concept, deterioration of concrete, corrosion of reinforcement. Sett of structures.

Unit 5: **[8 Hrs]**

Structural repairs and retrofitting, Different techniques, case studies, safety of structures.

Reference Books:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitorin John Wiley and Sons, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Me with Applications, John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastr Vol- 1, Taylor and Francis Group, London, U.K, 2006.

Web Resources:

1. *Structural Health Monitoring* – Prof. S. Bhalla, IIT Delhi (NPTEL)
2. *Vibration-Based Condition Monitoring* – Prof. P. Srinivasan, IIT Madras (NPTEL)
3. SHM System Tutorials – National Instruments and Dewesoft Learning Portal
4. *Machine Learning Applications in SHM* – MIT OpenCourseWare
5. *Bridge Monitoring Case Studies* – FHWA/National Bridge Institute

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	3	3	2	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Computer-Aided Analysis and Design

Course Code: CSE-25007	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: -	TA: 20
Self-Study: 1	ESE: 50

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

1. To understand the fundamentals and significance of computer-aided analysis and design in civil engineering applications.
2. To acquire programming skills and computational techniques required for implementing CAAD solutions.
3. To apply database management and knowledge-based expert systems for civil engineering decision-support and project management.
4. To utilize simulation, finite element, optimization, and advanced computational methods for solving civil engineering problems.
5. To develop independent projects implementing CAAD concepts using programming tools, simulation, and computational techniques for practical civil engineering applications.

Unit 1 — Introduction (8 hours)

Overview of Computer-Aided Analysis and Design (CAAD) and its importance in civil engineering. Need for CAAD in structural, geotechnical, and construction management applications. Basics of computer graphics and programming environment. Introduction to matrix methods for structural analysis, stiffness matrices, coordinate transformations, and fundamental numerical methods for civil engineering problems.

Unit 2 — Programming for CAAD (8 hours)

Programming concepts for CAAD applications: variables, data types, operators, control structures, functions, arrays, pointers, and recursion. Object-oriented programming essentials. Input-output handling, file management, and basic data structures (trees, stacks, queues). Practical examples for civil engineering problems.

Unit 3 — Database Management and Knowledge-Based Systems (8 hours)

Introduction to Database Management Systems (DBMS): components, data models, query languages, and database design for engineering applications. Fundamentals of knowledge-based expert systems: AI overview, knowledge representation, inference mechanisms, rule-based systems, and expert system shells. Applications in construction management and structural decision-support.

Unit 4 — Simulation and Computational Techniques (8 hours)

Simulation concepts: system modeling, types of models, deterministic and stochastic approaches. Introduction to computational methods: Finite Element Method (FEM), optimization techniques, genetic algorithms, and fuzzy logic. Applications of computational tools for structural analysis, building technology, and civil engineering problem-solving.

Unit 5 — Advanced Boolean Algebra and Timing/Power Analysis (8 hours)

Advanced Boolean algebra concepts: Boole-Shannon expansion, Boolean difference, cofactors, consensus, unate functions, and positional cube representation. Graph-based algorithms for Boolean functions, Binary Decision Diagrams (BDDs), Reduced Ordered

BDDs (ROBDDs), and canonical representations. Applications in verification, power and timing analysis, Monte Carlo simulation, and large-scale civil engineering data processing.

Unit 6 — Self-Study / Project-Based Learning
Students perform a mini-project implementing CAAD concepts using programming languages and tools. Possible topics include structural analysis, optimization of civil structures, simulation of construction processes, database-driven design tools, or development of simple expert systems. Emphasis on problem formulation, algorithm implementation, result visualization, and interpretation. Deliverables: concise report and presentation.

Reference Books:

1. Krishnamoorthy, C.S., *Computer Aided Design: Theory and Practice*, Narosa Publishing House.
2. Chopra, S., *Computer-Aided Structural Analysis and Design*, Tata McGraw-Hill.
3. Logan, D.L., *A First Course in the Finite Element Method*, Cengage Learning.
4. Bhavikatti, S.S., *Finite Element Analysis*, New Age International.
5. Hibbeler, R.C., *Structural Analysis*, Pearson Education.

Web Resources:

1. NPTEL Course: *Computer Aided Design and Analysis* – Prof. S.R. Satish Kumar, IIT Madras
2. NPTEL Course: *Finite Element Analysis of Solids and Structures* – Prof. S. Srinivasan, IIT Madras
3. Bentley STAAD.Pro Learning Portal – https://education.bentley.com
4. Autodesk Structural Design Tutorials – https://www.autodesk.com/education
5. NPTEL Course: *Building Information Modeling* – Prof. Koshy Varghese, IIT Madras

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	2	2	3
CO2	3	1	2	2	3
CO3	2	1	1	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

SEMESTER II

Finite Element Method

Course Code: CSE-25001	**Credit: 4**
Teaching Scheme:3 Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Lab: 2	TA: 20
Self-Study: 1	ESE: 50

Course Outcomes: At the end of the course, the students demonstrate the ability to:

1. Formulate numerical models to solve mathematical problems related to structural engineering.
2. Solve structural engineering problems using a one-dimensional finite element.
3. Solve structural engineering problems using two and three-dimensional elements.
4. Solve simple free vibration problems.
5. Use the commercial software/ Computer programs for the analysis of Structures

Unit 1: Introduction **[8 Hrs]**

History and applications. General steps of the Finite Element Method, Concept of stiffness matrix and load vector. Application of boundary conditions.

Unit 2: One-dimensional Finite Element Analysis: **[8 Hrs]**

Bar elements, analysis of plane and space trusses, beam element and analysis of beams

Unit 3: Two-dimensional Finite Element Analysis: **[8 Hrs]**

CST and LST elements for the analysis of plane stress and plane strain problems, Rectangular and quadrilateral elements for the analysis of plane stress and plane strain problems.

Unit 4: Three-dimensional Finite Element Analysis: **[8 Hrs]**

Tetrahedral and hexahedral elements. Analysis of Axi-Symmetric solids.

Unit 5: Vibration Problems: **[8 Hrs]**

Lumped Mass Matrix, consistent Mass matrix, algorithm for Free vibration

Unit 6: Self-Study

Pre-processing, solution, Post-processing, Use of commercial FEA software for Structural problems.

Reference Books:

[1] P. Seshu, Finite Element Analysis, 1st ed. New Delhi, India: Prentice-Hall of India, 2003.

[2] A. D. Belegundu and T. R. Chandrupatla, Finite Element Methods in Engineering, 2nd ed. New Delhi, India: Prentice-Hall of India, 1991.

[3] Y. M. Desai, T. I. Eldho, and A. H. Shah, Finite Element Method with Applications in Engineering, 1st ed. Gurgaon, India: Pearson Education, 2011.

[4] D. V. Hutton, Fundamentals of Finite Element Analysis, 1st ed. New Delhi, India: Tata McGraw-Hill, 2004.

[5] D. Logan, A First Course in the Finite Element Method, 5th ed. Boston, MA: Prentice Hall, 2011.

Web Resources:

[1] Basics of Finite Element Analysis, Prof. Nachiketa Tiwari, IIT Kanpur, (NPTEL) https://nptel.ac.in/courses/112104193

[2] Introduction to Finite Element Method, by Dr. R.Krishnakumar, IIT Madras, (NPTEL) https://nptel.ac.in/courses/112106135

[3] Finite Element Analysis, Dr. B. N. Rao, IIT Madras, (NPTEL) , https://nptel.ac.in/courses/105106051

Suggested List of Lab Assignments:

1. Shape Functions for Beam Elements.
2. Study of Shape Functions for Iso-parametric Elements.
3. Finite Element Analysis of Plane Stress Problems.
4. Finite Element Analysis of Plane Strain Problems.
5. Analysis of axisymmetric structure.
6. Finite Element Analysis of Raft foundations.
7. Free Vibration Analysis of Beam Structures.
8. Sanalysis of water tanks using computer program.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	2	2
CO2	3	1	3	2	2
CO3	3	2	3	2	2
CO4	3	1	3	2	2
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Structural Design of Foundations

Course Code:	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures:	3 Hrs MSE: 30
Self-Study:	1 Hrs TA: 20
Tutorial:	1 Hrs ESE: 50

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

1. CO1: Analyze load transfer mechanisms and structural behavior of shallow foundations including isolated and combined, and raft footings.
2. CO2: Design shallow foundations as per IS codes and prepare accurate reinforcement detailing for isolated and combined footings.
3. CO3: Design deep foundation systems such as piles and pile caps for varied loading and soil conditions.
4. CO4: Analyze and design well and caisson foundations using relevant IS provisions to ensure stability, safety, and structural performance.
5. CO5: Evaluate foundations for uplift, seismic, and durability requirements, and explore emerging foundation technologies through case studies or reviews.

Unit 1: Isolated & Combined Footings: [7 Hrs]

Analysis and design of isolated square/rectangular footings, combined footings (rectangular, trapezoidal, strap). Effects of eccentric loading. Detailing of reinforcement

Unit 2: Raft Foundations: [7 Hrs]

Structural design of raft foundations using conventional and approximate methods. Rigid and flexible analysis. Introduction to FEM/plate analysis. Serviceability checks.

Unit 3: Pile Foundations [8 Hrs]

Classification of piles (end bearing, friction, bored cast-in-situ). Structural design of piles (axial, lateral, uplift). Pile group action. Design of pile caps using IS 2911.

Unit 4: Well & Caisson Foundations [7 Hrs]

Types, components, stability checks (tilt, shift). Structural design of well steining, base slab, and well cap. Design provisions for bridges and heavy loads.

Unit 5: Special Structural and Geotechnical Considerations [6 Hrs]

Uplift pressure due to rise in water table, seismic design aspects of foundations, settlement, leakage in basement

Unit 6: Self-study: Emerging Foundation Systems

Micro piles, diaphragm walls, jack piles, barrette piles. Construction practices, case studies,

Reference Books:

[1] P.C. Varghese, *Foundation Engineering*, PHI Learning.

[2] N. Krishna Raju, *Design of Reinforced Concrete Foundations*, CBS Publishers.

[3] J.E. Bowles, *Foundation Analysis and Design*, McGraw Hill.
[4] Tomlinson, M.J. & Woodward, J., *Pile Design and Construction Practice*, CRC Press.
[5] Poulos, H.G. & Davis, E.H., *Pile Foundation Analysis and Design*, Wiley.
[6] Teng, W.C., *Foundation Design*, McGraw Hill.
[7] IS 456:2000 – *Plain and Reinforced Concrete – Code of Practice*.
[8] IS 2911 (Parts 1–4): *Design and Construction of Pile Foundations*.
[9] IS 2950: *Design of Raft Foundations*
[10] *IRC Guidelines for Bridge Substructures*.

CO-PO Articulation Matrix:

	Program Outcomes (POs)				
Course Outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	2	1
CO2	3	1	3	2	1
CO3	3	1	3	2	1
CO4	3	1	3	2	1
CO5	2	2	2	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Earthquake Analysis and Design of Structures

Course Code: CSE-25001		**Credit: 4**	
Teaching Scheme: Hrs/Week		**Examination Scheme:**	
Lectures:	3	MSE:	30
Tutorial:	0	TA:	20
Self-Study:	1	ESE:	50

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

1. Calculate the seismic forces and displacements for Multi-Degree-of-Freedom (MDOF) systems.
2. Analyze RC and Steel Structural components with seismic considerations.
3. Design RC and Steel Structural components with seismic considerations.
4. Assess the nonlinear seismic performance of structures using methods like Pushover Analysis and Capacity Spectrum Method and recommend appropriate vibration control techniques.

Unit 1: Introduction: Seismic Design Considerations: [8 Hrs]
Important attributes of seismic design, concepts, Planning for Aseismic buildings, structural response, Principles of member design

Unit 2: Earthquake response of MDOF system with reference to IS 1893 [8 Hrs]
Equivalent static method, Response spectrum method, Linear Time history analysis, P-Δ effect, Torsion response of the building

Unit 3: Ductility Considerations in Earthquake Resistant Design of RC Buildings [8 Hrs]
Introduction- Impact of Ductility- Requirements for Ductility- Assessment of Ductility- Factors affecting Ductility- Ductile detailing considerations as per IS 13920. Behaviour of beams, columns and joints in RC buildings during earthquakes,

Unit 4: Seismic Design Considerations for Steel Buildings: [8 Hrs]
Performance of steel Structures in past earthquakes, Design philosophy for Steel Structures, Capacity Design concept, Ductility of Steel Buildings, Seismic Design and detailing of moment resisting frames

Unit 5: Performance-based seismic design: [8 Hrs]
Performance levels, Pushover analysis, Capacity spectrum method, Seismic coefficient method. Applications to beam bending, beam vibration, plate bending, and column buckling problems

Unit 6: Self-Study
Introduction to Vibration control techniques Base isolation, Elastomeric and friction isolators, Dampers for seismic response mitigation; Analysis, design and ductile detailing of structures for seismic loads with commercially available software/computer program

Reference Books:

[1] Bruce A. Bolt, "Earthquakes", 4th Edition, W. H. Freeman and Company, New York

[2] Farzad Naeim, "The Seismic Design Handbook", 2nd Edition, Kluwer Academic Publishers Group, 2003

[3] Thomas Paulay and M.J.N Priestley , "Seismic Design for R.C. and Masonry Building", John Wiley and Sons, 1992

[4] Sharad Manohar and Suhasini Madhekar, Seismic Design of RC Buildings – Theory and Practice, ISBN 978-81-322-2318-4 (Print Book), ISBN 978-81-322-2319-1 (eBook), Springer, 2015

[5] James Kelly and Farzad Naeim, " Design of Seismic Isolated Structures: From Theory to Practice", 1999, John Wiley and Sons

[6] IS 1893(Part 1) : 2016, "Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings", 5th Revision

[7] IS 1893(Part2) : "Criteria for Earthquake Resistant Design of Structures, Part 2: Liquid Retaining Tanks - Elevated and Ground Supported"

[8] IS 13920: 2016, "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces"

[9] IS 4326:1993, "Earthquake Resistant Design and Construction of Buildings

Web Resources:

[1] Introduction to Engineering Seismology by Prof. P. Anbazhagan (NPTEL) https://nptel.ac.in/courses/105108204

[2] Seismic Analysis of Structures, by Dr. T.K. Datta, Dr. Ashok Gupta IIT Delhi (NPTEL) https://nptel.ac.in/courses/105102016

[3] Introduction to Earthquake Engineering, by Dr. R.S. Jangid, IIT Bombay (NPTEL) https://nptel.ac.in/courses/105101004

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	2	2
CO4	3	3	3	2	3
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

High-Rise Structures

Course Code:	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Lectures:	3 Hrs MSE: 30
Self-Study:	1 Hrs TA: 20
Tutorial:	1 Hrs ESE: 50

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

1. CO1: Analyze the behavior of various structural systems used in high-rise buildings under lateral loads.
2. CO2: Apply relevant provisions of design codes (IS, NBC, ASCE) for wind and seismic analysis of tall buildings.
3. CO3: Analyze and design transmission towers and masts for gravity and wind loads.
4. **CO4:** Analyze and design reinforced concrete and steel chimneys under gravity, lateral, and thermal loads.
5. **CO5:** Evaluate advanced fire safety, sustainability, and disaster mitigation provisions for tall structures.

Unit 1: Introduction to High Rise Structures: [8 Hrs]

Design philosophy, structural concepts, load paths. Configurations and systems of tall buildings (moment resisting frames, shear walls, tube systems, outrigger systems, diagrids). Wind and seismic effects on tall structures. Dynamic behavior and vibration control devices.

Unit 2: Chimneys: [8 Hrs]

Structural systems of RC and steel chimneys. Load considerations: self-weight, wind, temperature, seismic forces. Analysis and design as per IS:4998 and IS:1893. Foundation design for chimneys on varied soil strata.

Unit 3: Transmission Towers and Masts: [8 Hrs]

Classification of towers (self-supporting, guyed). Design of transmission line towers for wind and earthquake loading. Detailing of bracing systems. Special provisions for TV towers and communication masts.

Unit 4: Tall Buildings: [6 Hrs]

Gravity and lateral load analysis of tall buildings. Wind tunnel studies. Earthquake-resistant design of tall buildings. Firefighting provisions and evacuation systems. Case studies of recent tall buildings in India and abroad.

Unit 5: Special Provisions in Codes: [6 Hrs]

Fire safety standards, disaster mitigation, sustainability requirements, and performance-based design. Provisions from IS codes, NBC, ACI, and Eurocodes.

Unit 6: Emerging Trends in High Rise Design:

Use of high-performance materials, prefabrication, damping devices, tuned mass dampers, base isolation, and sustainability practices. Students prepare case study reports or reviews on iconic tall structures.

Reference Books:

[1] Bungale S. Taranath, *Structural Analysis and Design of Tall Buildings*, CRC Press.

[2] P. Dayaratnam, *Design of Steel Structures*, S. Chand Publishing.

[3] P.C. Varghese, *Advanced Reinforced Concrete Design*, Prentice Hall of India.

[4] O.P. Jain & P. Jain, *Reinforced Concrete – Vol II*, Nem Chand & Bros, Roorkee

[5] S.N. Manohar, *Tall Chimneys: Design and Construction*, McGraw Hill, 1985.

[6] Ali Mir, *Structural Design of Tall Buildings*, McGraw Hill.

[7] Relevant IS Codes: IS 456, IS 4998, IS 1893, IS 800, National Building Code (NBC)

CO-PO Articulation Matrix

	Program Outcomes (POs)				
Course Outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	2	1
CO2	3	1	3	3	1
CO3	3	1	3	3	1
CO4	3	1	3	2	1
CO5	2	2	2	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Bridge Engineering

Course Code: CSE	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 0	TA: 20
Self-Study: 1	ESE: 50

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

1. Analyze the superstructure of bridges - slab, T-beam and Box type
2. Design the superstructure of bridges - slab, T-beam and Box type
3. Analysis of Bridge Substructures, bearings and wing walls.
4. Analyze and design the type of bearings

Unit 1: Introduction **[8 Hrs]**
Classification and Types. IRC Specifications for Road Bridges. Earthquake Resistant Design Considerations.

Unit 2: Analysis of Bridges **[8 Hrs]**
Concentrated loads on slabs, Load Distribution Theories - Courbon's method, Hendry- and Guyon-Massonet method.

Unit 3 : Design of PSC Bridge **[8 Hrs]**
Slab Type, T-beam Type, Box Type

Unit 4: Analysis and Design of Abutment and Pier **[8 Hrs]**
Introduction to the Design of Open Well, Pile and Caisson Foundations.

Unit 5: Analysis and Design of Wing Walls. **[8 Hrs]**
Analysis and Design of Wing Walls

Unit 6: Classification and Design of Bearings
Metallic bearings, Elastomeric bearings, POT and PTFE bearings

Reference Books:

[1] N. Krishna Raju, "Design of Bridges", Oxford and IBH Publishing Co. Ltd., New Delhi and Kolkata (2001)
[2] T.R. Jagdeesh, M. A. Jayaram, "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd., New Delhi (2003)
[3] D. Johnson Victor, "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. Ltd., 5th Edition, (2001)
[4] M.J.N. Priestley, G. M. Calvi, "Seismic Design and Retrofit of Bridges"
[5] IRC 6 (2014), Section II: Loads and Stresses.
[6] IRC 78 (2000), Section VII: Foundations and Substructures
[7] IRC 83 (1982), Section IX: Bearings, Part I: Metallic Bearings (1994)
[8] IRC 83 (1987), Section IX: Bearings, Part II: Elastomeric Bearings (1994)
[9] IRC 83 (1987), Section IX: Bearings, Part III: POT and PTFE Bearings (1994)
[10] IRC 112 (2012), Design Criteria for RCC and PSC Bridges

Web Resources:

[1] Bridge Engineering by Prof. Piyali Sengupta, IIT (ISM) Dhanbad (NPTEL) https://onlinecourses.nptel.ac.in/noc22_ce63/preview
[2] Reinforced Concrete Road Bridges by Prof. Nirjhar Dhang, IIT Kharagpur (NPTEL) https://onlinecourses.nptel.ac.in/noc22_ce73/preview

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	2	2
CO4	3	3	3	2	3
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Theory of Thin Plates and Shells

Course Code:	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: -	TA: 20
Self-Study: 1	ESE: 50

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

1. Formulate the governing plate equation in Cartesian coordinates based on the Poisson-Kirchoff assumptions and determine appropriate boundary conditions for thin rectangular plates.
2. Analyse rectangular plates subjected to various loads and support conditions by applying analytical techniques such as Navier's method and Levy's method.
3. Derive and solve the differential equations of plate theory in Polar coordinates to determine the deflection and stresses in circular plates under axis-symmetric loading.
4. Differentiate between various classifications of shell surfaces and explain the fundamental characteristics and behaviour of shell structures.
5. Apply the membrane theory to analyse the internal forces and displacements of shells of revolution and cylindrical shells subjected to different types of external loading.

Unit 1: Introduction to Plate Theory **[8 Hrs]**
Assumptions made in the Poission-Kirchoff plate theory, Plate equation and Boundary conditions, behavior of thin plates in Cartesian coordinates.

Unit 2: Analysis of Rectangular Plates **[8 Hrs]**
Cylindrical bending of plates, Navier's method of solution for simply supported plates subjected to different loading cases, Levy's method of solution for plates under different boundary conditions.

Unit 3: Analysis of Circular Plates **[8 Hrs]**
Governing differential equations of plate theory in Polar coordinates, Analysis of Circular plates for various loading and support conditions.

Unit 4: Theory of Surfaces **[8 Hrs]**
Introduction to space curves and surfaces, shell surfaces and characteristics, classifications of shells.

Unit 5: Introduction to Shell Theory **[8 Hrs]**
Basic concepts of the theory, equilibrium equations in curvilinear coordinates, force displacement relations, Membrane analysis of shells of revolution and cylindrical shells under different loads.

Unit 6: Self Study: **[8 Hrs]**
Analysis for raft foundations, circular and spherical water tanks

Reference Books:

1. J. N. Reddy: Theory and Analysis of Elastic Plates and Shells: CRC Press
2. K. Chandrashekhara: Theory of Plates: Universities Press
3. H. Kraus: Thin Elastic Shells: John Wiley and Sons
4. S. Timoshenko and W. Krieger: Theory of plates and shells: Mc – Graw Hill
5. A. C. Ugural: Stresses in Plates and Shells: Mc Graw Hill

Web Resources:

1. Plates and Shells, by Prof. Sudip Talukdar, IIT Guwahati (NPTEL)
   https://onlinecourses.nptel.ac.in/noc23_ce103/preview

2. Theory Of Composite Shells, by Prof. Poonam Kumari, IIT Guwahati (NPTEL)
   https://onlinecourses.nptel.ac.in/noc24_me60/preview

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	3	1	2
CO2	3	1	3	1	2
CO3	3	1	3	1	2
CO4	2	1	2	1	2
CO5	3	2	3	2	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Structural Optimization

Course Code: CSE-25002 **Credit: 3**

Teaching Scheme: Hrs/Week		**Examination Scheme:**	
Lectures:	3	MSE:	30
Tutorial:	0	TA:	20
Self-Study:	1	ESE:	50

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

1. Understand the principles and mathematical foundation of optimization techniques applicable to structural systems.
2. Formulate design optimization problems for different structural configurations.
3. Apply classical and numerical algorithms for structural sizing, shape, and topology optimization.
4. Implement computational methods using MATLAB/Python/ANSYS for solving optimization problems.
5. Critically analyze optimization results for performance improvement and sustainability in structural design.

Unit 1: Fundamentals of Structural Optimization **[8 Hrs]**

Definition and scope; Role of optimization in structural engineering; Categories – sizing, shape, and topology optimization; Objective functions, design variables, and constraints; Review of classical optimization concepts; Structural performance measures – weight, stiffness, cost, and deflection criteria.

Unit 2: Problem Formulation and Classical Methods **[8 Hrs]**

Mathematical formulation of optimization problems; Stress and displacement constraints; Lagrange multiplier and penalty function approaches; Unconstrained and constrained optimization; Kuhn–Tucker optimality conditions; Direct search and gradient-based algorithms; Applications to trusses and frames.

Unit 3: Numerical and Metaheuristic Techniques **[8 Hrs]**

Linear and nonlinear programming methods; Sequential Quadratic Programming (SQP), interior-point methods; Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Simulated Annealing (SA); Comparative study of deterministic and stochastic methods; Implementation using MATLAB/Python.

Unit 4: Structural Applications and Case Studies **[8 Hrs]**

Design optimization of steel and concrete members; Topology optimization using finite element models; Multi-objective optimization in seismic and wind-resistant design; Integration with FEM and CAD software (ANSYS, STAAD.Pro, ABAQUS); Optimization-based decision making in sustainable design.

Unit 5: Advanced Topics and Research Trends **[8 Hrs]**

Sensitivity analysis and design space exploration; Surrogate modeling and response surface methods; Reliability-based and robust optimization; Machine learning in optimization; Review of recent research papers in structural optimization and AI-driven design automation.

Self-Study Component:

Each student shall undertake a mini-project or literature-based case study involving modeling, analysis, and optimization of a structural system (e.g., truss bridge, building frame, or composite beam) using MATLAB, Python, or commercial software. A short report and presentation will be part of the TA assessment.

Reference Books:

1. Arora, J.S., *Introduction to Optimum Design*, Elsevier, 4th Ed., 2016.
2. Rao, S.S., *Engineering Optimization: Theory and Practice*, New Age International, 5th Ed., 2023.
3. Belegundu, A.D. and Chandrupatla, T.R., *Optimization Concepts and Applications in Engineering*, Cambridge Univ. Press, 2011.
4. Haftka, R.T. and Gürdal, Z., *Elements of Structural Optimization*, Springer, 2012.
5. Vanderplaats, G.N., *Numerical Optimization Techniques for Engineering Design*, McGraw-Hill, 1984.

Web Resources:

1. *Structural Optimization* – Prof. S. Suresh, IIT Madras (NPTEL)
2. *Engineering Optimization* – Prof. A. Srivastava, IIT Guwahati (NPTEL)
3. ANSYS and MATLAB Optimization Toolboxes – https://courses.ansys.com / https://matlabacademy.mathworks.com
4. *Computational Structural Optimization* – Prof. H. Takagi, University of Tokyo (OCW)
5. *Topology Optimization in Structural Design* – ETH Zurich Open Lectures

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	3	3	2	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3

1 – Slightly; 2 – Moderately; 3 - Substantially

Design of Prestressed Concrete Structures

Course Code: CSE-25001	**Credit: 03**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 0	TA: 20
Self-Study: 0	ESE: 50

Course Outcomes: On successful completion of this course students will be able to

1. To analyze statically determinate PSC flexural members considering prestressing types, losses, stresses, and codal provisions.
2. To evaluate prestress transmission and anchorage zone stresses in pretensioned and post-tensioned members.
3. To analyze and design continuous PSC beams using cable profiling, linear transformation, and concordancy.
4. To apply composite and partial prestressing concepts and perform crack-width calculations.
5. To design PT slabs as per IS provisions.

Unit 1: Introduction and Statically determinate PSC beams

Types of prestressing, systems and devices, materials, losses in prestress, Analysis of PSC flexural members: basic concepts, stresses at transfer and service loads, ultimate strength in flexure, code provisions.

Design for ultimate and serviceability limit states for flexure, analysis and design for shear and torsion, code provisions.

Unit 2: Anchorage Zones

Transmission of prestress in pretensioned members; Anchorage zone stresses for post-tensioned members**.**

Unit 3: Statically indeterminate structures

Design of two span continuous beams, choice of cable profile, linear transformation and concordancy.

Unit 4: Composite construction

Composite construction with precast PSC beams and cast in-situ RC slab, Deflection of Composite members.

Unit 5: PT Slabs

Design of Post-Tensioned (PT) concrete slabs for buildings, IS code provisions.

Unit 6: Self Study

Design of PT beams, bridges, Segmental construction methods, Partial prestressing - principles, analysis and design concepts, crack width calculations, Use of commercial software for analysis and design of PT slabs / any other PSC element from the above theory covered.

Textbooks:

1 N. Krishna Raju, Prestressed Concrete, New Delhi, India: Tata McGraw-Hill Publishing Company, 2012.
2 G. S. Pandit and S. P. Gupta, Prestressed Concrete, New Delhi, India: CBS Publishers & Distributors, 2008.

Reference Books:

1 T. Y. Lin, Design of Prestressed Concrete Structures, Mumbai, India: Asia Publishing House, 1963.
2 Y. Guyan, Limit State Design of Prestressed Concrete, London, U.K.: Applied Science Publishers, 1980.
3 P. Dayaratnam, Prestressed Concrete, New Delhi, India: Oxford & IBH Publishing Co., 1983.
4 N. C. Sinha and S. K. Roy, Fundamentals of Prestressed Concrete, New Delhi, India: S. Chand & Company, 1985.
5 N. Rajagopalan, Prestressed Concrete, New Delhi, India: Narosa Publishing House, 2002.Bureau of Indian Standards, *IS 1343: Code of Practice for Prestressed Concrete*, New Delhi, India: BIS, 2012.
6 Indian Roads Congress, *IRC:112 – Code of Practice for Concrete Road Bridges*, New Delhi, India: Indian Roads Congress, 2011.

Web Resources:

1 Pre-stressed Concrete Structures by Prof. Devdas Menon & Dr. Amlan Kumar Sengupta, IIT Madras (NPTEL) https://nptel.ac.in/courses/105106117
2 Advanced Prestressed Concrete Design by Prof. S. Suriya Prakash, IIT Hyderabad (NPTEL) https://nptel.ac.in/courses/105106686

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	2	2
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Mechanics of Composite Materials

Course Code:	**Credit: 3**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: -	TA: 20
Self-Study: 1	ESE: 50

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

1. Understand concept and types of laminates.
2. Understand the methods of testing of laminates and its micro and macro mechanical behavior
3. Evaluate the material constitutive relations for General anisotropic material, specially orthotropic material, transversally isotropic material.
4. Apply the classical laminate theories to analyses beam problems
5. Apply the classical laminate theories to analyses plate problems

Unit 1: Introduction **[8 Hrs]**

Introduction: Definitions, Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Metal, ceramic and polymer matrix composites. Properties of composites in comparison with standard materials.

Unit 2: Mechanical Properties- Stiffness and Strength **[8 Hrs]**

Geometrical aspects – volume and weight fraction. Unidirectional continuous fiber,– Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear, failure criteria, Macromechanical and micromechanical behavior of a lamina, Macromechanical and micromechanical behavior of a laminate,

Unit 3: Constitutive Relations for Composites Lamina **[8 Hrs]**

General anisotropic material, especially orthotropic material, transversally isotropic material, Stress-strain relations for composite lamina, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters

Unit 4: Classical Theories of Laminated Composite Beams **[8 Hrs]**

Assumptions made in the analysis, governing equations, various boundary conditions and loading conditions, bending analysis of laminated composite beams.

Unit 5: Classical Theories of Laminated Composite Plates **[8 Hrs]**

Assumptions made in the analysis, governing equations, cylindrical bending of laminated plates, bending of finite plates

Unit 6: **Self-Study**

Manufacturing methods: Hand and spray lay-up, injection moulding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs. Fibre/Matrix Interface, mechanical. Measurement of interface strength. Characterization of systems: carbon fibre/epoxy, glass fibre/polyester, etc.

Reference Books:

1. Isaac M. Daniel and Ori lshai," Engineering Mechanics of Composite Materials", Oxford University Press.
2. Robert Jones," Mechanics of Composite Materials", Taylor & Francis Inc., Second Edition.
3. Jack R. Vinson and Robert L. Sierakowski," The Behavior of Structures Composed of Composite Material"
4. J. N. Reddy, and Miravete A., Practical Analysis of Composite laminates, CRC Press.
5. Chawla K.K., Composite Materials: Science and Engineering, Springer.
6. Mukopadhyay M., Mechanics of composite Materials and Structures, Oriental Swan.
7. J. N. Reddy, "Mechanics of Laminated Composite Plates and Shells Theory and Analysis", CRC Press, Second Edition.
8. Jianqiao Ye, "Laminated Composite Plates and Shells", Springer

Web Resources:

1. Composite Materials and Structures, by Dr. P.M. Mohite, IIT Kanpur (NPTEL) https://nptel.ac.in/courses/101104010
2. Composite Materials, by Prof. R. Velmurugan, IIT Madras(NPTEL) https://nptel.ac.in/courses/101106038

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	1	2	2	2
CO2	3	1	2	2	2
CO3	3	1	2	2	2
CO4	3	1	2	2	2
CO5	3	1	2	2	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Advanced Concrete Technology

Course Code: - **Credit: 3**

Teaching Scheme: 3 Hours/Week **Examination Scheme:**

Lectures:	3	MSE:	30
Tutorial:	1	TA:	20
Self-Study:	1	ESE:	50

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

1. CO1: Understand the structure, chemistry, and microstructure of concrete to predict its behavior.
2. CO2: Design and optimize concrete mixes using environmentally friendly materials like fly ash, silica fume, metakaolin, and GGBS.
3. CO3: Evaluate fresh concrete properties, rheology, and special concretes such as SCC and fiber-reinforced concrete.
4. CO4: Assess mechanical, time-dependent, and durability properties of hardened concrete using tests including NDT methods (core, UPV, rebound hammer).
5. CO5: Conduct self-study, experimental, or simulation projects and analyze results for concrete mix design and durability improvement.

Unit 1 - Structure and Chemistry of Concrete (8 hours): This unit covers the fundamentals of concrete as a three-phase material and its microstructure, including capillary and gel pores and the Interfacial Transition Zone (ITZ). It includes cement chemistry, hydration reactions, Bogue compounds (C_3S, C_2S, C_3A, C_4AF), heat of hydration, hydration products (C–S–H, CH, ettringite), and microstructural development. Basic aggregate properties are discussed, including geological and physical classifications, grading, shape, surface area, thermal properties, and the use of natural and recycled aggregates.

Unit 2 - Admixtures and Construction Chemicals (8 hours): This unit focuses on mineral admixtures (fly ash, silica fume, metakaolin, GGBS) and their pozzolanic/chemical reactions, effects on fresh and hardened concrete, and proportioning strategies. Chemical admixtures including water reducers, superplasticizers, set controllers, air-entraining agents, and specialty admixtures (shrinkage reducers, viscosity modifiers, corrosion inhibitors) are discussed with their mechanisms, optimization, compatibility, and role in modern high-performance concrete.

Unit 3 - Fresh Concrete Properties, Rheology, and Special Concretes (8 hours): Covers workability, bleeding, segregation, environmental effects, and empirical tests (slump, compaction factor, Vee-Bee). Rheology fundamentals (yield stress, plastic viscosity), rheological models, and measurement methods are discussed. Self-Compacting Concrete (SCC) mix design, particle packing, stability, testing (slump-flow, L-box, V-funnel), and considerations for special concretes such as high-strength, lightweight, fiber-reinforced, and pumpable concrete are included.

Unit 4 - Hardened Concrete: Mechanical Behavior and Time-Dependent Properties (8 hours):
Focuses on compressive, tensile, shear, and flexural behavior, including biaxial/triaxial stress states, stress–strain relationships, localization, and end effects. Covers impact, dynamic, and fatigue behavior, creep, shrinkage, plastic and elastic deformations, thermal

effects, and fire behavior. Includes basic methods for non-destructive testing, quality control, and assessment of hardened concrete.

Unit 5 — Durability, Performance, and Advanced Design Concepts (8 hours): Covers permeability, porosity, transport properties, and chemical/environmental attacks including sulphate, chloride, carbonation, ASR/ACR, acid and seawater attack, freeze–thaw, and reinforcement corrosion. Discusses durability parameters, protective measures, performance-based design, service-life modeling, mass concrete behavior, hot and cold weather concreting, shotcreting, and concrete curing strategies. Introduces repair technologies, distress evaluation, and crack sealing techniques.

Unit 6 — Self-Study / Project-Based Learning : Students undertake an independent mini-project focusing on experimental studies (SCC trials, shrinkage/creep measurement, NDT correlation), numerical/simulation analysis (particle packing, hydration modeling, service-life prediction), or case studies on durability, performance, or innovative concrete applications. Deliverables include a concise report and a short presentation.

Reference Books:

1. Neville, A.M., 'Properties of concrete', 4th ed., Pearson Education Limited, London, 2000.
2. P. Kumar Metha and P. J. M. Monterio, Concrete- Microstructures, Properties and Materials, Indian Edition, Indian Concrete Institute, Chennai, 1999.
3. Lea, F.M., Chemistry of cement and concrete, 3rd ed, Edward Arnold, London, 1970 .
4. De Larrard, F, Concrete Mixture proportioning – A scientific Approach, E&FN Spon, London, 1999.
5. Aitcin, P. C., High Performance Concrete, E&FN Spon, London, 1998.
6. Santhakumar, A. R., Concrete Technology, Oxford University Press, New Delhi, 2007.
7. Neville, A.M., and Brooks, J. J., Concrete Technology, Pearson Education Ltd., 2012

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	2	2
CO4	3	3	3	2	3
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Application of Artificial Intelligence and Machine Learning in Structural Engineering

Course Code:	**Credit: 3**
Teaching Scheme: 3 Hrs/Week	**Examination Scheme:**
Lectures: 3	MSE: 30
Tutorial: 1	TA: 20
Self-Study: 1	ESE: 50

Course Outcomes: At the end of the course, the students demonstrate the able to:
CO1: Understand fundamental concepts of AI and Machine Learning and their applications in structural engineering decision-making and smart infrastructure.
CO2: Apply supervised learning techniques, including regression, classification, decision trees, and random forests, to structural engineering problems.
CO3: Implement unsupervised learning methods, clustering, and dimensionality reduction for civil engineering data analysis and feature extraction.
CO4: Utilize neural networks, deep learning, and advanced ML methods for applications such as structural health monitoring, traffic prediction, and water resources modeling.
CO5: Conduct independent projects involving data preprocessing, ML model selection, residual analysis, visualization, and interpretation for practical structural engineering applications.

Unit 1 — Introduction to Artificial Intelligence (8 hours): Introduction to AI and its relevance to civil engineering, history and evolution, key applications across civil domains (construction, structural monitoring, transportation, water resources). Basic concepts: problem-solving, knowledge representation, search and optimization explained in an easy, conceptual manner. Role of AI in enabling smart infrastructure, digital construction, and decision-support systems.

Unit 2 — Fundamentals of Machine Learning and Data Analytics (8 hours): Introduction to ML concepts, supervised and unsupervised learning, classification and regression, clustering, dimensionality reduction (PCA, kernel PCA). Data types in civil engineering, preprocessing, feature selection, formalizing learning tasks, handling missing data, and importance of studentized residual tests and error analysis for model evaluation.

Unit 3 — Supervised Learning Techniques and Civil Engineering Applications (8 hours):
Regression techniques (linear, multiple, polynomial, logistic), classification techniques (k-nearest neighbors, support vector machines, decision trees, random forests, ensemble methods). Applications include structural damage detection, soil classification, traffic prediction, water quality modeling, and predictive maintenance of infrastructure. Case studies demonstrating model implementation with civil datasets.

Unit 4 — Unsupervised Learning and Feature Extraction (8 hours): Clustering methods: k-means, hierarchical clustering, DBSCAN. Feature extraction and dimensionality reduction (PCA, kernel PCA) for civil engineering applications such as site characterization, anomaly detection in structural health monitoring, transportation mode inference, and level-of-service prediction. Visualization and interpretation of unsupervised learning results.

Unit 5 — Advanced Machine Learning Techniques (8 hours): Artificial neural networks (ANNs) and backpropagation, convolutional neural networks (CNNs) for image classification and object detection (structural inspections, vehicle detection), recurrent neural networks (RNNs) and LSTM for traffic, soil strength prediction, and rainfall-runoff modeling. Advanced techniques: variational autoencoders and GANs for sensor data generation and fault diagnostics. Practical introduction to ML frameworks: Keras, PyTorch, and Spark for large-scale civil datasets.

Unit 6 — Self-Study / Project-Based Learning : Application of ML techniques to a structural engineering problem and possible themes: structural health monitoring, crack detection, vibration-based damage identification, load prediction, or material strength estimation. Emphasis on dataset handling, model selection (regression, trees, random forest), residual/error analysis, and interpretation of results. Deliverables: brief report and presentation.

Reference Books:

[1] Heggond, S. (2025). Artificial Intelligence and Machine Learning for Smart Construction: Enhancing Real-Time Monitoring and Decision Making. Deep Science Research.

[2] Siddiqui, S. (2024). AI in Construction: AI Tools for Smarter, Safer Construction. Atlantic Publishers.

[3] Russell, S. J., & Norvig, P. (2020). Artificial Intelligence: A Modern Approach (4th ed.). Pearson.

[4] Christopher M. Bishop, 2006, Pattern recognition and machine learning, Springer.

[5] Bernhard Scholkopf, and J Smola Alexander, 2002, Learning with kernels: support vector machines, regularization, optimization, and beyond, MIT press.

[6] Tom Michael Mitchell, 1998, Machine Learning, McGraw-Hill Education.

[7] John Shawe-Taylor & Nello Cristianini, 2000. Support Vector Machines and other kernel-based learning methods, Cambridge University Press.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	2	2
CO4	3	3	3	2	3
CO5	3	2	3	3	2

1 – Slightly; 2 – Moderately; 3 - Substantially

Structural Engineering Laboratory – II

Course Code: CSE (PE) 2500 **Credit: 2**

Teaching Scheme: Hrs/Week **Examination Scheme:**

Practical:	4	MSE:	50
Tutorial :	0	ESE:	50
Self-Study:	1		

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

1. Analyse the structure for gravity and lateral load.
2. Design a concrete mix as per the requirement at the field.
3. Function as team member for laboratory work.
4. Write a report based on Site visits and Mini Project
5. Present outcome of the study of Mini project with the help of presentation

Part A

Laboratory Experiments:

a) Mix design for regular quality Concrete
b) Mix design for pavement quality Concrete
c) Mix design of Fiber Reinforced Concrete
d) Mix design of High Strength Concrete
e) Tests for measuring Corrosion parameters
f) Load test on steel/RCC flexural elements (beams and slabs)
g) Structural Audit of a small building (Minimum G+3)
h) Analysis of plane frames using different types of lateral load resisting systems with relevant software

Part B

Mini Project:

Mini project presentation is to be performed and reported by the end of the second semester

Part C

Site Visits (Minimum Two)

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	1	1
CO2	3	1	2	1	1
CO3	1	1	1	3	2
CO4	1	1	1	3	1
CO5	2	3	3	1	1

1 – Slightly; 2 – Moderately; 3 - Substantially

Technical Communication Skills

Course Code:	**Credit: 2**
Teaching Scheme: Hrs/Week	**Examination Scheme:**
Lectures: 1	ISE: 100
Self-Study: 1	
Lab: 2	

Course Outcomes: Students will be able to:

1. Produce effective dialogue for business related situations
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
3. Analyze critically different concepts/principles of communication skill s
4. To appreciate, analyze, and evaluate business reports and research papers

Unit 1: Fundamentals of Communication [4 Hrs]

7 Cs of communication, common errors in English, enriching vocabulary, styles, and registers.

Unit 2: Aural-Oral Communication [4 Hrs]

The art of listening, stress and intonation, group discussion, oral presentation skills.

Unit 3: Reading and Writing [8 Hrs]

Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers.

Textbooks:

[1]. Raman Sharma, "Technical Communication", Oxford University Press.
[2]. Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge
[3]. University Press.
[4]. Markel, M., & Rosson, P. (2024). Technical Communication (14th ed.). Bedford/St. Martin's.
[5]. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh
[6]. edition), Prentice Hall
[7]. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non- native speakers of English", McGraw Hill.

Reference Books:

[1]. Thomas Huckin, Leslie Olsen, "Technical writing and Professional Communications for Non- native speakers of English", McGraw-Hill.
[2]. Pfeiffer, W., & Goodall, H. L. (2024). Technical Communication: A Practical Approach. Pearson.

Web Resources:

[1]. MIT OpenCourseWare – Technical Communication, https://ocw.mit.edu/courses/technical- communication
[2]. Purdue OWL (Online Writing Lab) – Technical Writing, https://owl.purdue.edu/owl/subject_specific_writing/technical_writing/in

dex.html
[3]. IEEE Author Center – Resources for Writing Technical Papers, https://authorcenter.ieee.org
[4]. Nature Masterclasses – Scientific Writing and Publishing, https://masterclasses.nature.com
[5]. Toastmasters International – Public Speaking Resources, https://www.toastmasters.org/resources
[6]. GitHub: Awesome Technical Writing, https://github.com/maestroj/awesome-technical- writing
[7]. The Hemingway App: A tool for clear writing, http://www.hemingwayapp.com/

Liberal Learning

Course Code:	**Credit: 1**
Teaching Scheme	**Examination Scheme**
Lectures: 0	ISE: 100
Lab: 2 hrs	
Self-study: 2 Hrs/week	

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Develop capacity to understand multidisciplinary sciences in a friendly manner.
CO 2: Create openness to diversity.
CO 3: Acquire ability to lead and examine life and value the need for life learning.

Student will be able to choose and enhance practical learning and application in the subject of his/her choice. One credit course spread over the semester to enhance practical learning and application.

- Dance
- Film Appreciation
- Music Vocal
- Painting
- Agriculture
- Business
- Clay Art & Pottery
- Corporate Culture
- Defense
- French
- Geography
- Holistic Health
- Modern Film Making
- Music (Instrumental)
- Photography
- Political Science
- Music (Vocal)
- Wood and Metal Art
- Japanese

SEMESTER III

Massive Open Online Course – I

Course Code:	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Lecture: 3 Hrs/week	CIE: 50
Self study : 1 Hrs/week	ESE: 50

Course Outcomes: Students will be able to:

1. Acquire new skills or knowledge to enhance their personal and professional development.
2. Receive a flexible learning environment, allowing one to study at own pace and convenience.
3. Opportunity for lifelong learning.
4. Foster collaboration and networking among participants.

The students in consultation with the PG Coordinator/Faculty/Head of the department opt for a course of 12 weeks PG level offered by the NPTEL/SWAYM in the semester. The students need to register for the examination conducted by the NPTEL.

Massive Open Online Course – II

Course Code:	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Lecture: 3 Hrs/week	CIE: 50
Self-study: 1 Hrs/week	ESE: 50

Course Outcomes: Students will be able to:

1. Acquire new skills or knowledge to enhance their personal and professional development.
2. Receive a flexible learning environment, allowing one to study at own pace and convenience.
3. Opportunity for lifelong learning.
4. Foster collaboration and networking among participants.

The students in consultation with the PG Coordinator/Faculty/Head of the department opt for a course of 12 weeks PG level offered by the NPTEL/SWAYM in the semester. The students need to register for the examination conducted by the NPTEL.

Dissertation Phase – I

Course Code:	**Credit: 11**
Teaching Scheme	**Examination Scheme**
Lab: 22 Hrs	CIE: 70
Self-Study: 12 Hrs	ESE: 30

Course Outcomes: Students will be able to:

1. Demonstrate how to search the existing literature to gather information about a specific problem or domain.
2. Identify the state-of-the-art technologies and research in the chosen domain and highlight open problems that are relevant to societal or industrial needs.
3. Evaluate various solution techniques to determine the most feasible solution within the given constraints for the chosen dissertation problem.
4. Write a dissertation report that details the research problem, objectives, literature review, and solution architecture.
5. Deliver effective oral presentations to communicate the findings and outcomes of the research work.

Guidelines:

The Dissertation work will start in semester III, and should involve scientific research, design, collection and analysis of data, determining solutions and must bring out the individuals contribution. Dissertation-I will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted

SEMESTER IV

Dissertation Phase – II

Course Code:	**Credit: 11**
Teaching Scheme	**Examination Scheme**
Lab: 22 Hrs	CIE: 70
Self-Study: 12 Hrs	ESE: 30

Course Outcomes: Students will be able to

1. Achieve proficiency in the languages, tools, libraries, and technologies used in the dissertation work.
2. Apply project planning principles and techniques to ensure effective and efficient project execution.
3. Produce artifacts such as source code, test plans, and test results based on the dissertation work.
4. Write research paper(s) and a thesis in accordance with publication ethics.
5. Exhibit the presentation skills needed to effectively present the work at various platforms.

Guidelines:

Dissertation Phase – II will be continuation to work on the topic identified in Dissertation Phase – I. Mid semester presentation, Continuous assessment. There will be pre submission seminar at the end of academic term. After the approval, the student has to submit the detail report. Continuous assessment of Dissertation – I and Dissertation – II will be monitored by the departmental committee. Students are expected to publish their research work done at a suitable peer-reviewed conference/ journal.