



GOVERNMENT COLLEGE OF ENGINEERING, SALEM

(NAAC Accredited with A⁺, An Autonomous Institution, Affiliated to Anna University, Chennai)

POSTGRADUATE CURRICULUM

(Applicable to the students admitted in M.E. Programme, from the Academic Year 2026-2027)

Programme: M.E. Structural Engineering

Regulations: 2026

Overview of Credits

Sem	BS	ES(PC)	ES(PE)	SD	MC	AC	Total
I	4	14		1	3	0	22
II	2	11	6			0	19
III			6	9			15
IV				14			14
Total	6	25	12	24	3	0	70
% of Category	8.57	35.71	17.14	34.29	4.29	0.00	100.00

Abbreviations:

Course Type:

- T** - Theory
- L** - Laboratory
- PW** - Project Work

Category :

- BS** - Basic Science
- ES** - Engineering Science [Programme Core (**PC**)
Programme Elective (**PE**)]
- SD** - Skill Development
- MC** - Mandatory Course
- AC** - Audit Course

Others :

- TCP** - Total Contact Periods
- L** - Lecture
- T** - Tutorial
- P** - Practical

Semester I											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26MP101	Analytical and Numerical Methods for Structural Engineering	T	45	15	0	60	4	BS	40	60
2.	26ST101	Advanced Structural Analysis	T	45	15	0	60	4	ES(PC)	40	60
3.	26ST102	Theory of Elasticity and Plasticity	T	45	0	0	45	3	ES(PC)	40	60
4.	26ST103	Advanced Reinforced Concrete Design	T	45	0	0	45	3	ES(PC)	40	60
5.	26ST104	Structural Design Laboratory	L	0	0	60	60	2	ES(PC)	60	40
6.	26ST105	Concrete and Experimental Stress Analysis Laboratory	L	0	0	60	60	2	ES(PC)	60	40
7.	26MLC01	Research Methodology and IPR	T	45	0	0	45	3	MC	40	60
8	26ST106	Technical Seminar	-	0	0	30	30	1	SD	100	0
9	26AC00X	Audit Course – I	T	30	0	0	30	0	AC	100	0
Total							435	22			

Semester II											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26MP201	Numerical Analysis Laboratory	L	0	0	60	60	2	BS	60	40
2.	26ST201	Finite Element Method in Structural Engineering	T	45	0	0	45	3	ES(PC)	40	60
3.	26ST202	Structural Dynamics	T	45	0	0	45	3	ES(PC)	40	60
4.	26ST203	Advanced Steel Design	T	45	0	0	45	3	ES(PC)	40	60
5.	26ST204	Model Testing Laboratory	L	0	0	60	60	2	ES(PC)	60	40
6.	26STEXX	Programme Elective – I	T	45	0	0	45	3	ES(PE)	40	60
7.	26STEXX	Programme Elective – II	T	45	0	0	45	3	ES(PE)	40	60
8	26AC00X	Audit Course – II	T	30	0	0	30	0	AC	100	0
Total							375	19			

Semester III											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26STEXX	Programme Elective - III	T	45	0	0	45	3	ES(PE)	40	60
2.	26STEXX	Programme Elective - IV	T	45	0	0	45	3	ES(PE)	40	60
3.	26ST301	Dissertation Phase - I	PW	0	0	240	240	8	SD	60	40
4.	26ST302	Internship	L	0	0	0	0	1	SD	100	0
Total							330	15			

Semester IV											
Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26ST401	Dissertation Phase–II	PW	0	0	420	420	14	SD	60	40
Total							420	14			
Total Credits for the Programme = 22 +19+15+14								70			

Programme Electives

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26STE01	Theory of Thin Plates and Shells	T	45	0	0	45	3	ES(PE)	40	60
2.	26STE02	Design of Prefabricated Structures	T	45	0	0	45	3	ES(PE)	40	60
3.	26STE03	Corrosion and its Prevention	T	45	0	0	45	3	ES(PE)	40	60
4.	26STE04	Analysis of Laminated Composite Plates	T	45	0	0	45	3	ES(PE)	40	60
5.	26STE05	Fracture Mechanics of Concrete Structures	T	45	0	0	45	3	ES(PE)	40	60
6.	26STE06	Soil Structure Interaction	T	45	0	0	45	3	ES(PE)	40	60
7.	26STE07	Offshore Structures	T	45	0	0	45	3	ES(PE)	40	60
8.	26STE08	Modern Construction Materials	T	45	0	0	45	3	ES(PE)	40	60
9.	26STE09	Structural Health Monitoring	T	45	0	0	45	3	ES(PE)	40	60
10.	26STE10	Structural Optimization	T	45	0	0	45	3	ES(PE)	40	60
11.	26STE11	Advanced Concrete Technology	T	45	0	0	45	3	ES(PE)	40	60
12.	26STE12	Disaster Resistant Structures	T	45	0	0	45	3	ES(PE)	40	60
13.	26STE13	Wind and Cyclone Effects on Structures	T	45	0	0	45	3	ES(PE)	40	60
14.	26STE14	Experimental Techniques and Instrumentation	T	45	0	0	45	3	ES(PE)	40	60
15.	26STE15	Design of Formwork	T	45	0	0	45	3	ES(PE)	40	60
16.	26STE16	Design of High Rise Structures	T	45	0	0	45	3	ES(PE)	40	60
17.	26STE17	Design of Masonry Structures	T	45	0	0	45	3	ES(PE)	40	60
18.	26STE18	Theory and Applications of Cement Composites	T	45	0	0	45	3	ES(PE)	40	60
19.	26STE19	Design of Steel - Concrete Composite Structures	T	45	0	0	45	3	ES(PE)	40	60
20.	26STE20	Design of Prestressed Concrete Structures	T	45	0	0	45	3	ES(PE)	40	60

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
21.	26STE21	Theory of Structural Stability	T	45	0	0	45	3	ES(PE)	40	60
22.	26STE22	Advanced Design of Foundations	T	45	0	0	45	3	ES(PE)	40	60
23.	26STE23	Design of Industrial Structures	T	45	0	0	45	3	ES(PE)	40	60
24.	26STE24	Substructure Design	T	45	0	0	45	3	ES(PE)	40	60
25.	26STE25	Design and Construction of Ferro Cement Structures	T	45	0	0	45	3	ES(PE)	40	60
26.	26STE26	Design of Thin Plates and Shell Structures	T	45	0	0	45	3	ES(PE)	40	60
27	26STE27	Design of Bridges	T	45	0	0	45	3	ES(PE)	40	60

Audit Courses

Sl. No.	Course Code	Course Name	Course Type	Hours per Semester				Credits	Category	Weightage	
				L	T	P	TCP			CA %	ES %
1.	26AC001	English for Research paper writing	T	30	0	0	30	0	AC	100	0
2.	26AC002	Disaster Management	T	30	0	0	30	0	AC	100	0
3.	26AC003	Sanskrit for Technical Knowledge	T	30	0	0	30	0	AC	100	0
4.	26AC004	Value Education	T	30	0	0	30	0	AC	100	0
5.	26AC005	Constitution of India	T	30	0	0	30	0	AC	100	0
6.	26AC006	Pedagogy Studies	T	30	0	0	30	0	AC	100	0
7.	26AC007	Stress Management by Yoga	T	30	0	0	30	0	AC	100	0
8.	26AC008	Personality Development through Life Enlightenment Skills	T	30	0	0	30	0	AC	100	0
9.	26AC009	Sustainable Development Goals	T	30	0	0	30	0	AC	100	0

26MP101	ANALYTICAL AND NUMERICAL METHODS FOR STRUCTURAL ENGINEERING (M.E. Structural Engineering)			SEMESTER		I		
Prerequisites				Category	BS	Credits	4	
Basic knowledge of solution of equations, differentiation and integration, ordinary and partial differential equations.				Hours/ Semester	L	T	P	TH
					45	15	0	60
COURSE OBJECTIVES								
1.	Understand and apply numerical methods for solving algebraic and transcendental equations.							
2.	Acquire skills in interpolation techniques and least squares approximation.							
3.	Learn numerical techniques for differentiation and integration.							
4.	Solve initial value problems of ordinary differential equations using numerical approaches.							
5.	Apply finite difference techniques to solve boundary value problems and basic PDEs.							
UNIT - I		SOLUTION OF NONLINEAR EQUATIONS, LINEAR SYSTEMS AND EIGEN VALUE PROBLEMS						9+3
Bisection method, Fixed-point iteration method, Newton-Raphson method – Solutions of linear system of equations by Gauss Elimination, Gauss-Jordan, Gauss-Jacobi and Gauss-Seidel methods – Eigenvalue of a matrix by Power method.								
UNIT - II		CURVE FITTING AND INTERPOLATION						9+3
Curve fitting by the Method of Least Squares –Fitting of straight lines, second-degree parabolas and curves reducible to linear forms – Newton’s divided difference formula, Lagrange’s interpolation – Newton’s Forward and backward difference formula.								
UNIT - III		NUMERICAL DIFFERENTIATION AND INTEGRATION						9+3
Numerical differentiation with interpolation polynomials – Numerical integration by Trapezoidal rule – Simpson’s 1/3 rule, Simpson’s 3/8 rule – Two-point and three-point Gaussian quadrature formula– Double integrals using Trapezoidal rule and Simpson’s rule.								
UNIT - IV		INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS						9+3
Single step methods: Taylor series method – Euler and modified Euler Method – Fourth order Runge-Kutta method for first order differential equations – Multistep method: Milne's Predictor-Corrector Method and Adams-Bashforth Predictor-Corrector Method.								
UNIT - V		BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS						9+3
Finite difference solution of second order ordinary differential equations – Finite difference solutions of one-dimensional heat equation by explicit and implicit methods – Finite difference solutions of one-dimensional wave equation and two-dimensional Laplace and Poisson equations.								
L:45, T:15, Total: 60 Hours								

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Kandaswamy, P., Thilagavathy, K., and Gunavathi, K., "Numerical Methods", S. Chand Publishing, New Delhi. 2010.
2.	Veerarajan, T., and Ramachandran, T., "Numerical Methods with Programs in C and C++", Tata McGraw-Hill Education, New Delhi, 2006.
3.	Jain, M. K., Iyengar, S. R. K., and Jain, R. K., "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Ltd., Publishers, New Delhi, 2003.
4.	Goyal, Manish, "Numerical Methods and Statistical Techniques Using C", 1 st Edition, Laxmi Publications (P) Ltd., New Delhi, 2009.
5.	Gerald, C. F., and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, 2002.

E-RESOURCES:

1.	NPTEL – Numerical Methods (Full Course) https://nptel.ac.in/courses/111/106/111106101
2.	NPTEL – Numerical Methods for Engineers https://nptel.ac.in/courses/111/104/111104125
3.	MIT OCW – Introduction to Numerical Methods https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/
4.	Open Textbook Library https://open.umn.edu/opentextbooks/textbooks?q=Numerical+Methods
5.	NPTEL – Computational Techniques (Numerical Methods Applications) https://nptel.ac.in/courses/103106074/

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the principles of numerical methods including solution of equations, interpolation, curve fitting, eigenvalue computation, numerical differentiation and numerical integration techniques.	PO3	PSO1
CO2	Apply numerical techniques to solve nonlinear equations, systems of linear equations, interpolation, curve fitting, numerical integration, and ordinary/partial differential equations.	PO1, PO3	PSO1
CO3	Analyze the accuracy, convergence and computational efficiency of numerical methods used for solving equations, interpolation, eigenvalue problems, differentiation and integration.	PO1, PO3	PSO1, PSO2
CO4	Evaluate and select appropriate numerical methods for engineering problems considering accuracy, convergence, stability and computational requirements.	PO1, PO3	PSO2
CO5	Develop computational models and numerical solutions for structural engineering problems involving algebraic equations, eigenvalue problems, ODEs and PDEs, and communicate the results effectively.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	—	—	2	2	—
CO2	3	—	3	3	—
CO3	3	—	3	3	3
CO4	2	—	2	—	2
CO5	2	2	2	2	2
Average	2.5	2	2.4	2.5	2.3

Activities:

1.	Develop a Python program to solve nonlinear equations using Bisection, Newton–Raphson methods and compare convergence.
2.	Construct Newton forward/backward interpolation polynomial for given data and estimate missing values using a program.
3.	Write a program to evaluate definite integrals using Trapezoidal and Simpson’s rules and compare accuracy for different step sizes.
4.	Implement Euler, Modified Euler and Runge-Kutta (RK4) methods to solve an initial value problem and analyze errors.
5.	Develop a finite difference program to solve boundary value problems and PDEs (heat, Laplace or Poisson equations) and present numerical results graphically and in tabular form.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (7-8)	Good (4-6)	Satisfactory (1–3)
1.	Understanding of the Problem and Numerical Methods	8	Demonstrates thorough understanding of the engineering problem and relevant numerical methods	Shows adequate understanding with minor gaps	Demonstrates limited understanding of the problem and methods
2.	Selection and Justification of Numerical Method	8	Selects the most appropriate numerical method with clear and logical justification	Selects a suitable method with partial justification	Method selection is inappropriate or lacks justification
3.	Algorithm Development and Implementation	8	Develops and implements the algorithm correctly and systematically	Minor errors in implementation or procedure	Significant errors in algorithm development or implementation
4.	Computational Accuracy and Error Analysis	8	Results are accurate with proper consideration of stability, convergence, and error analysis	Minor computational or error analysis issues	Major computational errors with little or no error consideration

5.	Analysis, Interpretation and Presentation of Results	8	Results are critically analyzed, interpreted effectively, and presented clearly and professionally	Interpretation and presentation are adequate with minor shortcomings	Poor analysis, interpretation, and presentation of results
	Total	40			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Formulation and Numerical Modelling	8	Engineering problem is clearly formulated with an appropriate numerical model	Minor issues in formulation or modelling	Problem formulation and modelling are unclear
2.	Selection of Numerical Method and Algorithm Development	8	Appropriate numerical method is selected and algorithm is correctly developed	Suitable method selected with minor errors in algorithm development	Inappropriate method selection or incomplete algorithm
3.	Implementation and Numerical Solution	8	Numerical solution is obtained correctly and efficiently through proper implementation	Minor implementation or computational errors	Significant errors in implementation and solution
4.	Validation and Engineering Interpretation	8	Results are accurately validated and effectively interpreted in the engineering context	Validation and interpretation are adequate with minor issues	Poor validation and limited engineering interpretation
5.	Technical Report Writing and Presentation	8	Report is well-organized, technically sound, and professionally presented	Minor issues in organization, documentation, or presentation	Poorly organized report and presentation
	Total	40			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	—	—	12	2
C02	24	24	—	—	24	3
C03	24	24	—	—	24	3
C04	—	—	40	—	20	2
C05	—	—	—	40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

Weightage:

Continuous Assessment 40%

End Semester Examinations 60%

REFERENCE BOOKS:

1.	Rubinstein F.M. , Matrix computer methods of Structural Analysis, Prentice Hall, 2016
2.	Weaver, W. Jr. and Gere, J.M. , Matrix Analysis of Framed Structures, CBS Publishers & Distributors, New Delhi, 3rd Edition, 2012
3.	Rajasekaran, S. and Sankarasubramanian, G. , Computational Structural Mechanics, PHI Learning Private Limited, New Delhi, 2nd Edition, 2017.
4.	Kassimali, A. , Matrix Analysis of Structures, Cengage Learning India Pvt. Ltd., New Delhi, 3rd SI Edition, 2021
5.	Hibbeler, R.C. , Structural Analysis, Pearson Education, Noida, 10th Edition, 2023.
6.	Rubinstein F.M. , Matrix computer methods of Structural Analysis, Prentice Hall, 2016

E-RESOURCES:

1.	NPTEL – Matrix Method of Structural Analysis https://nptel.ac.in (Stiffness and flexibility methods, matrix formulation, trusses, beams, frames)
2.	MIT Open Courseware – Techniques for Structural Analysis and Design https://ocw.mit.edu (Energy methods, matrix structural analysis, structural behaviour, and design applications)
3.	American Society of Civil Engineers (ASCE) https://www.asce.org (Structural engineering standards, design guidelines, and professional resources.)
4.	Engineering Structures Journal (Science Direct) https://www.sciencedirect.com/journal/engineering-structures (Research papers on matrix methods, stiffness analysis, structural mechanics, computational methods)
5.	MIT Open Courseware – Structural Analysis and Control https://ocw.mit.edu (Structural modelling, system response, computer-based analysis, and advanced structural analysis techniques.)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the basic concepts of structures, stiffness, flexibility, forces, and displacements and compute simple structural responses using stiffness and flexibility coefficients.	-	-
CO2	Describe strain energy concepts and matrix properties and apply transformation principles to relate system and element forces and displacements.	PO1, PO2, PO3	PSO1
CO3	Apply the flexibility method to analyse determinate and indeterminate structures and determine internal forces and displacements in trusses, beams, frames, and grids.	PO1, PO2, PO3	PSO1
CO4	Analyse structures using the stiffness method, develop stiffness matrices, and solve structural problems involving trusses, beams, frames, and grids.	PO1, PO2, PO3	PSO1
CO5	Evaluate structural systems using substructure and iterative analysis methods and select suitable approaches for efficient structural analysis.	PO1, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	2	3	3	2	–
CO3	3	2	3	3	–
CO4	3	2	3	3	–
CO5	3	–	3	3	2
Average	2.75	2.33	3	2.75	2

Activities:

1. Computer-Based Structural Analysis of a Multi-storey Building (CO4)
2. Structural Analysis Challenges in High-Rise Buildings (CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Structural Modelling Accuracy	20	Accurate Modelling	Minor Errors	Inaccurate Modelling
2.	Software Analysis & Outputs	30	Comprehensive Analysis	Partial Analysis	Limited Analysis
3.	Interpretation of Structural Behaviour	20	Critical Interpretation	Basic Interpretation	Limited Interpretation
4.	Presentation & Report Quality	30	Professional Presentation	Acceptable Presentation	Poor Presentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Project Study & Data Collection	30	Comprehensive Study	Adequate Study	Limited Study
2.	Application of Structural Analysis Concepts	30	Strong Application	Moderate Application	Limited Application
3.	Technical Evaluation & Conclusions	20	Critical Evaluation	Basic Evaluation	Limited Evaluation
4.	Presentation & Documentation	20	Professional Documentation	Acceptable Documentation	Poor Documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST102	THEORY OF ELASTICITY AND PLASTICITY		SEMESTER		I	
Prerequisites		Category	ES(PC)	Credits	3	
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the fundamental concepts of stress, strain, and elasticity, including stress and strain components, generalized Hooke's law, and three-dimensional stress analysis.					
2.	To develop the ability to analyze principal stresses and strains and apply equilibrium and compatibility equations in Cartesian coordinate systems.					
3.	To study stress and strain transformations and apply appropriate boundary conditions for solving engineering mechanics problems.					
4.	To formulate and solve two-dimensional elasticity problems in polar coordinates, including thick cylinders, shrink fits, curved beams, and stress concentration problems.					
5.	To introduce the fundamentals of plasticity theory, including yield criteria, flow rules, plastic stress-strain relationships, plastic work, and strain hardening for engineering design and analysis.					
UNIT - I		ANALYSIS OF STRESS AND STRAIN				9
Elasticity approach – definition and notation of stress - components of stress and strain – Generalized Hooke's law- Principal stresses and strains for three dimensional element - equations of equilibrium and compatibility conditions for 3-D problems in Cartesian coordinates – Transformation of stresses and strains – Boundary conditions.						
UNIT - II		TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES				9
Plane stress and plane strain problems with practical examples – Equations of equilibrium and compatibility conditions in Cartesian coordinates – Airy's stress function						
UNIT - III		TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES				9
Equations of equilibrium and compatibility conditions in polar coordinates – axisymmetric problems; thick cylinder under uniform pressure, shrink and force fits, circular arc beams subjected to pure bending – stress concentration due to circular hole in plate – effect of concentrated and uniformly distributed load on straight boundary of semi infinite plates, stresses in circular disc subjected to diametrically opposite concentrated loads.						
UNIT - IV		TORSION				9
Torsion of various shaped bars, pure torsion of prismatic bars, Prandtl's membrane analogy, torsion of thin walled tubes and hollow shafts, Plastic torsion – elastic-plastic torsion analysis – circular section – sand heap analogy						
UNIT - V		THEORY OF PLASTICITY				9
Theory of Plasticity – Stress-strain diagram – Ideal plastic body – illustration of plastic analysis – yield criteria – Rankine's theory – St. Venant's theory – Tresca Criterion – Beltrami's theory – Von mises criterion – Mohr's theory of yielding – yield surface – Flow rule (stress-strain relationship for perfectly plastic flow) – PrandtlReuss equality – Plastic work – stress-strain relation based on Tresca – Plastic potential – uniqueness of a stress distribution – strain hardening.						
Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	"Theory of Elasticity "Stephen P. Timoshenko, J. N. Goodier - 3rd Edition Reprint, 2017_ McGraw-Hill Education publisher.				
2.	Sadd, M.H., Theory and Problems of Elasticity , 4th Edition, Academic Press, 2021.				
3.	"Advanced Mechanics of Materials and Applied Elasticity "Ansel C. Ugural, Saul K. Fenster -6th Edition, 2020publisher Pearson .				
4.	Ugural, A.C. &Fenster, S.K. , Advanced Mechanics of Materials and Applied Elasticity, 6th Edition, Pearson, 2020.				
5	Beer, F.P., Johnston, E.R., DeWolf, J.T. &Mazurek, D.F. , Mechanics of Materials, 8th Edition, McGraw-Hill Education, 2020.				
E-RESOURCES:					
1.	https://nptel.ac.in/ - _ NPTEL : 2024				
2.	https://www.coursera.org - _ Coursera - 2024				
3.	NPTEL, Theory of Elasticity and Plasticity , Online Certification Course, 2023.				
4.	COMSOL Learning Center, Elasticity and Plasticity Simulation Resources, 2025				
5	ScienceDirect, Mechanics of Materials and Plasticity Journals, 2025				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the fundamental concepts of stress, strain, generalized Hooke's law, principal stresses and strains, and equilibrium equations in three-dimensional elasticity problems.	PO1, PO2	PSO1		
CO2	Analyze plane stress and plane strain problems using equilibrium, compatibility equations, and Airy's stress function in Cartesian coordinates.	PO1, PO2, PO3	PSO1		
CO3	Apply elasticity solutions in polar coordinates to analyze thick cylinders, curved beams, stress concentration, and semi-infinite plate problems.	PO1, PO2, PO3	PSO1		
CO4	Evaluate torsional behavior of prismatic and thin-walled members using elasticity and elastic-plastic torsion theories.	PO1, PO2,	PSO1, PSO2		
CO5	Apply yield criteria and plasticity theories to solve engineering problems involving elastic-plastic material behavior.	PO1, PO2,	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	—	3	—
CO2	3	3	2	3	—
CO3	3	3	3	3	—
CO4	3	2	2	3	2
CO5	3	3	2	3	3
Average	3	2.6	2.25	3	2.5

Activities:

1.	Simulation-Solution to application-oriented problems using software (C05) ➤ Analysis of stress distribution in a thick cylinder subjected to internal and external pressure using ANSYS/Abaqus/COMSOL. ➤ Elastic-plastic analysis of circular shafts under torsion. ➤ Finite Element Analysis (FEA) of stress concentration around circular holes in plates. ➤ Comparison of Tresca and Von Mises yield criteria using simulation software. Numerical evaluation of torsional behavior of thin-walled sections.
2.	Case Study (C06)/ Technical Seminar Presentation (C06) (Independent study) ➤ Elastic-plastic behaviour of steel members during extreme loading conditions. ➤ Yielding and collapse of structural components under torsional loading. ➤ Elastic-Plastic Analysis of Structures using ANSYS. ➤ Stress Concentration and Fracture Mechanics. Recent Developments in Computational Plasticity (2020–2026).

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem formulation & boundary conditions	20	Problem and boundary conditions are clearly defined and justified.	Problem is defined, but some boundary conditions are unclear.	Problem statement is defined, but boundary conditions are unclear.
2.	Simulation & plots	30	Simulation is correctly performed and plots are well presented.	Simulation is performed with minor errors in plots or modeling.	Simulations and plots are incomplete.
3.	Interpretation of results	20	Results are clearly interpreted and justified using engineering concepts.	Results are interpreted but with limited justification.	Interpretation is unclear.
4.	Report presentation	10	Report is clear, well-structured, and professionally presented	Report is structured but needs improvement.	Report is poorly structured.
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Elasticity / Plasticity Concepts	20	Clearly explains stress, strain, torsional behavior, deformation, and related engineering concepts	Explanation is adequate but needs improvement in clarity and depth.	Limited understanding of the concepts.

2.	Safety & Economic considerations	30	Clearly discusses safety aspects, material selection, and cost implications with engineering justification.	Safety aspects are discussed, but material comparison or cost analysis is limited.	Safety and economic considerations are poorly explained.
3.	Evidence of self-learning	30	Extensive use of relevant journals, technical papers, standards, and credible sources beyond the syllabus.	Limited use of external sources and references.	Very limited or no evidence of self-learning.
4.	Presentation & Communication	20	Presentation is clear, well-structured, visually effective, and confidently delivered	Presentation is understandable but needs improvement in organization or delivery.	Presentation is poorly structured and lacks clarity
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST103	ADVANCED REINFORCED CONCRETE DESIGN			SEMESTER		I		
Prerequisites				Category	ES(PC)	Credits	3	
Advanced Structural Analysis Theory of Elasticity Design of Reinforced Concrete Elements Advanced Concrete Technology				Hours/ Semester	L	T	P	TH
					45	0	0	45
COURSE OBJECTIVES								
1.	To master the design of R.C. beams and columns by evaluating limit states of collapse and serviceability.							
2.	To understand the design principles for special R.C. elements.							
3.	To apply advanced analysis techniques for floor systems, flat slabs and grid floors.							
4.	To study the inelastic behavior of concrete structures their vital role of ductility in structural frames.							
5.	To implement seismic-resistant detailing and fire resistance requirements for structural members in accordance with Indian Standard codes such as IS:13920, IS:5525, and SP:34							
UNIT - I		DESIGN OF R.C. BEAMS AND R.C. COLUMNS						9
Design for limit state of collapse and serviceability - Calculation of deflection and crack width -Design of beams for combined effect of shear, bending moment and torsion. Behaviour of short and long columns -Behaviour of short column under axial load with uniaxial and bi-axial moments - Design of slender columns.								
UNIT - II		DESIGN OF SPECIAL R.C. ELEMENTS						9
Design of RC walls and shear walls - Design of rectangular and flanged shear walls – Design of simply supported and continuous deep beams - Design of corbels, strut and tie method.								
UNIT - III		DESIGN OF FLAT SLAB AND GRID FLOORS						9
Design of flat slabs according to IS method - Check for shear - Design of spandrel beams - Yield line theory - Hillerberg's method of design of slab, virtual work method - Equivalent frame method of design- Approximate analysis and Design of grid floors								
UNIT - IV		INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES						9
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								
UNIT - V		DETAILING REQUIREMENTS						9
Design and detailing of structural members using seismic design-Reinforcement detailing of structural members as per SP: 34& IS: 5525- Earthquake resistant Design - Detailing requirements for Ductility as per IS:13920 - Fire resistance of buildings								
Total: 45 Hours								
Weightage:								
Continuous Assessment 40%								
End Semester Examinations 60%								

REFERENCE BOOKS:					
1.	S Unnikrishna Pillai, Devdas Menon. "Reinforced Concrete Design" McGraw Hill, 2021				
2.	Varghese P.C., Advanced Reinforced Concrete Design, Prentice Hall of India, 2020				
3.	KirshnaRaju N., Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2016				
4.	Purushothaman P., Reinforced Concrete Structural Elements. Behaviour Analysis and Design, Tata Mcgraw Hill.				
5.	Gambhir, M. L. (2012). Design of reinforced concrete structures. Prentice Hall of India.				
6.	Park R. and Paulay T., Reinforced Concrete Structures, John Wiley & Sons.2017.				
7.	Relevant IS Codes (IS 456, IS 13920, SP 16, SP34), Bureau of Indian Standards.				
E-RESOURCES:					
1.	NPTEL, Advanced Reinforced Concrete Design, Prof. S. Suriya Prakash, IIT Hyderabad, https://onlinecourses.nptel.ac.in/noc23_ce109/ .				
2.	Bureau of Indian Standards (BIS) https://www.services.bis.gov.in				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Analyze the mechanical behavior of RC members, special elements, floor systems, inelastic redistribution, and seismic/fire responses.		----	----	
CO2	Apply design principles to RC beams/columns, shear walls, flat slabs, ductile frames, and earthquake-resistant structures.		PO1, PO2, PO3	PSO1, PSO2	
CO3	Evaluate structures using limit state theory, strut-and-tie models, yield line theory, moment-curvature curves, and seismic standards.		PO1, PO2, PO3	PSO1, PSO2	
CO4	Ensure integrity by assessing deflection, shear safety, grid floor stability, ductility, and fire resistance.		PO1, PO2, PO3	PSO1, PSO2	
CO5	Prepare reinforcement drawings for basic members, walls, slabs, and ductile joints per IS:13920 and SP:34.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	---	---	---	---	---
CO2	3	2	3	3	2
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	2	3	2	3	3
Average	2.2	2.5	2.2	3	2.5
Activities:					
1.	Software Simulation (CO4) Use structural software to model a grid floor and analyze how varying spans affect stability and deflection.				
2.	Drafting Lab (CO5) A hands-on session using CAD to create reinforcement schedules for a multi-story frame, specifically focusing on ductile detailing of beam-column joints.				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Serviceability Analysis	25	Precise calculation of deflection and crack width per IS codes.	Accurate with minor errors in non-critical limits.	Significant errors in serviceability checks.
2.	Shear Safety Capacity	30	Comprehensive assessment for beams, columns, and walls.	Correct safety checks with minor oversights.	Fails to evaluate shear safety for critical components.
3.	Grid Floor Stability	25	Advanced analysis of stability and load distribution.	Sound analysis with minor errors in distribution.	Poor understanding of grid floor behavior.
4.	Fire & Ductility	20	Flawless integration of fire ratings and ductility safety.	Includes major provisions but lacks specific depth.	Inadequate consideration of fire/ductile safety.
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Codal Compliance	20	Flawless application of IS 13920 and SP 34.	Follows standards with minor omissions.	Significant deviations from Indian Standards.
2.	Joint Detailing	30	Highly accurate detailing for joints and confinement.	Accurate with minor scaling or labeling errors.	Missing reinforcement for critical joints.
3.	Seismic Provisions	30	Implements all ductility/seismic requirements.	Major features included but lacks precision.	Fails to incorporate essential seismic detailing.
4.	Drafting Quality	20	Professional-grade drawings; fully annotated.	Organized and clear with minor presentation issues.	Poor organization; difficult to interpret.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST104	STRUCTURAL DESIGN LABORATORY			SEMESTER		I	
Prerequisites			Category	ES(PC)	Credits		2
Auto CADD Software			Hours/ Semester	L	T	P	TH
				0	0	60	60
COURSE OBJECTIVES							
1.	To develop the ability to model and analyze structural components such as beams, frames, trusses and foundations using modern structural analysis software.						
2.	To impart practical skills in the use of structural design software tools such as ETABS, STAAD, STRAP, and similar packages for structural analysis and design.						
3.	To enable students to apply relevant Indian Standard codes and engineering principles for the design and detailing of reinforced concrete and steel structures.						
4.	To develop competency in evaluating structural behaviour through computer-based simulations and interpreting the results for engineering decision-making.						
5.	To enhance professional skills in preparing detailed structural drawings, technical reports, and presentations using modern engineering tools and practices.						
LIST OF EXPERIMENTS:							
1.	Analysis of continuous beam						
2.	Analysis of Single Storey frame						
3.	Analysis of multi-storey frame						
4.	Design of multi-storey frame						
5.	Analysis and Design of Multistorey Building						
6.	Analysis and Design of Steel Truss						
7.	Analysis and Design of Foundation						
8.	Analysis of Prefabricated/Pre-engineered Structures						
Total:60 Hours							
Weightage: Observation & Record 60% Activities/Internal Test 40%							
REFERENCE BOOKS:							
1.	S. Ramamrutham and R. Narayanan, <i>Design of Reinforced Concrete Structures</i> , Dhanpat Rai Publishing Company, New Delhi.						
2.	P. C. Varghese, <i>Limit State Design of Reinforced Concrete</i> , Prentice Hall of India, New Delhi.						
3.	N. Subramanian, <i>Design of Steel Structures</i> , Oxford University Press, New Delhi.						
4.	S. S. Bhavikatti, <i>Design of Steel Structures by Limit State Method</i> , I.K. International Publishing House.						
5.	A. S. Arya, J. L. Ajmani and P. Agarwal, <i>Structural Analysis</i> , Nem Chand & Bros., Roorkee.						
E-RESOURCES:							
1.	NPTEL – Design of Reinforced Concrete Structures Covers beams, slabs, columns, footings, staircases and multi-storey building-frame design. NPTEL – Design of Reinforced Concrete Structures						
2.	NPTEL – Design of Steel Structures Covers steel members, bolted and welded connections, tension members, compression members and steel-structure design based on IS 800:2007. NPTEL – Design of Steel Structures						

3.	CSI ETABS – Official Documentation Useful for building modelling, analysis, concrete-frame design, steel-frame design and interpretation of structural results
4.	NPTEL – Structural Analysis-I Useful for the theoretical background of beams, frames and structural analysis before performing computer-based laboratory exercises
5.	Bureau of Indian Standards (BIS) Useful for accessing and referring to Indian Standards applicable to structural design, including IS 456 for reinforced concrete

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the principles of structural analysis and behaviour of beams, frames, trusses, and foundations using structural engineering concepts.	--	--
CO2	Apply software tools such as ETABS, STAAD, and STRAP for analysis of continuous beams and single storey frames.	PO1, PO2, PO3	PSO1, PSO2
CO3	Analyze and design multi-storey buildings, steel trusses, and foundations using standard design codes and computational tools.	PO1, PO2, PO3	PSO1, PSO2
CO4	Perform self-learning activities related to prefabricated and pre-engineered structures considering safety, societal, and economic aspects.	PO1, PO2, PO3	PSO1, PSO2
CO5	Prepare technical reports and presentations on structural design projects using modern engineering software and professional practices.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	----	----	----	----	----
CO2	3	2	3	3	2
CO3	3	2	2	3	3
CO4	3	3	3	3	2
CO5	3	2	2	3	3
AVERAGE	3	2.25	2.5	3	2.5

Activities:

1.	Structural Behaviour Demonstration and Interpretation (CO1)
2.	Software-Based Wind Load Analysis of Single-Storey Frame and Continuous Beam (CO2)
3	Integrated Design Project on Building/Truss/Foundation (CO3)
4	Structural Response Evaluation through Simulation (CO4)
5	Case Study on Wind-Resistant Prefabricated and Pre-Engineered Structures (CO5)

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Case Study Understanding	20	Demonstrates thorough understanding of prefabricated/pre-engineered structures, wind load effects, and structural safety requirements.	Shows good understanding with minor gaps in wind-resistant design concepts.	Limited understanding of prefabricated structures and wind loading principles.

2.	Technical Analysis	30	Provides comprehensive analysis of structural configuration, wind load resistance mechanisms, and design features with appropriate technical justification.	Good technical analysis with adequate interpretation of wind-resistant features.	Inadequate or inaccurate analysis of structural performance under wind loads.
3.	Application & Problem Solving	30	Effectively evaluates safety, societal, and economic aspects and proposes practical recommendations for improving wind resistance.	Good application of concepts with relevant suggestions and conclusions.	Minimal application of engineering concepts and limited recommendations.
4.	Report & Presentation	20	Well-organized, professional report and presentation supported by case data, drawings, figures, and references.	Organized report and presentation with minor deficiencies in documentation.	Poor organization, inadequate documentation, and weak presentation quality.
Total		100			

Rubrics for evaluation: C06

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Structural Modelling & Design	30	Develops an accurate structural model, applies appropriate load combinations (including wind loads), and completes design as per relevant IS codes with minimal errors.	Develops a suitable model with minor errors in loading, modelling, or design procedures.	Incomplete or inaccurate modelling and design with significant errors.
2.	Technical Understanding	20	Demonstrates strong understanding of structural behaviour, design concepts, software tools, and code provisions used in the project.	Shows good understanding with minor gaps in concepts or software application.	Limited understanding of structural design principles and software usage.
3.	Analysis, Interpretation & Drawings	30	Clearly interprets analysis results, evaluates structural performance, and prepares professional CAD drawings with proper detailing and annotations.	Provides reasonable interpretation and satisfactory drawings with minor deficiencies.	Inadequate analysis, interpretation, or incomplete structural drawings.

4.	Report & Presentation	20	Submits a well-organized technical report and delivers a professional presentation with clear communication, supporting calculations, figures, and references.	Good report and presentation with minor issues in documentation or communication.	Poor report organization, inadequate documentation, and ineffective presentation.
Total		100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Evaluation of Student Work, Observation of Record and Model Test	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST105	CONCRETE AND EXPERIMENTAL STRESS ANALYSIS LABORATORY			SEMESTER		I
Prerequisites			Category	ES(PC)	Credits	2
			Hours/ Semester	L	T	P
				0	0	60
COURSE OBJECTIVES						
1.	To impart practical knowledge about the tests on properties of fresh and hardened concrete.					
2.	To understand the procedure for designing concrete mixes.					
3.	To learn about measuring devices including mechanical, optical, and electrical strain gauges.					
4.	To apply non-destructive testing and permeability evaluations on concrete members.					
5.	To execute experimental stress analysis using photoelastic apparatus and BeggsDeformator.					
LIST OF EXPERIMENTS:						
1.	Determination of Modulus of Elasticity of concrete using Compressometer.					
2.	Mix Design.					
3.	Experimental stress analysis using photoelastic apparatus.					
4.	Study of BeggsDeformator.					
5.	Study of mechanical strain gauges.					
6.	Study of optical and electrical strain gauges.					
7.	Load vs deflection characteristics of simply supported beam using load cell, LVDT and Data acquisition system.					
8.	Permeability test for concrete.					
9.	Experimental study on fresh properties of self compacting concrete.					
10.	Accelerated curing of concrete.					
Total: 60 Hours						
Weightage: Observation & Record 60% Activities/Internal Test 40%						
REFERENCE BOOKS:						
1.	Shetty M.S., Concrete Technology, S.Chand and Company Ltd., Delhi. 2005					
2.	Santhakumar A.R., Concrete Technology, Oxford University press, New Delhi. 2007					
3.	Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2009.					

E-RESOURCES:					
1.	NPTEL, "Concrete Technology," IIT. https://nptel.ac.in/courses/105102012				
2.	NPTEL, "Experimental Stress Analysis," IIT. https://nptel.ac.in/courses/112106068				
3.	Virtual Labs, "Structural Engineering Lab," MoE, India. http://vlabs.iitb.ac.in/vlabs-dev/labs/structural-engineering				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Identify equipment, materials, and standard procedures for concrete testing and strain measurements. (Covers Modules I to V)			--	--
CO2	Perform standard laboratory tests on fresh and hardened concrete and analyze experimental stress. (Covers Modules I to V)			PO1, PO3	PSO1, PSO2
CO3	Evaluate structural behavior and concrete properties using data acquisition systems and specific mix designs. (Covers Modules I to V)			PO1, PO3	PSO1, PSO2
CO4	Execute a simple model-making or simulation activity related to load deflection or stress analysis.			PO2	PSO2
CO5	Present technical findings from an independent study on advanced concrete testing or modern gauges.			PO2, PO3	PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	3	-
CO3	3	-	3	3	-
CO4	-	3	-	-	3
CO5	-	3	3	-	3
Average	3	3	3	3	3
Activities:					
1.	Execution of stress analysis experiments and apparatus setup (CO4)				
2.	Data acquisition, plotting, and interpretation of load-deflection characteristics (CO5)				
Rubrics for evaluation:CO4					
Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Activity Execution & Methodology	40	Methodology is clear, accurate, and completely executed	Methodology is clear but has minor flaws in execution	Methodology is unclear or poorly executed
2.	Data Collection & Analysis	30	Data is well-collected and thoroughly analyzed	Data is collected but analysis needs improvement	Incomplete data and analysis
3.	Interpretation of results	30	Results are clearly interpreted & justified	Results are interpreted but limited justification	Unclear interpretation
	Total	100			

Rubrics for evaluation:CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding of topic	30	Clearly explains the selected topic and parameters	Explanation needs improvement	Limited understanding
2.	Evidence of self-learning	30	Excellent use of relevant journals/sources	Limited sources used	Very limited sources
3.	Presentation & Communication	40	Presentation is clear, confident, and well-structured	Presentation needs improvement	Poorly structured and communicated
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Evaluation of Student Work, Observation of Record and Model Test	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26MLC01	RESEARCH METHODOLOGY AND IPR				SEMESTER		I	
Prerequisites				Category	MC	Credits		3
				Hours/ Semester	L	T	P	TH
					45	0	0	45
COURSE OBJECTIVES								
1.	To understand the fundamentals of research methodology and formulation of research problems.							
2.	To develop analytical and technical writing skills for research.							
3.	To understand research ethics, plagiarism and documentation practices.							
4.	To gain knowledge about Intellectual Property Rights and patent systems.							
5.	To encourage innovation, creativity and research-oriented learning.							
UNIT - I		INTRODUCTION TO RESEARCH						9
Meaning of research problem, sources of research problem, criteria characteristics of a good research problem, errors in selecting the research problem, scope and objectives of research problem, approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentation.								
UNIT - II		EFFECTIVE LITERATURE STUDIES APPROACHES, ANALYSIS						9
Developing the theoretical framework of research- developing operational statements of the problem-criteria for evaluating research approach-hypothesis: parametric and non-parametric testing- establishing the reliability and validity of findings with literature review and experiments- documentation, plagiarism, research ethics								
UNIT - III		EFFECTIVE TECHNICAL WRITING, HOW TO WRITE REPORT, PAPER						9
Developing a research proposal, format of research proposal, a presentation and assessment by a review committee								
UNIT - IV		NATURE OF INTELLECTUAL PROPERTY						9
Patents, designs, trade and copyright, process of patenting and development: technological research, innovation, patenting, development. International scenario: international cooperation on intellectual property. Procedure grants of patents, patenting under PCT								
UNIT - V		PATENT RIGHTS AND IPR						9
Scope of patent rights. Licensing and transfer of technology. Patent information and databases. Geographical indications. Administration of patents system. New developments in IPR; IPR of biological systems, computer software etc., traditional knowledge case studies , IPR and IITs.								
Total:45 Hours								
Weightage: Continuous Assessment 40% End Semester Examinations 60%								
REFERENCE BOOKS:								
1.	Research Methodology: Methods and Techniques C.R. Kothari, New Age International Publishers.							
2.	The Craft of Research - University of Chicago Press.							
3.	Research Methodology: A Step-by-Step Guide for Beginners - SAGE Publications.							
4.	Practical Research: Planning and Design Pearson Education							
5.	Research Design: Qualitative, Quantitative and Mixed Methods Approaches - SAGE Publications.							

E-RESOURCES:	
1.	NPTEL Online Course – Research Methodology https://nptel.ac.in
2.	National Digital Library of India (NDLI) https://ndl.iitkgp.ac.in
3.	Google Scholar https://scholar.google.com
4.	World Intellectual Property Organization (WIPO) https://www.wipo.int

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the fundamental concepts of research methodology, research problem formulation, research design, and data collection methods.	--	--
CO2	appropriate research methods, literature review techniques, and statistical tools for conducting scientific investigations	PO1, PO2	PSO1
CO3	Analyze technical reports, research papers and documentation procedures with proper ethical practices.	PO2	PSO1, PSO2
CO4	Develop research proposals, technical reports, and research papers by following ethical and professional standards	PO3	PSO2
CO5	Conduct a literature survey and prepare a review report on an emerging research topic using self-learning resources. (Activity Oriented).	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	-	3	-
CO2	3	3	-	3	-
CO3	-	3	-	3	3
CO4	-	-	3	-	3
CO5	2	3	3	3	3
Average	2.67	3	3	3	3

Activities:

1.	Case Study (CO4)
2.	Technical Seminar Presentation (CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification	20	Problem and boundary conditions are clearly-defined	Problem defined, but some of the boundary conditions are unclear	Problem statement defined but unclear boundary conditions
2.	Literature Review	30	Simulation is done and plots are well-presented	Simulation is done, but minor error in plots	Simulations and plots are incomplete

3.	Research Methodology	30	Results are clearly interpreted justified	Results are interpreted but limited justification	Unclear interpretation
4.	Technical Report	20	Reproducer and well structured	Report is structured, but needs improvement	Poorly structured report
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Technical Content	20	Clearly explains torsional stress, strain and deformation	Explanation needs improvement	Limited understanding
2.	Innovation / Case Study	30	Clearly discusses safety aspects and material comparison cost	Safety aspects discussed but material comparison is	Poorly explained
3.	Presentation Skills	30	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Report Preparation	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly structured
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST106		TECHNICAL SEMINAR		SEMESTER			I
Prerequisites			Category	SD	Credits		1
			Hours/ Semester	L	T	P	TH
				0	0	30	30
COURSE OBJECTIVES							
1.	To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation						
2.	To acquire technical writing abilities for seminars and conferences.						
3.	To identify and compare technical and practical issues related to the area of course specialization.						
4.	To outline annotated bibliography of research demonstrating scholarly skills						
5.	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting						
CONTENTS							
1.	The students will work for two hours per week guided by a group of staff members.						
2.	They will be asked to talk on any topic of their choice related to Engineering design, and search relevant journal paper on the selected topics for presentation and to engage in dialogue with the audience.						
3.	Student is expected to present two seminars per semester.						
4.	The student will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic along with the journal reference copy.						
5.	A Faculty Advisor and two experts from the Department will evaluate the seminar.						
6.	Evaluation will be based on the technical presentation, seminar paper and also on the interaction during the seminar using the specific rubrics.						
Total:30Hours							
Weightage:							
Continuous Assessment 100%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Explain the selected engineering design topic and its technical background using appropriate literature sources						
CO2	Collect, review, and summarize technical information from journals, conference papers, and industry reports.			PO1		PSO2	
CO3	Analyze and compare technical approaches, practical issues, and recent developments related to the selected topic.			PO1		PSO2	
CO4	Evaluate research findings, identify gaps, and respond to technical queries during seminar discussions.			PO2, PO3		PSO1	
CO5	Prepare and deliver a professional technical seminar report and presentation demonstrating communication, documentation, and scholarly skills.			PO1, PO2, PO3		PSO1, PSO2	

The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1		1	1
CO2	3			1	2
CO3	3	2		2	2
CO4		3	2	2	
CO5	3	3	3	2	2
AVERAGE	2.75	2.25	2.50	1.60	1.75
Activities:					
1.	Literature Review and Annotated Bibliography				
2.	Technical Seminar Presentation and Discussion				
Rubrics for evaluation:1					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Topic Selection and Relevance	20	Highly relevant and current topic	Relevant topic	Limited relevance
2.	Literature Search Quality	20	Comprehensive and credible sources	Adequate sources	Few or weak sources
3.	Annotated Bibliography	20	Clear, concise, and analytical summaries	Adequate summaries	Minimal analysis
4.	Technical Understanding	20	Strong understanding of the topic	Moderate understanding	Limited understanding
5.	Documentation and Formatting	20	Professional and error-free	Minor formatting issues	Poor formatting
	Total	100			
Rubrics for evaluation: 2					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Technical Content and Accuracy	20	Highly accurate and in-depth	Generally accurate	Superficial content
2.	Organization and Clarity	20	Excellent flow and clarity	Adequate organization	Poor organization
3.	Presentation Skills	20	Confident, engaging, professional delivery	Adequate delivery	Weak delivery
4.	Response to Questions	20	Accurate and insightful responses	Adequate responses	Unable to answer satisfactorily
5.	Report Quality and Referencing	20	Well-structured report with proper references.	Adequate report	Poor documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component		Percentage allocation	Mapping Strength
	Review 1	Review 2		
CO1	10	10	10	2
CO2	10	10	10	2
CO3	10	10	10	2
CO4	35	35	35	3
CO5	35	35	35	3
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26MP201	NUMERICAL ANALYSIS LABORATORY			SEMESTER		II	
Prerequisites			Category	BS	Credits		2
Basic knowledge of any programming language and fundamental numerical methods is required.			Hours/ Semester	L	T	P	TH
				0	0	60	60
COURSE OBJECTIVES							
1.	To introduce computational programming techniques for solving numerical analysis problems.						
2.	To compute roots of nonlinear equations using standard numerical methods through computational programming.						
3.	To solve systems of linear algebraic equations using direct and iterative techniques.						
4.	To perform curve fitting and numerical integration using computational programs.						
5.	To obtain numerical solutions of ordinary differential equations using standard numerical methods.						
SYLLABUS CONTENTS: / LIST OF EXERCISES:							
1.	Find the roots of Non-Linear equation using Bisection Method.						
2.	Find the roots of Non-Linear equation using Newton–Raphson Method.						
3.	Curve Fitting by Least Squares Approximation.						
4.	Solve the System of Linear equation using Gauss Elimination Method.						
5.	Solve the System of Linear equation using Gauss-Jordan Method.						
6.	Solve the System of Linear equation using Gauss-Seidel Iteration Method.						
7.	Integrate numerically using Trapezoidal rule.						
8.	Integrate numerically using Simpson’s rule.						
9.	Numerical Solution of Ordinary Differential equations by Euler’s Method.						
10.	Numerical Solution of Ordinary Differential equations by Runge-Kutta Method.						
Total: 60 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
REFERENCE BOOKS:							
1.	Chapra, S. C., and Canale, R. P., “Numerical Methods for Engineers”, 7 th Edition, McGraw-Hill Education, 2015.						
2.	Burden, R. L., and Faires, J. D., “Numerical Analysis”, 10 th Edition, Cengage Learning, 2016.						
3.	Jain, M. K., Iyengar, S. R. K., and Jain, R. K., “Numerical Methods for Scientific and Engineering Computation”, 6 th Edition, New Age International, 2012.						
4.	Gerald, C. F., and Wheatley, P. O., “Applied Numerical Analysis”, 7 th Edition, Pearson Education, 2004.						

E-RESOURCES:	
1.	NPTEL – Numerical Methods https://nptel.ac.in/courses/111/106/111106101
2.	NPTEL – Computational Techniques https://nptel.ac.in/courses/103106074/
3.	MIT OpenCourseWare – Introduction to Numerical Methods https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/
4.	Libre Texts Engineering – Numerical Methods https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Numerical_Methods
5.	YouTube – Numerical Methods Playlist https://www.youtube.com/results?search_query=numerical+methods

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Demonstrate basic knowledge of numerical methods and computational programming techniques for engineering applications.	PO1	PSO1, PSO2
CO2	Apply computational techniques for solving nonlinear equations, systems of linear equations, curve fitting, numerical integration and ordinary differential equations.	PO1, PO2	PSO1, PSO2
CO3	Analyze the accuracy, convergence and computational performance of numerical methods used for nonlinear equations, linear systems, curve fitting, numerical integration and ordinary differential equations.	PO1, PO2, PO3	PSO1, PSO2
CO4	Implement suitable numerical methods for solving engineering problems involving nonlinear equations, linear systems, curve fitting with accuracy and efficiency considerations.	PO1, PO3	PSO1, PSO2
CO5	Develop computational solutions for engineering problems using numerical methods and effectively present and interpret the computational results.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	-	2	1
CO2	3	2	-	3	2
CO3	3	2	3	3	2
CO4	3	-	3	3	3
CO5	3	3	3	3	3
Average	2.8	2.3	3	2.8	2.2

Activities:

1.	Develop a program to find roots of nonlinear equations using Bisection and Newton–Raphson methods and compare convergence.
2.	Develop programs for solving systems of linear equations using Gauss Elimination, Gauss–Jordan and Gauss–Seidel methods.
3.	Develop a program for curve fitting using least squares approximation

4.	Develop and implement a program to evaluate definite integrals using the Trapezoidal Rule and Simpson's Rule.
5.	Solve ordinary differential equations using Euler and Runge–Kutta methods and evaluate the accuracy of numerical solutions.
6.	Develop computational solutions for engineering problems using numerical methods and present the results through tables, graphs and reports.

Rubrics for evaluation: C04 (Evaluation and Selection of Numerical Methods for Engineering Problems)

Sl. No.	Criterion	Marks	Excellent (9–10)	Good (6–8)	Satisfactory (1–5)
1.	Understanding of the Problem	10	Demonstrates a thorough understanding of the engineering problem and identifies the numerical requirements accurately.	Demonstrates an adequate understanding with minor omissions.	Demonstrates limited understanding of the problem and its numerical requirements.
2.	Selection of Appropriate Numerical Method	10	Selects the most appropriate numerical method with clear technical justification.	Selects a suitable method with partial or limited justification.	Selects an inappropriate method or provides little/no justification.
3.	Implementation and Computational Accuracy	10	Correctly implements the numerical method with accurate computations and negligible errors.	Implementation is mostly correct with minor computational errors.	Implementation contains significant errors affecting the results.
4.	Error, Convergence, and Performance Analysis	10	Performs comprehensive error and convergence analysis with appropriate interpretation of numerical performance.	Provides basic error or convergence analysis with minor inaccuracies.	Provides little or no meaningful error/convergence analysis.
5.	Interpretation, Presentation, and Technical Communication	10	Results are critically interpreted, well organized, and presented using appropriate tables, graphs, and technical language.	Results are adequately interpreted and presented with minor deficiencies.	Results are poorly interpreted and inadequately presented.
	Total	100			

Rubrics for evaluation: C05 (Development of Computational Solutions for Engineering Applications)

Sl. No.	Criterion	Marks	Excellent (9–10)	Good (6–8)	Satisfactory (1–5)
1.	Problem Formulation and Mathematical Modelling	10	Engineering problem is clearly formulated with an appropriate mathematical/numerical model and assumptions.	Problem formulation and model are appropriate with minor omissions.	Problem formulation is incomplete or the numerical model is inappropriate.

2.	Algorithm Design and Program Development	10	Develops a logical algorithm and implements a correct, efficient, and well-structured program.	Algorithm and program are mostly correct with minor issues.	Algorithm or program is incomplete, inefficient, or contains significant errors.
3.	Computational Accuracy and Solution Validation	10	Produces accurate results and validates them using analytical solutions, benchmark results, or error analysis.	Results are generally accurate with partial validation.	Results contain major errors with little or no validation.
4.	Efficiency, Testing, and Debugging	10	Program is thoroughly tested, efficiently executed, and handles different test cases with proper debugging.	Program is tested adequately with minor issues in efficiency or debugging.	Program is inadequately tested or fails for multiple test cases.
5.	Analysis, Documentation, and Technical Presentation	10	Results are critically analyzed and clearly documented with appropriate tables, graphs, and technical discussion.	Documentation and presentation are satisfactory with minor deficiencies.	Analysis, documentation, and presentation are inadequate or unclear.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

COs	Evaluation of Student Work, Observation of Record and Model Test	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	10	--	--	5	1
CO2	50	--	--	25	3
CO3	40	--	--	20	2
CO4	--	50	--	25	3
CO5	--	--	50	25	3
Total	100	50	50	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST201	FINITE ELEMENT METHOD IN STRUCTURAL ENGINEERING	SEMESTER			II
Prerequisites		Category	ES(PC)	Credits	3
		Hours/ Semester	L	T	P
			45	0	0
COURSE OBJECTIVES					
1.	To remember the concepts of finite element method and boundary value problems.				
2.	To understand finite element formulation using weighted residual and variational methods.				
3.	To apply finite element techniques to one- and two-dimensional field problems.				
4.	To analyse vector variable problems involving elasticity, stress, strain, plates, and shells.				
5.	To evaluate isoparametric formulations, numerical integration, and computer-based FEM solutions.				
UNIT - I	INTRODUCTION				9
Historical background – mathematical modeling of field problems in engineering – governing equation – discrete and continuous models – boundary, initial and eigenvalue problems – weighted residual methods – variational formulation of boundary value problems – Ritz technique – basic concepts of finite element method – advantage, disadvantage of finite element analysis and its applications.					
UNIT - II	ONE DIMENSIONAL PROBLEMS				9
One dimensional second order equation – discretization – element types – linear and higher order elements – derivation of shape functions and stiffness matrices and force vectors – assembly of matrices					
UNIT - III	TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS				9
Second order 2D equations involving scalar variable functions – variational formulation – finite element formulation – triangular elements – shape function and element matrices and vectors. Application to field problems					
UNIT - IV	TWO-DIMENSIONAL VECTOR VARIABLE PROBLEMS				9
Equations of elasticity – plane stress, plane strain, and axisymmetric problems – body forces and temperature effects – stress calculations – plate and shell elements					
UNIT - V	ISOPARAMETRIC FORMULATION				9
Natural coordinate system – iso parametric elements – shape function for iso parametric elements – one and two dimensions – serendipity elements – numerical integration and application to plane stress problem – matrix solution techniques – solution techniques to dynamic problems – introduction of analysis software					
Total:45 Hours					
Weightage:					
Continuous Assessment 40%					
End Semester Examinations 60%					

REFERENCE BOOKS:			
1.	Rao, S.S., The Finite Element Method in Engineering, Butterworth-Heinemann (Elsevier), Oxford, 6th Edition, 2018.		
2.	Rajasekaran, S., Finite Element Analysis in Engineering Design, S. Chand Publishing / Wheeler Publishing, New Delhi, 2nd Edition, 2020		
3.	Bhavikatti, S.S., Finite Element Analysis, New Age International (P) Ltd., New Delhi, 3rd Edition, 2018		
4.	Seshu, P., Textbook of Finite Element Analysis, PHI Learning Private Limited, New Delhi, 2nd Edition, 2019.		
5.	Krishnamoorthy, C.S., Finite Element Analysis – Theory and Programming, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition, 2021 Reprint.		
E-RESOURCES:			
1.	NPTEL – Introduction to Finite Element Analysis https://nptel.ac.in <i>(Basic concepts of FEM, elasticity, weighted residual methods, isoparametric elements)</i>		
2.	NPTEL – Finite Element Method https://nptel.ac.in <i>(Fundamentals of FEM, variational methods, one-dimensional and two-dimensional elements)</i>		
3.	Coursera – Finite Element Analysis Courses https://www.coursera.org <i>(FEM fundamentals, structural analysis, dynamic analysis, and engineering software applications.)</i>		
4.	Science Direct – Finite Elements in Analysis and Design Journal https://www.sciencedirect.com/journal/finite-elements-in-analysis-and-design <i>(Research articles on finite element theory, numerical methods, structural analysis, and advanced computational mechanics.)</i>		
5.	MIT Open Courseware – Finite Element Procedures for Solids and Structures https://ocw.mit.edu <i>(Mathematical modeling, finite element formulation, stress analysis, plates, shells, and computational techniques)</i>		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the basic concepts of finite element analysis, mathematical modeling, governing equations, and variational formulations used in engineering problems.	–	–
CO2	Apply finite element procedures to formulate and solve one-dimensional problems using shape functions, stiffness matrices, and force vectors.	PO1,PO3	PSO1
CO3	Analyze two-dimensional scalar variable problems and develop finite element formulations using triangular elements and variational methods.	PO1,PO2, PO3	PSO1
CO4	Analyze elasticity problems involving plane stress, plane strain, axisymmetric conditions, plates, and shells to determine structural responses.	PO1,PO2, PO3	PSO1
CO5	Evaluate isoparametric elements, numerical integration techniques, and matrix solution procedures for solving static and dynamic engineering problems using finite element software.	PO1,PO2, PO3	PSO1,PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	1	–	3	2	–
CO3	3	1	3	3	–
CO4	3	3	3	3	–
CO5	3	3	3	3	3
Average	2.5	2.33	3	2.75	3

Activities:

1. Finite Element Modelling of Structural Components Using Software (CO4)
2. Application of FEM in Real Civil Engineering Projects (CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	FEM Model Development	20	Complete Model	Minor Errors	Incomplete Model
2.	Meshing, Loading & Analysis	30	Accurate Analysis	Partial Analysis	Inadequate Analysis
3.	Interpretation of FEM Results	20	Critical Interpretation	Basic Interpretation	Limited Interpretation
4.	Presentation & Documentation	30	Professional Documentation	Acceptable Documentation	Poor Documentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Project Investigation	30	Detailed Investigation	Adequate Investigation	Limited Investigation
2.	Understanding of FEM Application	30	Concept Mastery	Basic Understanding	Limited Understanding
3.	Technical Interpretation	20	Critical Interpretation	Moderate Interpretation	Minimal Interpretation
4.	Presentation & Report Quality	20	Professional Presentation	Acceptable Presentation	Poor Presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST202	STRUCTURAL DYNAMICS			SEMESTER		II	
Prerequisites			Category	ES(PC)	Credits	3	
Advanced Structural Analysis Seismic Design,			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
To impart the knowledge to the students about vibrations theory on stable structural systems, the response of a structure to a dynamic load.							
UNIT - I		PRINCIPLES OF DYNAMICS					9
Vibration and its importance to structural engineering problems - Elements of vibratory systems and simple harmonic motion - generalized mass - D'Alembert's principle - Mathematical modeling of dynamics systems - Degree of Freedom - equation of motion for SDOF - damped and undamped free vibrations - Undamped forced vibration - Critical damping - response to harmonic excitation - damped or undamped - evaluation of damping - resonance - force transmitted to foundation - Vibration Isolation.							
UNIT - II		MULTIPLE DEGREE OF FREEDOM SYSTEM					9
Mathematical modeling of MDOF systems - Two degree of freedom systems - Damped and Undamped free vibration - Undamped forced vibration - Normal modes of vibration - Free and forced vibrations of MDOF systems - Orthogonality of normal modes - Approximate methods - Holzer, Rayleigh and Mode superposition techniques.							
UNIT - III		NUMERICAL SOLUTION					9
Numerical solution to response using Newmark method and Wilson Method, Numerical solution for static space response using direct integration - finite difference method, linear acceleration method - Runge Kutta method - Newmark's β method							
UNIT - IV		CONTINUOUS SYSTEMS					9
Mathematical modeling of continuous systems - Free and forced vibration of continuous systems - axial vibration of a beam - flexural vibration of a beam - Rayleigh- Ritz method - Formulation using Conservation of Energy - Formulation using Virtual Work.							
UNIT - V		SPECIAL TOPICS IN STRUCTURAL DYNAMICS (CONCEPTS ONLY)					9
Dynamic Effects of Wind Loading, Moving Loads, Vibrations caused by Traffic, Blasting and Pile Driving, Foundations for Industrial Machinery - Base Isolation.							
Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Dynamics of Structures, Clough R. W. and Penzien J., McGraw Hill.						
2.	Structural Dynamics and Introduction to Earthquake Engineering, Chopra A. K., Pearson, 2014.						
3.	Structural Dynamics - Vibrations and Systems, Madhujit Mukhopadhyay, Ane Books India.2008.						
4.	Dynamics of Structures, Humar J. L., Prentice Hall.						
5.	Structural Dynamics - Theory and Computation, Paz Mario, CBS Publication.						
E-RESOURCES:							
1.	https://nptel.ac.in/courses/105106151						
2.	https://nptel.ac.in/courses/105101006						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Understand the basic concepts of Vibrations / Dynamics.	----	----
CO2	Apply the fundamental theory and the equation of motions to obtain the dynamic responses of SDOF, MDOF and continuous systems.	PO1	PSO1
CO3	Analyse the SDOF, MDOF systems using various numerical methods	PO1	PSO1
CO4	Simulate the dynamic response of SDOF, MDOF and Continuous system using MATLAB/Excel.	PO2, PO3	PSO2
CO5	Create an art of review reports from Histories of disasters occurred in India/World	PO2	---

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	---	---	---	---	---
CO2	3	---		3	3
CO3	3	---		3	---
CO4	---	3	---	—	2
CO5	---	3	---	---	---
Average	3	3	-	3	2.5

Activities:

1.	Software Simulation (CO4) Using MATLAB/ Excel simulate the dynamic responses of SDOF, MDOF and Continuous System.
2.	Art of Review Reports (CO5) Create an art of review reports from Histories of disasters occurred in India/World

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Mathematical modelling	25	Deriving complete Equation	Partially Complete	Incomplete
2.	Creating proper Boundary Conditions	25	Boundary Conditions are correct	Partial Complete	Boundary condition adopted but wrong
3.	Programming	25	Program completed with proper procedure	Program completed and procedure is partial	Incomplete program and the procedure is not correct.
4.	Presentation	25	Neat presentation and accurate results	Presentation is not proper but results are accurate	Presentation is completed and the results are wrong
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Collection of data	25	Data collected related to the topic	Partial	Incomplete
2.	Data interpretations	25	Done proper and completed	Partially completed	Incomplete and not satisfactory
3.	Write up	25	Write up with reference and explanation	Partial	Incomplete and not satisfactory
4.	Presentation	25	Neat presentation with Figures and tables	Presentation is in completed	Poor presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST203	ADVANCED STEEL DESIGN			SEMESTER		II	
Prerequisites			Category	ES(PC)	Credits	3	
Basic Knowledge of IS 800:2007 Provisions & Design of Steel Structural Elements			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the property of structural steel and gain knowledge of design of steel structures.						
2.	To develop the ability to analyze and design bolted and welded steel connections subjected to eccentric loads and moments as per relevant design codes.						
3.	To understand the stability behaviour and design principles of beam-columns considering local capacity and overall buckling requirements.						
4.	To provide knowledge on the analysis and design of Pre-Engineered Buildings (PEBs), including portal frames and connection details based on IS 800:2007.						
5.	To familiarize students with the behaviour, buckling characteristics, and design of light gauge cold-formed steel tension members, compression members, and flexural members.						
UNIT - I		INTRODUCTION					9
Properties of Structural Steel: Mechanical Properties, Hysteresis, Ductility. Hot Rolled Sections: Compactness and non compactness, slenderness, residual stresses. Design of Steel Structures: Inelastic bending curvature, plastic moments, design criteria stability, strength, drift. Methods of Designs: Allowable stress design, Philosophies of limit state design, Plastic Design, Load and Resistance factor design							
UNIT - II		ECCENTRIC AND MOMENT CONNECTIONS					9
Introduction – Beam-Column Connections- Connections Subjected to Eccentric Shear – Moment Resistant Connections – Bolted & Welded - Framed Connections- Seated Connections –Bracket Connections							
UNIT - III		DESIGN OF BEAM COLUMNS					9
Introduction – General behavior of beam-columns – codal provision for local capacity check and overall buckling check – Design of beam-columns.							
UNIT - IV		PRE-ENGINEERED BUILDINGS					9
Introduction – connection details – design of typical portal frame from Industrial shed using IS: 800-2007.							
UNIT - V		LIGHT GAUGE STEEL STRUCTURES					9
Types of cross sections - local buckling and lateral buckling - concepts of elastic width – design of compression and tension members, beams, deflection of beams and design of beam webs							
Total: 45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	"Advanced Steel Design of Structures" Srinivasan Chandrasekaran, 2020, CRC Press						
2.	"Design of Steel Structures" K. S. Sai Ram 3rd Edition, 2020						
3.	"Unified Design of Steel Structures" Louis F. Geschwindner, Judy Liu, Charles J. Carter 4 th Edition, 2023						
4.	AISC Steel Construction Manual American Institute of Steel Construction 16th Edition, 2023						
5.	Structural Steel Design "Jack C. McCormac and Stephen F. Csernak "6th Edition, 2021						

E-RESOURCES:

1.	NPTEL – Advanced Design of Steel Structures (IIT Madras) - https://www.youtube.com
2.	American Institute of Steel Construction (AISC) Education Portal _ https://www.aisc.org/education
3.	SCI – Steel Construction Institute _ https://www.steel-sci.com
4.	Autodesk Structural Steel Design Learning _ https://www.autodesk.com
5.	INSDAG Teaching Resource Materials _ https://www.insdag.com/teaching-resource-materials

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the mechanical properties of structural steel, design philosophies, and behaviour of steel members under various loading conditions.	PO1, PO2	PSO1
CO2	Analyze and design bolted and welded eccentric and moment-resistant connections as per relevant design codes.	PO1, PO2, PO3	PSO1
CO3	Evaluate the stability behaviour and design requirements of beam-columns considering local and overall buckling effects.	PO1, PO2, PO3	PSO1
CO4	Design pre-engineered building components and portal frames using IS 800:2007 provisions.	PO1, PO3,	PSO1, PSO2
CO5	Design light gauge steel tension members, compression members, and flexural members considering buckling and serviceability requirements.	PO1, PO2, PO3,	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	–	3	–
CO2	3	3	3	3	–
CO3	3	3	3	3	–
CO4	3	2	3	3	3
CO5	3	3	3	3	3
Average	3	3	3	3	3

Activities:

1.	Simulation-Solution to application-oriented problems using software (C04) ➤ Analysis and design of Pre-Engineered Building (PEB) portal frames using STAAD Pro / ETABS. ➤ Beam-column stability analysis using finite element software. ➤ Design and analysis of moment-resistant steel connections. Buckling analysis of steel compression members.
2.	Case Study (C05)/ Technical Seminar Presentation (C05) (Independent study) ➤ Case study on failure of steel structures due to connection deficiencies. ➤ Comparative study of IS 800:2007, AISC, and Eurocode steel design provisions. ➤ Recent advancements in Pre-Engineered Buildings (PEBs). ➤ Applications of cold-formed steel structures in modern construction. Performance of steel structures under earthquake and wind loading.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Problem formulation & boundary conditions	20	Problem and boundary conditions are clearly defined and justified for steel structure analysis.	Problem is defined, but some boundary conditions are unclear.	Problem statement is defined but boundary conditions are unclear.
2.	Simulation & plots	30	Simulation is performed correctly using suitable software and plots/results are well presented.	Simulation is performed with minor errors in modeling or plots.	Simulations and plots are incomplete or contain significant errors.
3.	Interpretation of results	20	Results are clearly interpreted and justified with relevant steel design concepts and codal provisions.	Results are interpreted but with limited justification.	Interpretation of results is unclear.
4.	Report presentation	10	Report is clear, well-structured, and professionally presented.	Report is structured but needs improvement.	Poorly structured report.
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Understanding of Advanced Steel Design Concepts	20	Clearly explains advanced steel design concepts, structural behavior, and engineering applications.	Explanation is adequate but needs improvement in technical depth	Limited understanding of the topic.
2.	Safety & Economic Considerations	30	Clearly discusses safety requirements, design considerations, material selection, and economic aspects with proper justification.	Safety aspects are discussed, but economic considerations or justification are limited.	Safety and economic aspects are poorly explained.
3.	Evidence of self-learning	30	Extensive use of relevant journals, codes, standards, technical papers, and other credible sources beyond the syllabus.	Limited use of external sources and references.	Very limited sources and evidence of self-learning.
4.	Presentation & Communication	20	Presentation is clear, well-structured, visually effective, and confidently delivered.	Presentation is understandable but needs improvement in organization or delivery.	Poorly structured presentation with unclear communication.

5.	Understanding of Advanced Steel Design Concepts	20	Clearly explains advanced steel design concepts, structural behavior, and engineering applications.	Explanation is adequate but needs improvement in technical depth	Limited understanding of the topic.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST204		MODEL TESTING LABORATORY		SEMESTER			II
Prerequisites		Category	ES(PC)	Credits		2	
		Hours/ Semester	L	T	P	TH	
			0	0	60	60	
COURSE OBJECTIVES							
1.	Understanding the mechanical properties of high-strength concrete, including stress-strain behaviour and correlations between different strength types.						
2.	Gaining proficiency in Non-Destructive Testing (NDT) like ultrasonic pulses and rebound hammers to evaluate existing structures.						
3.	Experimentally studying how reinforced concrete beams respond to flexural, shear, and cyclic loading.						
4.	Investigating long-term factors like corrosion and chloride penetration (RCPT).						
5.	Applying vibration analysis to determine damping coefficients in structural members.						
LIST OF EXPERIMENTS:							
1.	Determination of stress-strain curve of high strength concrete						
2.	Determination of Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture of concrete						
3.	Cyclic loading test						
4.	Non-Destructive testing on existing concrete members through i) Rebound hammer ii) Ultrasonic pulse velocity test iii) Measurement of cracks						
5.	Experimental study on the behavior of beam under flexure						
6.	Experimental study on the behavior of beam under shear						
7.	Corrosion study on reinforced concrete						
8.	Rapid chloride penetration test (RCPT) on concrete						
9.	Determination of density of hardened concrete using automated buoyancy balance						
10.	Perform the dynamic test on beam to determine the damping co-efficients for free vibration.						
Total: 60 Hours							
Weightage:							
Observation & Record 60%							
Activities/Internal Test 40%							
REFERENCE BOOKS:							
1	Subramanian N, 'Design of Steel Structures - Limit state method'. Oxford University Press, New Delhi, 2016						
2	Park.R and Paulay.T, 'Reinforced concrete structures'. Wiley India, New Delhi, 2013.						
3	Subramanian N, 'Design of Reinforced Concrete Structures'. Oxford University Press, New Delhi, 2014.						
4	Sai Ram KS, 'Design of Steel Structures'. Pearson, New Delhi, 2020.						

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/				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Characterize concrete properties by evaluating strength correlations, stress-strain behavior, density, and chemical durability (corrosion/RCPT) across all testing setups.			----	----
CO2	Analyze the response of concrete elements under static, cyclic, and dynamic loads to determine flexure/shear behavior and damping characteristics.			PO1, PO2, PO3	PSO1, PSO2
CO3	Utilize NDT, crack measurement, and experimental loading to assess the health, integrity, and performance of structural members.			PO1, PO2, PO3	PSO1, PSO2
CO4	Interpret complex experimental data to establish mathematical correlations between material properties, loading cycles, and structural vibrations.			PO1, PO2, PO3	PSO1, PSO2
CO5	Execute laboratory protocols—from high-strength material testing to dynamic analysis—to validate compliance with structural safety and serviceability requirements.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	----	----	----	----	----
CO2	3	2	3	3	2
CO3	3	2	2	3	3
CO4	3	3	3	3	2
CO5	3	2	2	3	3
Average	3	2.25	2.5	3	2.5
Activities:					
1.	CO1 (Material Profiling) Create a "Durability Map" comparing RCPT and corrosion rates of high-strength vs. standard concrete to predict service life.				
2.	CO2 (Energy Dissipation Workshop) During cyclic loading, have students plot hysteresis loops in real-time to visualize how the beam absorbs energy.				
3.	CO3 (Blind Strength Test) Conduct a "forensic" check on an existing campus structure. Use Rebound Hammer and UPV to estimate strength without destructive testing.				
4.	CO4 (Correlation Challenge) Use experimental data from all 10 tests to derive a site-specific mathematical formula for Modulus of Rupture based on cube strength.				

5.	CO5 (Compliance Audit) Have students draft a "Quality Assurance Report" verifying if their lab results meet the specific serviceability limits of Indian Standards.
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Rubrics for evaluation:CO1

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Property Characterization	40	Flawless stress-strain and strength correlation.	Accurate with minor calculation errors.	Poor property assessment.
2.	Durability (RCPT/Corrosion)	40	Precise chemical and density testing.	Minor omissions in durability protocols.	Significant deviations from RCPT/corrosion standards.
3.	Documentation	20	Professional-grade data logs and plots.	Clear but slightly unorganized.	Lacks detail or clarity.
	Total	100			

Rubrics for evaluation: CO2

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Flexure & Shear Analysis	40	Precise determination of beam behavior.	Accurate with minor data points missing.	Inaccurate behavior analysis.
2.	Dynamic & Cyclic Loading	40	Expert calculation of damping coefficients.	Correct loading with minor scaling errors.	Fails to capture dynamic response.
3.	Technical Presentation	20	Exceptional visual data representation.	Clear graphs with minor labeling issues.	Difficult to interpret.
	Total	100			

Rubrics for evaluation:CO3

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	NDT Proficiency (UPV/Hammer)	40	Masterful use of equipment for health assessment.	Reliable data with minor procedural errors.	Significant NDT measurement errors.
2.	Crack Measurement	40	Highly accurate crack mapping and analysis.	Accurate mapping with minor omissions.	Fails to detail structural integrity.
3.	Diagnostic Reporting	20	Flawless synthesis of health results.	Organized report with minor gaps.	Poor diagnostic clarity.
	Total	100			

Rubrics for evaluation:CO4

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Mathematical Modeling	50	Flawless correlation of complex data.	Accurate correlations with minor errors.	Fails to link material properties.
2.	Analytical Interpretation	50	Expert insight into structural vibrations.	Good interpretation of loading cycles.	Poor data synthesis.
	Total	100			

Rubrics for evaluation:CO5

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Codal Compliance	50	Perfect adherence to high-strength testing codes.	Minor procedural deviations.	Significant compliance issues.
2.	Validation Proficiency	50	Professional validation of safety limits.	Accurate validation with minor errors.	Fails to confirm serviceability.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Laboratory component		Percentage allocation	Mapping Strength
	Evaluation of Student Work, Observation of Record and Model Test	Activities		
CO1	20	20	20	2
CO2	20	20	20	2
CO3	20	20	20	2
CO4	20	20	20	2
CO5	20	20	20	2
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST301		DISSERTATION PHASE - I		SEMESTER		III	
Prerequisites			Category	SD	Credits		8
			Hours/ Semester	L	T	P	TH
				0	0	240	240
COURSE OBJECTIVES							
1.	To understand the principles of scientific research and experimental design.						
2.	To identify and define a research problem within the chosen field of study.						
3	To conduct a comprehensive literature review and identify research gaps.						
4	To develop an experimental framework and methodology for data collection and analysis.						
5	To evaluate ethical, practical, and technical considerations associated with the research.						
CONTENTS							
1.	Each student shall undertake an individual technical project under the guidance of a faculty member with expertise in the selected domain. The selected topic shall be relevant to the field of Structural Design, experimental methods and may involve theoretical investigations, analytical studies, simulation-based research, or engineering case studies.						
2.	The student shall formulate a well-defined engineering problem with clearly stated objectives, scope, and expected outcomes. A comprehensive literature review shall be conducted to analyze existing research, identify knowledge gaps, and establish the technical background for the proposed work.						
3.	The student shall present and defend the work through a report, presentation and viva-voce examination before a panel of examiners, including one external examiner, to assess technical competence, analytical ability, presentation skills, and understanding of the chosen topic. The evaluation shall be based on the quality of problem identification, literature survey, and technical methodology, originality of work, report quality, presentation, and viva-voce performance.						
4.	The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.						
Total:240 Hours							
Weightage: Continuous Assessment 60% End Semester Examinations 40%							
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Identify and formulate a research problem in structural engineering through critical evaluation of contemporary literature related to structural materials, analysis, design, rehabilitation, or advanced structural systems.			PO1, PO2, PO3		PSO1, PSO2	
CO2	Analyze existing theories, design codes, experimental investigations, and numerical modeling techniques to identify research gaps and establish the scope of the proposed study.			PO1, PO2, PO3		PSO1, PSO2	
CO3	Develop an appropriate experimental, analytical, or computational methodology for investigating structural behavior, including the formulation of objectives, hypotheses, testing procedures, instrumentation, and data analysis methods.			PO1, PO2, PO3		PSO1, PSO2	

CO4	Apply principles of structural safety, sustainability, reliability, and professional ethics in planning and conducting research on structural engineering systems and components.	PO1, PO2, PO3	PSO1, PSO2
CO5	Prepare and defend a comprehensive dissertation proposal demonstrating technical feasibility, innovation, scientific rigor, and potential contributions to the advancement of structural engineering knowledge and practice.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	2	1
CO2	3	1	3	3	1
CO3	3	1	3	3	2
CO4	2	3	2	3	2
CO5	3	3	3	2	3
Average	2.8	1.4	2.8	2.6	1.8

Activities:

1.	Research Gap Identification and Literature Survey
2.	Dissertation Proposal Development

Rubrics for evaluation:1

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and relevance	20	Clearly defined, novel, and significant research problem	Relevant problem with minor limitations	Basic problem formulation
2.	Literature Survey	20	Relevant survey with proper references	Adequate survey	Limited literature survey
3.	Methodology implementation	20	Effective implementation with technical rigor	Adequate implementation	Partial implementation
4.	Technical competence	20	Strong understanding and execution capability	Good understanding	Basic understanding
5.	Review presentation and discussion	20	Excellent presentation and response to queries	Good presentation	Basic presentation
	Total	100			

Rubrics for evaluation:2

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Research objectives and scope	20	Well-defined and achievable objectives	Adequately defined objectives	Objectives lack clarity
2.	Methodology selection	20	Appropriate and technically sound methodology	Adequate methodology	Limited methodology justification
3.	Feasibility and resource planning	20	Comprehensive feasibility assessment	Moderate feasibility study	Basic planning

4.	Preliminary investigation/results	20	Meaningful preliminary work and analysis	Partial investigation completed	Minimal progress
5.	Review presentation and technical discussion	20	Excellent presentation and response to queries	Good presentation	Limited discussion
	Total	100			

Rubrics for evaluation:3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Dissertation proposal quality	20	Comprehensive and professionally prepared proposal	Good proposal structure	Basic proposal
2.	Technical progress achieved	20	Significant progress with validated outcomes	Moderate progress	Limited progress
3.	Analysis and interpretation	20	Strong analytical approach and interpretation	Adequate analysis	Basic analysis
4.	Work plan and future scope	20	Realistic and well-defined execution plan	Adequate planning	Limited planning
5.	Presentation, report and viva voce	20	Excellent communication and defense of work	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	10		20	2
CO3	20	30		20	2
CO4	10	40	20	25	3
CO5		20	80	25	3
Total	100	100	100	100	

Note:Purely as anExample: Strength = 3 (if percentage >20%);
Strength =2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26ST302	INTERNSHIP			SEMESTER			III	
Prerequisites				Category	SD	Credits		1
				Hours/ Semester	L	T	P	TH
					0	0	0	0
COURSE OBJECTIVES								
1.	To provide practical exposure to structural engineering practices							
2.	To develop the ability to apply advanced structural engineering concepts to real-world problems encountered in consultancy offices							
3.	To familiarize students with modern engineering tools and software used for structural analysis							
4.	To develop professional skills through participation in real projects							
5.	To encourage critical thinking and independent learning by identifying practical structural engineering challenges							
CONTENTS								
Students shall undergo a two-week internship training in structural engineering-related industries, consultancy firms, construction organizations, research institutions, or other approved organizations during the second-semester vacation . At the end of the internship, students shall submit an internship report along with the internship completion certificate . The internship shall be validated and evaluated during the End-Semester Examination based on the submitted report, certificate, presentation, and viva-voce.								
Weightage: End Semester Examination 100%								
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					Mapping POs		Mapping PSOs	
CO1	Demonstrate an understanding of professional practices, procedures, and standards involved in structural engineering projects.				PO1, PO3		PSO1, PSO2	
CO2	Apply advanced structural engineering concepts to practical problems encountered during internship training.				PO1, PO3		PSO1, PSO2	
CO3	Analyze structural engineering practices related to planning, analysis, design, detailing, construction, inspection, and quality control.				PO1, PO3		PSO1, PSO2	
CO4	Evaluate practical engineering solutions considering safety, sustainability, constructability, and relevant codes and standards.				PO1, PO2, PO3		PSO1, PSO2	
CO5	Demonstrate professional competence through technical documentation, effective communication, teamwork, and presentation of the internship experience.				PO1, PO2, PO3		PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs								
COs / POs	PO1	PO2	PO3	PSO1	PSO2			
CO1	1	-	3	2	2			
CO2	2	-	3	3	2			
CO3	3	-	3	3	2			
CO4	2	1	3	3	2			
CO5	2	3	3	2	3			
Average	2	2	3	2.6	2.2			

Rubrics for evaluation					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Technical Content and Accuracy	20	Highly accurate and in-depth	Generally accurate	Superficial content
2.	Organization and Clarity	20	Excellent flow and clarity	Adequate organization	Poor organization
3.	Presentation Skills	20	Confident, engaging, professional delivery	Adequate delivery	Weak delivery
4.	Response to Questions	20	Accurate and insightful responses	Adequate responses	Unable to answer satisfactorily
5.	Report Quality and Referencing	20	Well-structured report with proper references	Adequate report	Poor documentation
	Total	100			

26ST401		DISSERTATION PHASE - II			SEMESTER		IV	
Prerequisites				Category	SD	Credits		14
Dissertation Phase-I				Hours/ Semester	L	T	P	TH
					0	0	420	420
COURSE OBJECTIVES								
1.	To develop the ability to analyze and solve complex structural engineering problems using appropriate experimental, analytical, and computational techniques.							
2.	To enhance technical communication skills for the preparation and presentation of engineering reports, research outcomes, and professional documentation.							
3.	To Practice ethical conduct, professional responsibility, and effective work culture in structural engineering and research environments.							
CONTENTS								
Dissertation Phase– II will be an extension of the to work on the topic identified in Dissertation Phase–I. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc. There will be a pre submission seminar at the end of the academic term. After the approval the student has to submit the detailed report and an external examiner is called for the viva-voce to assess along with the guide.								
Total:420 Hours								
Weightage:								
Continuous Assessment 60%								
End Semester Examinations 40%								
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					Mapping POs		Mapping PSOs	
CO1	Analyze and interpret experimental data to evaluate the behavior of structural systems or components				PO1, PO2, PO3		PSO1, PSO2	
CO2	Evaluate the performance of structural systems or components based on experimental results, considering factors such as safety, economy and sustainability.				PO1, PO2, PO3		PSO1, PSO2	
CO3	Critique and synthesize research findings, identifying limitations and potential areas for future research.				PO1, PO2, PO3		PSO1, PSO2	
CO4	Design and conduct experimental studies, integrating knowledge from multiple areas of structural engineering.				PO1, PO2, PO3		PSO1, PSO2	
CO5	Communicate research findings and results justifying conclusions and addressing potential concerns.				PO1, PO2, PO3		PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs								
COs / POs	PO1	PO2	PO3	PSO1	PSO2			
CO1	3	1	3	3				
CO2	2	1	3	3	1			
CO3	3	2	3	2	1			
CO4	3	1	3	3	2			
CO5	2	3	2	1	3			
Average	2.6	1.6	2.8	2.4	1.75			

Activities:					
1.	Research Paper Preparation and Publication Review				
2.	Prototype / Simulation Demonstration and Thesis Preparation				
Rubrics for evaluation: 1					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem identification and relevance	20	Clearly defined, novel, and significant research problem	Relevant problem with minor limitations	Basic problem formulation
2.	Literature Survey	20	Relevant survey with proper references	Adequate survey	Limited literature survey
3.	Methodology implementation	20	Effective implementation with technical rigor	Adequate implementation	Partial implementation
4.	Technical competence	20	Strong understanding and execution capability	Good understanding	Basic understanding
5.	Review presentation and discussion	20	Excellent presentation and response to queries	Good presentation	Basic presentation
	Total	100			
Rubrics for evaluation: 2					
Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Experimental / Simulation results	20	Comprehensive and reliable results obtained	Adequate results	Limited results
2.	Analysis and interpretation	20	Strong analytical interpretation and insight	Moderate analysis	Basic analysis
3.	Validation and comparison	20	Thorough validation with literature/theory /experiments	Adequate validation	Limited validation
4.	Novelty and technical contribution	20	Significant research contribution and originality	Moderate contribution	Limited novelty
5.	Review presentation and technical defense	20	Excellent technical defense and communication	Good communication	Basic communication
	Total	100			

Rubrics for evaluation: 3

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Achievement of objectives and outcomes	20	All objectives successfully achieved and validated	Most objectives achieved	Partial achievement
2.	Quality of dissertation report	20	Professional, publication-quality dissertation	Good report quality	Basic report quality
3.	Innovation and engineering contribution	20	Significant contribution with strong originality	Moderate contribution	Limited contribution
4.	Results, conclusions and future scope	20	Comprehensive conclusions and meaningful future work	Adequate conclusions	Limited conclusions
5.	Final presentation and viva voice	20	Excellent presentation, confidence, and technical defense	Good presentation	Basic presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Component			Percentage allocation	Mapping Strength
	Review 1	Review 2	Review 3		
CO1	40			10	2
CO2	30	20		20	2
CO3	20	40	20	20	2
CO4	10	30	60	25	3
CO5		10	20	25	3
Total	100	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE01	THEORY OF THIN PLATES AND SHELLS				SEMESTER			
Prerequisites				Category	ES(PE)	Credits	3	
				Hours/ Semester	L	T	P	TH
					45	0	0	45
COURSE OBJECTIVES								
1.	To impart knowledge on the behavior and analysis of thin plates and shells							
2.	To understand the governing equations and analytical solutions of rectangular and circular plates.							
3.	To study membrane theory and bending theory of shells.							
4.	To apply analytical and numerical techniques for solving engineering problems related to plates and shells.							
5.	To develop practical understanding through activity-oriented learning.							
UNIT - I		INTRODUCTION						9
Space Curves, Surfaces, Shell Coordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equilibrium Equations using Virtual Work Principle, Boundary Conditions.								
UNIT - II		STATIC ANALYSIS OF PLATES						9
Governing Equation for a Rectangular Plate, Navier Solution for Simply- Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions.								
UNIT - III		CIRCULAR PLATES						9
Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Coordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple Cases in Rectangular Plates.								
UNIT - IV		STATIC ANALYSIS OF SHELLS						9
Membrane Theory of Cylindrical, Conical and Spherical Shells.								
UNIT - V		SHELLS OF REVOLUTION						9
Shells with Bending Resistance, Cylindrical and Conical Shells, Applications to Pipes and Pressure Vessels, Thermal Stresses in Plates and Shells.								
Total:45 Hours								
Weightage: Continuous Assessment 40% End Semester Examinations 60%								
REFERENCE BOOKS:								
1.	Theory of Plates and Shells Authors: Stephen Timoshenko and S. Woinowsky-Krieger Publisher: McGraw Hill Edition: 2nd Edition, 1987							
2.	Stresses in Plates and Shells Author: Ansel C. Ugural Publisher: McGraw Hill Edition: Illustrated Edition, 1981							
3.	Thin Elastic Shells Author: H. Kraus Publisher: John Wiley and Sons Edition: 1st Edition, 1967							
4.	Theory of Plates Author: K. Chandrashekhara Publisher: Universities Press Edition: 2001							
5.	Design and Construction of Concrete Shell Roofs Author: G. S. Ramaswamy Publisher: Krieger Publishing Edition: 2nd Edition, 1984							

E-RESOURCES:

- | | |
|----|--|
| 1. | Internet Archive – Theory of Plates and Shells |
| 2. | Google Books – Stresses in Plates and Shells |
| 3. | NPTEL Courses on Plates and Shells |
| 4. | MIT OpenCourseWare – Structural Mechanics |
| 5. | Springer Engineering E-Books |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

- | | | | |
|------------|---|---------------|------------|
| CO1 | Explain the fundamental concepts, assumptions, stress resultants and governing equations related to thin plates and shells. | - | - |
| CO2 | Apply analytical methods such as Navier and Levy solutions for solving rectangular plate problems under various loading conditions. | PO1, PO3 | PSO1, PSO2 |
| CO3 | Analyze circular plates subjected to axisymmetric loading and apply approximate methods such as Rayleigh–Ritz technique. | PO2, PO3 | PSO1, PSO2 |
| CO4 | Analyze cylindrical, conical and spherical shells using membrane theory and bending theory | PO2, PO3 | PSO1, PSO2 |
| CO5 | Investigate the behaviour of shells of revolution used in pressure vessels, pipelines, and storage structures through self-learning activities and present findings considering safety, societal, and economic aspects. | PO1, PO2, PO3 | PSO1, PSO2 |

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	2	3	3
CO3	-	3	2	3	3
CO4	-	3	3	3	3
CO5	2	3	3	3	3
Average	2.5	3	2.5	3	3

Activities:

- | | |
|----|--|
| 1. | Study shells of revolution used in pressure vessels, silos, storage tanks, chimneys, pipelines, cooling towers, and industrial structures. Analyze their structural behaviour and submit a technical report. |
| 2. | Case Study / Technical Seminar
Conduct a case study on modern applications of thin plates and shell structures such as aircraft fuselage, domes, folded plates, cooling towers, offshore structures, and shell roofs. Present findings through seminar and report |

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Shell Behaviour	25	Clearly explains structural behaviour	Good understanding with minor gaps	Limited understanding
2.	Technical Analysis	30	Detailed analysis with calculations	Moderate analysis	Basic analysis only
3.	Safety & Economic Aspects	25	Clearly discusses safety and economy	Partial discussion	Limited discussion
4.	Report Presentation	20	Well organized report	Minor improvements needed	Poor presentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Selection of Case Study	20	Highly relevant and innovative	Relevant topic	Basic topic
2.	Technical Content	30	Comprehensive and accurate	Adequate content	Limited content
3.	Evidence of Self-Learning	30	Extensive references and literature review	Moderate references	Few references
4.	Presentation & Communication	20	Excellent communication and presentation	Good presentation	Needs improvement
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE02	DESIGN OF PREFABRICATED STRUCTURES	SEMESTER			
Prerequisites		Category	ES(PE)	Credits	3
		Hours/ Semester	L	T	P
			45	0	0
COURSE OBJECTIVES					
1.	To understand the planning, layout, and IS Codal specifications for prefabricated plants.				
2.	To analyze the structural behavior of reinforced concrete prefabricated elements.				
3.	To design floors, stairs, roofs, and load-bearing walls using prefabricated components.				
4.	To design components of single-storey industrial sheds including roof trusses and crane gantry girders.				
5.	To design and detail shell roofs for industrial sheds, including jointing and erection techniques.				
UNIT - I	INTRODUCTION AND DESIGN PRINCIPLES				9
General civil engineering requirements, specific requirements for planning and layout of prefabricated plant - IS Codal specifications - Modular co-ordinations, standardizations, Disuniting of Prefabricated, productions, transportations, erection, stages of loading and codal provisions, safety factor, material properties, deflection control, lateral load resistance.					
UNIT - II	REINFORCED CONCRETE PREFABRICATED STRUCTURAL ELEMENTS				9
Prefabricated Structures - long wall, cross-wall, large panel buildings, one way and two way prefabricated slabs, framed buildings with partials and curtain walls, single storey industrial buildings with trusses, shells, crane- gantry systems.					
UNIT - III	FLOORS, STAIRS, ROOFS AND WALLS				9
Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slabs design, types of roof slabs and insulation requirements, description of joints, their behavior and reinforcement requirements, deflection control for short term and long term loads, ultimate strength calculations in shear and flexure. Types of wall panels, blocks and large panels, shear walls, curtain, partition and bearing walls, load transfer from floor to wall panels, vertical loads, eccentricity and stability of wall panels.					
UNIT - IV	DESIGN OF INDUSTRIAL BUILDINGS				9
Components of single-storey industrial sheds with crane gantry systems, design of R.C Roof trusses, roof panels, design of R.C. crane gantry girders, corbels and columns, wind bracing design.					
UNIT - V	DESIGN OF SHELL ROOFS FOR INDUSTRIAL SHEDS				9
Cylindrical, folded plate and hyper-prefabricated shells, erection and jointing, joint design, hand book based design.					
Total:45 Hours					
Weightage:					
Continuous Assessment 40%					
End Semester Examinations 60%					

REFERENCE BOOKS:

1. Lewicki B, Building with large Prefabricated, Elsevier Publishing Company, Amsterdam/ London/ New York, 1998.
2. Koncz T, Manual of Precast Concrete Constructions, Vol. I, II and III, Bauverlag, GMBH, 1976.
3. Structural Design Manual, Precast Concrete Connections & Details, Society for the Studies in the Use of Precast Concrete, NeatherlandBetorVerlag, 1978.
4. LassloMokk, Prefabricated Concrete for Industrial and Public Sectors, AkademiaiKiado, Budapest, 1964.
5. Murashev V, Sigalov E and Bailov V, Design of Reinforced Concrete Structures, Mir Publishers, 1976.

E-RESOURCES:

1. NPTEL Course on Precast Concrete Structures
2. PCI Design Handbook (Precast/Prestressed Concrete Institute) Manuals

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamental principles, planning, and IS codal specifications across all units. (Covers Units I to V)	--	--
CO2	Analyze the structural behavior of prefabricated components, floors, walls, and industrial buildings under various loads. (Covers Units I to V)	PO1, PO3	PSO1, PSO2
CO3	Evaluate and design structural systems including prefabricated elements, crane gantry systems, and shell roofs based on standard practices. (Covers Units I to V)	PO1, PO3	PSO1, PSO2
CO4	Conduct a simple activity involving the simulation or design of a specific prefabricated joint or structural element.	PO2	PSO3
CO5	Present technical findings from a case study on modern prefabrication techniques or shell roofs.	PO2, PO3	PSO3

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	3	3	-
CO3	3	-	3	3	-
CO4	-	3	-	-	3
CO5	-	3	3	-	3
Average	-	-	-	-	-

Activities:

1. Prepare a detailed structural drawing or a small-scale physical model of a prefabricated roof or wall panel (CO4)
2. Seminar presentation on a real-world case study of prefabricated building erection and jointing techniques (CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Activity Execution & Methodology	40	Methodology is clear, accurate, and completely executed	Methodology is clear but has minor flaws in execution	Methodology is unclear or poorly executed
2.	Data Collection & Analysis	30	Data is well-collected and thoroughly analyzed	Data is collected but analysis needs improvement	Incomplete data and analysis
3.	Interpretation of results	30	Results are clearly interpreted & justified	Results are interpreted but limited justification	Unclear interpretation
4.	Activity Execution & Methodology	40	Methodology is clear, accurate, and completely executed	Methodology is clear but has minor flaws in execution	Methodology is unclear or poorly executed
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of topic	30	Clearly explains the selected topic and parameters	Explanation needs improvement	Limited understanding
2.	Evidence of self-learning	30	Excellent use of relevant journals/sources	Limited sources used	Very limited sources
3.	Presentation & Communication	40	Presentation is clear, confident, and well-structured	Presentation needs improvement	Poorly structured and communicated
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

REFERENCE BOOKS:

1.	Edward Ghali, V. S. Sastri, M. Elboudjaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
2.	U.KamachiMudali Baldev Raj, S.Rangarajan Corrosion prevention and control, Narosa Publication,2009 edition.
3.	R.D.Angal, Principles and prevention of corrosion, Narosa Publication,2010 edition.
4.	Fontanna, G,Mars, "Corrosion Engineering", Third Edition, McGraw-Hill Book Company, 2017.

E-RESOURCES:

1.	NPTEL – Corrosion https://nptel.ac.in/courses/113104082
2.	National Association of Corrosion Engineers (NACE) http://www.naceindia.org/
3.	Bureau of Indian Standards (BIS) https://www.services.bis.gov.in

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Describe the mechanisms of corrosion, identification techniques, monitoring methods, protective measures, and inhibitors used in reinforced concrete structures.	-	-
CO2	Apply corrosion assessment, monitoring, and protection techniques for evaluating durability and serviceability of structures.	PO1	PSO1, PSO2
CO3	Analyze corrosion behavior and deterioration mechanisms in structures using electrochemical, resistivity, and nondestructive evaluation methods.	PO1, PO3	PSO1, PSO2
CO4	Evaluate suitable corrosion prevention strategies, protective systems, and rehabilitation methods for enhancing structural durability under different environmental conditions.	PO1, PO3	PSO1, PSO2
CO5	Develop a corrosion prevention and protection plan for structures by integrating monitoring methods, material selection, and suitable protective techniques.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	-	-
CO2	3	–	2	2	2
CO3	3	–	3	3	3
CO4	3	–	3	3	3
CO5	3	2	3	3	3
Average	3.0	2	2.75	2.75	2.75

Activities:

1.	Compute and analyze vehicle hybridization profiles using specialized longitudinal simulation tools.
2.	Independent seminar study evaluating engine-motor matching constraints and scaling laws.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification & Understanding	20	Demonstrates thorough understanding of environmental conditions, corrosion risks, and structural requirements	Shows good understanding with minor gaps	Limited understanding of corrosion problem and conditions
2.	Technical Analysis	30	Provides detailed analysis of corrosion mechanisms, materials, and influencing factors	Good analysis with adequate justification	Inadequate or incorrect technical analysis
3.	Design & Solution Development	30	Develops effective and innovative corrosion prevention strategies with proper justification	Suitable design with reasonable justification	Weak or inappropriate design solutions
4.	Report & Presentation	20	Well-organized, clear, professional report with strong technical support and presentation	Organized with minor issues	Poor organization, clarity, or documentation
5.	Problem Identification & Understanding	20	Demonstrates thorough understanding of environmental conditions, corrosion risks, and structural requirements	Shows good understanding with minor gaps	Limited understanding of corrosion problem and conditions
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Technical Knowledge	20	Demonstrates excellent understanding of corrosion and protection methods.	Demonstrates good understanding with minor gaps.	Demonstrates basic understanding.
2.	Application of Concepts	20	Applies corrosion concepts correctly to practical situations.	Applies concepts with minor errors.	Applies concepts partially.
3.	Problem Solving	20	Identifies problems and provides effective practical solutions.	Identifies problems and provides suitable solutions.	Identifies problems but solutions are limited.

4.	Teamwork & Participation	20	Actively contributes and coordinates effectively with the team.	Participates well in team activities.	Participates with some guidance.
5.	Communication & Presentation	20	Presents clearly, confidently and uses appropriate technical terminology.	Presents clearly with minor communication issues.	Presentation is understandable but needs improvement.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE04		ANALYSIS OF LAMINATED COMPOSITE PLATES		SEMESTER			
Prerequisites			Category	ES(PE)	Credits		3
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To understand the fundamental behavior, theory, and displacement formulations of laminated composite plates using classical and shear deformation theories.						
2.	To learn the governing equations and analytical methods for determining stresses and deflections in laminated composite plates.						
3.	To analyze the behavior of composite plates under various boundary conditions using Navier and Levy solution approaches.						
4.	To apply finite element methods for the analysis of laminated composite plates using CLPT and FSDT formulations.						
5.	To explore advanced numerical techniques and post-processing methods for evaluating stresses and structural response of composite plates.						
UNIT - I		INTRODUCTION					9
Displacement Field Approximations for Classical Laminated Plate Theory (CLPT) and First Order Shear Deformation Theory (FSDT), Analytical Solutions for Bending of Rectangular Laminated Plates using CLPT.							
UNIT - II		GOVERNING EQUATIONS					9
Navier Solutions of Cross-Ply and Angle-Ply Laminated Simply-Supported Plates, Determination of Stresses.							
UNIT - III		ANALYTICAL SOLUTIONS					9
Levy Solutions for Plates with Other Boundary Conditions. Analytical Solutions for Bending of Rectangular Laminated Plates Using FSDT.							
UNIT - IV		FINITE ELEMENT SOLUTIONS USING CLPT					9
Finite Element Solutions for Bending of Rectangular Laminated Plates using CLPT. Introduction to Finite Element Method, Rectangular Elements, Formation of Stiffness Matrix, Formation of Load Vector, Numerical Integration, Post Computation of Stresses.							
UNIT - V		FINITE ELEMENT SOLUTIONS USING FSDT					9
Finite Element Solutions for Bending of Rectangular Laminated Plates using FSDT. Finite Element Model, C0 Element Formulation, Post Computation of Stresses. Analysis of Rectangular Composite Plates using Analytical Methods.							
Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Mechanics of Laminated Composites Plates and Shells, Reddy J. N.,2nd edition CRC Press.						
2.	Mechanics of Composite Materials, Kaw A.K., CRC Press, Second Edition, 2005						
3.	Mechanics of Composite Materials, Jones R.M., Taylor & Francis, Second Edition, 1999						
4.	Theory and Analysis of Plates: Classical and Numerical Methods, Szilard R., Prentice Hall, 1974.						
5.	Mechanics of Laminated Composites Plates and Shells, Reddy J. N.,2nd edition CRC Press.						

E-RESOURCES:

- | | |
|----|--|
| 1. | NPTTEL – Mechanics of Laminated composite structure https://nptel.ac.in/courses/112104161 |
| 2. | MDPI Buildings – Analysis of Laminated Composite Plates: A Comprehensive Bibliometric Review https://www.mdpi.com/2075-5309/14/6/1574 |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs****CO1**

Describe the theories, governing equations, analytical solutions, and finite element formulations used in the analysis of laminated composite plates.

-

-

CO2

Apply Classical Laminated Plate Theory (CLPT), First Order Shear Deformation Theory (FSDT), and analytical methods to determine stresses and deflections in laminated composite plates.

PO1, PO3

PSO1,
PSO2**CO3**

Analyze the structural behavior of laminated composite plates under different boundary conditions using Navier, Levy, and finite element solution techniques.

PO1, PO3

PSO1,
PSO2**CO4**

Evaluate the accuracy and effectiveness of analytical and finite element approaches for predicting the response of laminated composite plates.

PO1, PO3

PSO1,
PSO2**CO5**

Develop a computational model for the analysis of laminated composite plates by integrating appropriate plate theories, boundary conditions, and numerical solution techniques.

PO1, PO2,
PO3PSO1,
PSO2**The Course Articulation Matrix (CAM) for defined COs**

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	-	-
CO2	3	–	2	2	2
CO3	3	–	3	3	3
CO4	3	–	3	3	3
CO5	3	2	3	3	3
Average	3.0	2.0	2.75	2.75	2.75

Activities:

- | | |
|----|---|
| 1. | Laminated Composite Plate Analysis Activity (CO5) Analyze a laminated composite plate using analytical or numerical methods and compare the effects of different laminate layups and boundary conditions on structural response. |
|----|---|

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Definition and Model Selection	20	Clearly defines the problem, selects appropriate laminate configuration, boundary conditions, and analysis method	Defines the problem and model with minor gaps	Limited understanding of the problem and model selection

2.	Application of Analytical / Numerical Methods	30	Correctly applies CLPT, FSDT, or finite element techniques with appropriate assumptions and methodology	Applies methods with minor errors or omissions	Incorrect or incomplete application of analysis methods
3.	Results Interpretation and Comparison	30	Effectively evaluates stress and deflection behavior and provides meaningful comparison of laminate configurations or boundary conditions	Provides reasonable interpretation and comparison with minor gaps	Limited analysis and interpretation of results
4.	Technical Report and Presentation	20	Well-organized, technically sound report with clear presentation of methodology, results, and conclusions	Good report and presentation with minor deficiencies	Poor organization, inadequate documentation, or unclear presentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Definition and Model Selection	20	Clearly defines the problem, selects appropriate laminate configuration, boundary conditions, and analysis method	Defines the problem and model with minor gaps	Limited understanding of the problem and model selection
2.	Application of Analytical / Numerical Methods	30	Correctly applies CLPT, FSDT, or finite element techniques with appropriate assumptions and methodology	Applies methods with minor errors or omissions	Incorrect or incomplete application of analysis methods
3.	Results Interpretation and Comparison	30	Effectively evaluates stress and deflection behavior and provides meaningful comparison of laminate configurations or boundary conditions	Provides reasonable interpretation and comparison with minor gaps	Limited analysis and interpretation of results
4.	Technical Report and Presentation	20	Well-organized, technically sound report with clear presentation of methodology, results, and conclusions	Good report and presentation with minor deficiencies	Poor organization, inadequate documentation, or unclear presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE05		FRACTURE MECHANICS OF CONCRETE STRUCTURES		SEMESTER		
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the fundamental concepts of fracture mechanics, crack formation, propagation, and failure mechanisms in concrete structures.					
2.	To learn the different types of fracture and cracking phenomena affecting the performance and durability of concrete structures.					
3.	To analyze stress fields near crack tips and fracture parameters used in linear and nonlinear fracture mechanics.					
4.	To evaluate fracture models and continuum damage mechanics approaches for predicting crack growth and structural failure.					
5.	To apply fracture mechanics principles and numerical modeling techniques to assess the behavior of special concretes and advanced concrete structures.					
UNIT - I						
UNIT - I		INTRODUCTION				9
Basic Fracture Mechanics, Crack in a Structure, Mechanisms of Fracture and Crack-growth						
UNIT - II		TYPES OF FRACTURE				9
Cleavage Fracture, Ductile Fracture, Fatigue Cracking, Environment assisted Cracking, Service Failure Analysis.						
UNIT- III		STRESS AT CRACK TIP				9
Stress at Crack Tip, Linear Elastic Fracture Mechanics, Griffith's Criteria, Stress Intensity Factors, Crack Tip Plastic Zone, Erwin's Plastic Zone Correction, R curves, Compliance, J Integral, Concept of CTOD and CMD.						
UNIT- IV		MATERIAL MODELS				9
General Concepts, Crack Models, Band Models, Models based on Continuum Damage Mechanics.						
UNIT - V		APPLICATION ON SPECIAL CONCRETE AND NUMERICAL MODELING				9
Applications to High Strength Concrete, Fiber Reinforced Concrete, Crack Concepts and Numerical Modeling.						
Total:45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	Fracture Mechanics: Fundamentals and Applications, Anderson, T.L., CRC Press, 4th Edition, 2017.					
2.	Fracture and Size Effect in Concrete and Other Quasi-Brittle Materials, Bazant, Z. P., & Planas, J. CRC Press (1998).					
3.	Elementary Engineering Fracture Mechanics (4th ed.). Broek, D. Springer (1986)					

E-RESOURCES:

1.	Covers basic concepts, LEFM, nonlinear fracture models, softening, fracture parameters, and size effects. ACI provides PDF access for members.
2.	MIT OpenCourseWare – Mechanics and Design of Concrete Structures — Free course reading/reference list. It specifically cites Bažant's <i>Fracture Mechanics of Concrete Structures</i> .
3.	Springer – Fracture Mechanics of Concrete: Structural Application and Numerical Calculation — Includes chapters on progressive cracking, size effects, numerical fracture modeling, and discrete crack

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Describe the fundamental concepts of fracture mechanics, crack propagation mechanisms, fracture modes, crack-tip behavior, and fracture parameters in concrete structures.	-	-
CO2	Apply fracture mechanics principles and crack-tip parameters to determine fracture behavior and failure characteristics of concrete structures.	PO1, PO3	PSO1, PSO2
CO3	Analyze different fracture mechanisms, crack growth behavior, stress intensity factors, and fracture criteria for assessing structural performance.	PO1, PO3	PSO1, PSO2
CO4	Evaluate fracture models, damage mechanics approaches, and numerical methods for predicting crack propagation and structural failure in concrete.	PO1, PO3	PSO1, PSO2
CO5	Develop a fracture assessment model for concrete structures by integrating fracture parameters, material models, and numerical techniques to evaluate crack growth and structural integrity.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	—	—	—	-	-
CO2	3	—	2	3	2
CO3	3	—	3	3	2
CO4	3	—	3	3	3
CO5	3	2	3	3	2
Average	3.0	2.0	2.0	3.0	2.25

Activities:

1.	Fracture Assessment and Crack Analysis Activity (CO5) Analyze a concrete structural element containing cracks and develop a fracture assessment model by evaluating crack propagation behavior, fracture parameters, and suitable material models to predict structural performance.
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Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification and Crack Assessment	20	Clearly identifies crack characteristics, fracture behavior, and structural problem with comprehensive understanding	Identifies the problem with minor gaps in assessment	Identifies the problem with minor gaps in assessment

2.	Application of Fracture Mechanics Concepts	30	Effectively applies fracture parameters, crack propagation concepts, and material models with proper technical justification	Applies concepts with minor errors or omissions	Applies concepts with minor errors or omissions
3.	Fracture Analysis and Model Development	30	Develops a suitable fracture assessment model and provides detailed evaluation of structural performance	Develops a reasonable model with adequate analysis	Develops a reasonable model with adequate analysis
4.	Technical Report and Presentation	20	Well-organized, technically sound report with clear presentation of methodology, results, and conclusions	Good documentation and presentation with minor deficiencies	Good documentation and presentation with minor deficiencies
5.	Problem Identification and Crack Assessment	20	Clearly identifies crack characteristics, fracture behavior, and structural problem with comprehensive understanding	Identifies the problem with minor gaps in assessment	Identifies the problem with minor gaps in assessment
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification and Crack Assessment	20	Clearly identifies crack characteristics, fracture behavior, and structural problem with comprehensive understanding	Identifies the problem with minor gaps in assessment	Identifies the problem with minor gaps in assessment
2.	Application of Fracture Mechanics Concepts	30	Effectively applies fracture parameters, crack propagation concepts, and material models with proper technical justification	Applies concepts with minor errors or omissions	Applies concepts with minor errors or omissions
3.	Fracture Analysis and Model Development	30	Develops a suitable fracture assessment model and provides detailed evaluation of structural performance	Develops a reasonable model with adequate analysis	Develops a reasonable model with adequate analysis
4.	Technical Report and Presentation	20	Well-organized, technically sound report with clear presentation of methodology, results, and conclusions	Good documentation and presentation with minor deficiencies	Good documentation and presentation with minor deficiencies

5.	Problem Identification and Crack Assessment	20	Clearly identifies crack characteristics, fracture behavior, and structural problem with comprehensive understanding	Identifies the problem with minor gaps in assessment	Identifies the problem with minor gaps in assessment	
	Total	100				
The Internal Assessment Matrix (IAM) for the defined COs:						
	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	
Note: Purely as an Example: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);						

E-RESOURCES:

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

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Understand the various concepts and applications to soil structure interaction.	----	----
CO2	Apply the theory/ concepts to various soil- structures interaction problems	PO1	PSO1
CO3	Analyse the structures which are in contact with soil	PO1	PSO1
CO4	Apply SSI principles, modelling tools, and case studies to evaluate real-world structural–soil interaction problems.	PO2, PO3	PSO2
CO5	Numerical Solutions to Soil - Structure Problems	PO2	---

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	---	---	---	---	---
CO2	3	---	2	3	3
CO3	3	---	2	3	---
CO4	3	2	1	—	2
CO5	3	2	1	---	---
Average	3.0	2.0	1.5	3.0	2.5

Activities:

1. **Case Study (CO4)**
Apply SSI principles, modelling tools and case studies to evaluate real-world structural–soil interaction problems.
2. **(CO5)**
Numerical Solutions to Soil - Structure Problems

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Problem Identification	25	Clearly identifies all issues, gaps and problem statement.	Identify major issues and minor gaps and undefined problem statement	Incomplete
2.	Analysis & Method	25	Systematic step by step analysis	Correct method with minor errors	Wrong method applied or major conceptual error
3.	Solution & Interpretation	25	Good Interpretation with high accuracy results	Partially Completed	Wrong interpretation and wrong results
4.	Presentation & Ethics	25	Neat presentation with proper figures etc	Presentation is not satisfactory	Poor presentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Mathematical modelling	25	Deriving complete Equation	Partially Complete	Incomplete
2.	Creating proper Boundary Conditions	25	Boundary Conditions are correct	Partial Complete	Boundary condition adopted but wrong
3.	Programming	25	Program completed with proper procedure	Program completed and procedure is partial	Incomplete program and the procedure is not correct.
4.	Presentation	25	Neat presentation and accurate results	Presentation is not proper but results are accurate	Presentation is completed and the results are wrong
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	3
C05				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

E-RESOURCES:

1.	NPTEL – Offshore Structures https://nptel.ac.in (Fundamentals of offshore platforms, ocean environmental loading, wave theories and offshore structural analysis)
2.	NPTEL – Ocean Engineering https://nptel.ac.in (Oceanographic parameters, marine hydrodynamics, offshore engineering principles and applications)
3.	DNV Offshore Standards and Recommended Practices https://www.dnv.com/oilgas (Design, fabrication, installation, inspection and maintenance of offshore structures)
4.	Bureau of Indian Standards (BIS) – Marine and Offshore Codes https://www.bis.gov.in (Indian standards related to structural design, loading and offshore engineering practices)
5.	Offshore Technology Conference (OTC) https://www.otcnet.org (Technical papers, industry developments, innovations and emerging offshore technologies)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamental concepts, environmental conditions, oceanographic parameters, loading mechanisms, and structural systems adopted in offshore structures.	---	---
CO2	Apply wave theories, ocean engineering principles, design methodologies, and codal provisions for offshore structural components and systems.	PO1, PO3	PSO1
CO3	Analyze offshore structures subjected to wave, wind, current, seismic, and operational loads and assess their structural response.	PO1, PO3	PSO1
CO4	Evaluate offshore structural systems, design approaches, safety requirements, and published technical studies considering marine environmental effects.	PO1, PO2	PSO1
CO5	Develop and present a seminar on emerging technologies, innovative offshore systems, renewable energy applications, or recent developments in offshore engineering.	PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	2	2	-
CO3	3	-	3	2	-
CO4	3	2	-	2	-
CO5	-	3	2	2	2
Average	1.80	1.00	1.40	1.60	0.40

Activities:

1.	Activity I – Journal Article Review and Presentation on Offshore Structures (CO4) Students shall review a recent journal article related to offshore structures, critically evaluate the methodology, structural configuration, environmental loading considerations, design approach, findings, and conclusions, and present the review through a seminar and technical report.
2.	Activity II – Emerging Technology Seminar on Offshore Structures (CO5) Students shall prepare and deliver a seminar on emerging offshore technologies such as floating offshore wind turbines, deep-water platforms, smart monitoring systems, digital twin applications, autonomous offshore inspection systems, renewable ocean energy structures, or sustainable offshore infrastructure and submit a summary report.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Offshore Structural Systems	25	Demonstrates comprehensive understanding of offshore platforms, subsea systems, foundations, and marine environmental conditions discussed in the article	Demonstrates good understanding with minor gaps	Demonstrates Limited understanding
2.	Evaluation of Environmental Loading and Design Methods	30	Critically evaluates wave, wind, current, seismic, and operational loading considerations along with design methodologies	Provides reasonable evaluation with adequate justification	Limited evaluation of loading and design aspects
3.	Analysis of Structural Behaviour	25	Effectively analyses structural response, stability, hydrodynamic effects, and performance under marine conditions	Provides acceptable analysis with minor omissions	Limited analysis and interpretation
4.	Technical Report and Presentation	20	Presents findings professionally with strong technical documentation and supporting references	Presentation and documentation are satisfactory	Presentation lacks clarity and completeness
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Relevance of Emerging Offshore Technology	20	Selects a highly relevant topic such as floating platforms, offshore wind structures, deep-water systems, digital twin technology, or smart marine infrastructure	Topic is relevant with adequate justification	Topic relevance is limited

2.	Technical Knowledge and Application	35	Demonstrates strong understanding of the technology and its offshore engineering applications	Demonstrates good technical understanding	Technical understanding is limited
3.	Evaluation of Engineering Benefits and Challenges	25	Clearly evaluates structural, operational, economic, environmental, and sustainability aspects	Provides reasonable evaluation	Evaluation lacks depth
4.	Seminar Delivery and Documentation	20	Professional presentation supported by high-quality technical documentation and references	Good presentation with minor shortcomings	Poor presentation and documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE08		MODERN CONSTRUCTION MATERIALS		SEMESTER		
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To study special concretes and their properties in construction.					
2.	To Understand metals and advanced metallic materials used in buildings.					
3.	To Learn about composite materials and their engineering applications.					
4.	To gain Knowledge on waterproofing, flooring, façade and other construction materials.					
5.	To learn about smart and intelligent materials for modern construction.					
UNIT - I		SPECIAL CONCRETES				9
Concretes, Behavior of concrete - High Strength and High Performance Concrete - Fiber Reinforced Concrete, Self compacting concrete, Geopolymer Concrete, Alternate Materials to concrete - Aerocon blocks - Self Curing Concrete-Nano Concrete and nano technology in construction						
UNIT - II		METALS				9
Steels - New Alloy Steels - Aluminum and its Products - Coatings to reinforcement – Applications – Galvalume roofing sheets - M2 panels for wall panels.						
UNIT- III		COMPOSITES				9
Plastics - Reinforced Polymers - Fiber Reinforced Concrete - Steel Fiber-reinforced cement composites – Fiber reinforced plastic composites - carbon fibers and composite reinforcement - Applications						
UNIT- IV		OTHER MATERIALS				9
Water Proofing Compounds - Non-weathering Materials - Flooring and Façade Materials						
UNIT - V		SMART AND INTELLIGENT MATERIALS				9
Smart and Intelligent Materials for intelligent buildings - Special features - Case studies on applications of smart and Intelligent materials.						
L:45, Total:45 Hours						
Weightage: Continuous Assessment 40% End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	Santhakumar A.R., <i>Concrete Technology</i> , Second Edition, Oxford University press, New Delhi. 2018					
2.	Shetty, M.S. <i>Concrete Technology: Theory and Practice</i> . New Delhi: S. Chand & Company Ltd., Revised Edition, 2022.					
3.	Mamlouk, M.S. and Zaniewski, J.P. <i>Materials for Civil and Construction Engineers</i> . Pearson / Prentice Hall, 4th Edition, 2017.					
4.	Ashby, M.F. and Jones, D.R.H. <i>Engineering Materials 1: An Introduction to Properties, Applications and Design</i> . Elsevier, 5th Edition, 2019.					
5.	Shan Somayaji, <i>Civil Engineering Materials</i> , Prentice Hall Inc., 2001					

E-RESOURCES:

1.	NPTEL – Advanced Concrete Technology https://nptel.ac.in (Special concretes, high-performance concrete, fiber reinforced concrete)
2.	NPTEL – Composite Materials and Structures https://nptel.ac.in (Composite materials, polymers, carbon fibers, reinforcement applications)
3.	American Concrete Institute (ACI) https://www.concrete.org (Concrete materials, standards, advanced concrete technologies)
4.	ScienceDirect – Construction and Building Materials Journal https://www.sciencedirect.com/journal/construction-and-building-materials (Research articles on metals, composites, smart and sustainable materials)
5.	MIT OpenCourseWare – Materials Science and Engineering https://ocw.mit.edu (Advanced engineering materials, smart materials, material properties and applications)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Analyze combustion thermodynamics, ignition phenomena, flame propagation, and heat release mechanisms in SI and CI engines for performance evaluation.	PO1, PO3	PSO1
CO2	Evaluate combustion chamber characteristics, fuel injection systems, abnormal combustion behavior, and emission formation under varying engine operating conditions.	PO1, PO3	PSO1
CO3	Analyze advanced combustion concepts, low-temperature combustion strategies, and alternative fuel combustion characteristics for efficient and sustainable engine operation.	PO1, PO3	PSO1
CO4	Design and develop combustion-related experimental setups, working models, or simulation-based combustion studies for IC engine applications considering engineering and environmental constraints through project/model-building activities.	PO1, PO2, PO3	PSO1, PSO2
CO5	Evaluate contemporary combustion technologies, emission reduction strategies, and sustainable IC engine systems through seminar, open-ended experimental investigations, or industry case studies considering societal and environmental impacts.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	–	—	—	—	—
CO2	2	—	3	3	1
CO3	3	—	3	3	2
CO4	3	3	2	2	3
CO5	3	3	3	2	3
Average	2.75	3.0	2.75	2.75	2.25

Activities:

1.	Technical Report Preparation (CO4)
2.	Patent Exploration Activity (CO5) Search and analyze patents related to construction materials, smart concrete, coatings, or composites

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Relevant Content	20	Good and clear	Average	Poor
2.	Methodology, Advantages and disadvantages	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Report and presentation	30	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Patent Innovation	30	Good and clear	Average	Poor
2.	Methodology and material used	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE09		STRUCTURAL HEALTH MONITORING		SEMESTER			
Prerequisites			Category	ES(PE)	Credits		3
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To Understand structural design philosophy for earthquake, cyclone, and flood-resistant construction with relevant codes and regulations.						
2.	To Familiarize with structural health monitoring concepts and safety assessment during alteration of existing structures.						
3.	To gain Knowledge in structural audit principles using pressure, flow, acoustic, wind measurement, and structural modeling techniques.						
4.	To Awareof static and dynamic field testing methods with sensor systems and structural response evaluation for certification.						
5.	Exposure to repair, rehabilitation techniques, and smart materials including piezoelectric and EMI-based structural assessment methods.						
UNIT - I		STRUCTURAL HEALTH					9
Philosophy for design to resist earthquake, cyclone and flood – National and international codes of practice – Bye law of urban and semi-urban area – Traditional and modern structures							
UNIT - II		STRUCTURAL HEALTH MONITORING					9
Concepts, Various Measures, Structural Safety in Alteration							
UNIT- III		STRUCTURAL AUDIT					9
Principles of pressure and flow measurements – Pressure transducer – Sound level meter – Venturi Meter and Flow meters – Wind tunnel and its use in structural analysis – structural modeling - Direct and indirect model analysis							
UNIT- IV		FIELD TESTING					9
Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement, Issue of stability certificate. Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.							
UNIT - V		INTRODUCTION TO REPAIRS AND REHABILITATIONS OF STRUCTURES					9
Case Studies (Site Visits), piezoelectric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2010.						
2.	Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007						

3.	Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan, Taylor and Francis Group, London, UK, 2006
4.	Structural Health Monitoring with Wafer Active Sensors, Victor Giurgutiu, Academic Press Inc, 2 nd Edition 2014
5.	Handbook on Repair and Rehabilitation of RCC Buildings, Central Public Works Department, Government of India.

E-RESOURCES:

1.	NPTEL – Structural Health Monitoring (IIT Courses) NPTEL SHM Course
2.	FHWA – Structural Health Monitoring of Bridges (PDF Guide) FHWA SHM Guide for Bridges
3.	Springer – Structural Health Monitoring Journal Springer Structural Health Monitoring Journal
4.	Isevier – Journal of Structural Health Monitoring Elsevier SHM Journal
5.	Encyclopedia of Structural Health Monitoring (Wiley) Wiley SHM Encyclopedia

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain structural design philosophy, codal provisions, and effects of natural hazards on structural safety and performance.	–	–
CO2	Interpret principles and techniques of structural health monitoring including sensors, instrumentation, and safety assessment during structural modifications.	PO1, PO2, PO3	PSO1, PSO2
CO3	Analyze structural behavior using pressure, flow, acoustic, wind, and vibration-based measurement techniques and structural modeling approaches.	PO1, PO2, PO3	PSO1, PSO2
CO4	Investigate and critically evaluate structural health monitoring (SHM) techniques, smart sensing technologies, and relevant national/international codes for assessing the safety, serviceability, and performance of civil engineering structures under various loading conditions.	PO1, PO2, PO3	PSO1, PSO2
CO5	assess advanced field testing methods, structural audit procedures, and repair and rehabilitation techniques for existing structures, and recommend appropriate strategies for enhancing structural safety and durability.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	--	--	--	--	--
CO2	3	2	1	2	1
CO3	3	3	2	3	1
CO4	2	3	2	3	2
CO5	3	3	2	3	2
Average	2.75	2.75	1.75	2.75	1.5

Activities:

- | | |
|----|---|
| 1. | Numerical Modeling and Health Assessment of a Multi-Storey Building under Dynamic Loading (CO4) |
| 2. | Numerical Simulation of Structural Damage and Health Monitoring (CO5) |

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Structural Modeling	30	Develops an accurate and complete 3D structural model with correct geometry, material properties, boundary conditions, and load assignments as per relevant IS codes.	Develops a correct structural model with only minor omissions in modeling or loading details.	Develops a basic model with several errors in geometry, material properties, or load application.
2.	Dynamic Analysis and Interpretation	20	Performs modal/response spectrum analysis correctly and accurately interprets natural frequencies, mode shapes, storey drift, displacement, and base shear.	Performs analysis correctly with minor errors in interpretation of results.	Performs analysis but interpretation is incomplete or partially incorrect.
3.	Health Assessment and Engineering Decisions	30	Correctly identifies vulnerable structural members, assesses structural performance, and provides well-justified recommendations for sensor placement and health monitoring.	Identifies most critical members and provides reasonable recommendations with minor omissions.	Identifies most critical members and provides reasonable recommendations with minor omissions.
4.	Technical Report and Presentation	20	Presents a well-organized report with clear methodology, software outputs, graphical results, engineering discussion, and professional presentation.	Report is organized with adequate analysis and presentation, containing minor deficiencies.	Report contains limited analysis, incomplete discussions, or unclear presentation.
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	System Design and Planning	30	Develops a comprehensive monitoring framework with appropriate selection of structure, sensors, data acquisition, communication, and monitoring strategy	Basic design addressing essential components	Incomplete or poorly planned monitoring system

2.	Technical Justification and Engineering Analysis	20	Provides clear technical reasoning for sensor placement, monitoring parameters, data collection, and expected structural response	Limited justification and analysis	Weak or unsupported technical decisions
3.	Innovation and Practical Feasibility	30	Incorporates innovative technologies (IoT, AI, wireless sensing, digital twins, smart materials, etc.) with strong consideration of practical implementation	Limited innovation or feasibility assessment	Minimal innovation and poor feasibility considerations
4.	Documentation and Presentation	20	Well-organized report/design proposal with clear schematics, figures, and professional presentation; responds effectively to queries	Adequate report and presentation	Poor documentation, unclear presentation, and inability to explain design choices
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE10		STRUCTURAL OPTIMIZATION		SEMESTER		
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the basic principles, classical optimization techniques, and formulations of structural optimization problems.					
2.	To learn linear programming methods and their application to optimize structural systems.					
3.	To explore non-linear programming methods including one-dimensional minimization and multivariable unconstrained optimization.					
4.	To study geometric and dynamic programming concepts for solving multi-stage decision problems.					
5.	To apply optimization theorems and techniques for the minimum weight design of structural elements and frames.					
UNIT - I	BASIC PRINCIPLES, CLASSICAL OPTIMIZATION TECHNIQUES					9
Definition Objective function, Constraints Equality and inequality Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space Feasible and infeasible Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - Lagrange Multiplier Method with equality constraints - Khun-Tucker Criteria with inequality constraints.						
UNIT - II	LINEAR PROGRAMMING					9
Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, Surplus and Artificial variables - Canonical form - Basic feasible solution - Simplex Method - Two phase method - Penalty method - Duality theory - Primal-Dual algorithm.						
UNIT- III	NON-LINEAR PROGRAMMING					9
One dimensional minimization methods: Unidimensional Unimodal function Exhaustive and Unrestricted search Dichotomous search Fibonacci Method Golden Section Method Interpolation methods. Unconstrained optimization techniques. Multivariables: Unconstrained multivariable functions - Univariate method - Cauchy's steepest descent method - Conjugate gradient method (Fletcher Reeves) - Variable metric method (Davidon Fletcher Powell).						
UNIT- IV	GEOMETRIC & DYNAMIC PROGRAMMING					9
Posynomial-degree of difficulty - reducing GPP to a set of simultaneous equations - Unconstrained and constrained problems with zero degree of difficulty - Concept of solving problems with one degree of difficulty. Bellman's principle of optimality - Representation of a multistage decision problem - Concept of sub-optimization problems using classical and tabular methods.						
UNIT - V	STRUCTURAL APPLICATIONS					9
Methods for optimal design of structural elements, continuous beams and single storeyed frames using plastic theory -Minimum weight design for truss members - Fully stressed design.						
Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:					
1.	Singiresu S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2020.				
2.	Uri Kirsch, "Optimum Structural Design: Concepts, Methods, and Applications", McGraw-Hill Book Co., 1981.				
3.	Gupta P.K. & Hira D.S., "Operations Research", 7th Edition, S. Chand & Company Ltd., New Delhi, 2018.				
4.	Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples", 2nd Edition, PHI Learning Pvt. Ltd., 2012.				
E-RESOURCES:					
1.	NPTEL – Optimization Methods in Engineering Design https://nptel.ac.in (Classical optimization, linear and non-linear programming)				
2.	NPTEL – Structural Optimization https://nptel.ac.in (Minimum weight design, structural applications)				
3.	ASCE Library / Journal of Structural Engineering https://ascelibrary.org/journal/jsendh (Structural optimization research, dynamic programming applications)				
4.	ScienceDirect / Advances in Engineering Software https://www.sciencedirect.com/journal/advances-in-engineering-software (Computer search methods, structural optimization techniques)				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Explain the fundamental principles of structural optimization, objective functions, constraints, and classical optimization techniques.	–	–		
CO2	Apply linear programming algorithms such as the Simplex method and Primal-Dual algorithm to structural problems.	PO1, PO3	PO1, PO3		
CO3	Analyze non-linear programming problems using one-dimensional minimization and multivariable unconstrained optimization methods.	PSO1	PSO1		
CO4	Formulate and solve engineering problems using geometric and dynamic programming principles.	PO1, PO2,	PSO1, PSO2		
CO5	Design optimized structural elements, continuous beams, and single-storeyed frames using plastic theory and fully stressed design principles.	PO3	PSO3		
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	1	–	3	2	–
CO3	3	1	3	3	–
CO4	3	3	3	3	–
CO5	3	3	3	3	3
Average	2.5	2.33	3	2.75	3
Activities:					
1.	Algorithm Implementation (CO4) Develop a computational code (using MATLAB/Python) to solve an unconstrained multivariable optimization problem.				
2.	Structural Optimization Project (CO5) Apply structural optimization techniques to design a minimum-weight steel truss or frame under specific load constraints.				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Model Development & Software Usage	30	Accurate geometry, boundary conditions, meshing, and effective use of simulation software	Minor errors in modeling or software application	incorrect model setup and poor software usage
2.	Technical Analysis & Interpretation	20	Comprehensive analysis of wind flow patterns, pressure distribution, drag effects, and aerodynamic behavior	Good analysis with reasonable interpretation	Weak or incorrect analysis and interpretation
3.	Validation & Engineering Relevance	30	Results are logically validated with theory/literature/code s and linked to structural behavior	Adequate validation and engineering correlation	No validation or weak correlation with engineering concepts
4.	Presentation & Documentation	20	Clear visualization, organized report/presentation, and effective communication of findings	Good presentation with minor issues in clarity/documentation	Poor presentation, visualization, or documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Structural Modeling & Parameters	30	Appropriate real case selected; clear understanding of cyclone damage, structural system, and failure context	Relevant case selected with good understanding	Poor case selection or unclear understanding
2.	Optimization Technique Application	20	Comprehensive analysis of failure causes using wind engineering concepts, codes, and structural behavior	Good technical analysis with minor gaps	Inadequate or inaccurate analysis
3.	Weight Minimization Check	30	Innovative, feasible, and technically justified wind-resistant design recommendations proposed	Suitable solutions with reasonable justification	Weak or impractical recommendations

4.	Drafting / Result Presentation	20	Well-organized report/presentation with strong evidence, visuals, references, and clear communication	Good organization and communication	Poor organization, insufficient evidence, or unclear communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE11	ADVANCED CONCRETE TECHNOLOGY (IS 456:2000, IS 10262-2019, ACI 211.1-22) may be permitted	SEMESTER			III
Prerequisites		Category	ES(PE)	Credits	3
		Hours/ Semester	L	T	P
		45	0	0	45
COURSE OBJECTIVES					
1.	To understand the properties and behavior of fresh and hardened concrete.				
2.	To learn concrete mix design principles and standard design methods.				
3.	To study concrete strength characteristics and the role of chemical and mineral admixtures				
4.	To explore special concretes, their properties, applications, and rehabilitation materials.				
5.	To understand concrete manufacturing, concreting methods, curing, and special construction techniques.				
UNIT - I	CONCRETE PROPERTIES				9
Properties of fresh concrete- Hardened concrete- Thermal expansion- Permeability-Water tightness and crack control-Elastic properties - Creep and shrinkage-Variability of Concrete strength.					
UNIT - II	CONCRETE MIX DESIGN				9
Principles of Concrete mix design- Methods of Concrete mix design – I.S. Method, ACI Method and DOE Method Testing of Concrete.					
UNIT- III	STRENGTH OF CONCRETE AND ADMIXTURES				9
Strength Under Uniaxial and Multiaxial Stresses – Failure Modes – Strength –Density Relationship- Parameters affecting strength – Accelerating and Retarding admixtures-Super plasticizers -Water proofing agents - Chemical admixtures, Mineral admixtures					
UNIT- IV	SPECIAL CONCRETES				9
Light Weight Concrete-Fly Ash Concrete- Fiber Reinforced Concrete- Polymer Concrete, Super Plasticized Concrete- Epoxy Resins and Screeds for Rehabilitation – Properties and applications – High Performance Concrete- Ready mixed concrete					
UNIT - V	CONCRETING METHODS				9
Process of Manufacturing of Concrete - Methods of Transportation, Placing and Curing – Extreme Weather concreting - Special Concreting methods - Vacuum concrete – Shotcrete - Under water concrete, Special formwork.					
Total:45 Hours					
Weightage: Continuous Assessment 40% End Semester Examinations 60%					
REFERENCE BOOKS:					
1.	Santhakumar A.R., <i>Concrete Technology</i> , Second Edition, Oxford University press, New Delhi. 2018				
2.	Shetty, M.S. <i>Concrete Technology: Theory and Practice</i> . New Delhi: S. Chand & Company Ltd., Revised Edition, 2022.				
3.	IS 456:2000 Indian standard plain and reinforced concrete-Code of practice				
4.	IS 10262-2019 Indian standard recommended guild lines for concrete mix design, Bureau of Indian standard, New Delhi				
5.	ACI 211.1- 22, Standard practice of selecting proportions for normal, heavy weight and mass concrete				

E-RESOURCES:					
1.	NPTEL – Advanced Concrete Technology https://nptel.ac.in (Concrete properties, mix design, strength, admixtures, special concretes, concreting methods)				
2.	American Concrete Institute (ACI) https://www.concrete.org (Concrete technology, ACI mix design, admixtures, special concretes, technical standards)				
3.	IS Codes / Bureau of Indian Standards (BIS) https://www.services.bis.gov.in (IS Mix Design methods, testing procedures, concrete materials and construction practices)				
4.	ScienceDirect – Construction and Building Materials Journal https://www.sciencedirect.com/journal/construction-and-building-materials (Research papers on concrete properties, admixtures, high-performance concrete, and advanced concreting methods)				
5.	Portland Cement Association (PCA) – Concrete Technology Resources https://www.cement.org (Concrete manufacturing, curing, durability, special concretes, and field concreting practices)				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs		
CO1	Describe the properties, behavior, mix design principles, strength characteristics, special concretes, and concreting methods.	–	–		
CO2	Apply concrete mix design methods, testing procedures, and the use of admixtures to analyze the strength, durability, and performance of conventional and special concretes under varying conditions.	PO1,PO3	PSO1, PSO2		
CO3	Assess and select appropriate concreting methods, materials, and special concrete applications to satisfy construction, strength, and durability requirements	PO1, PO2, PO3	PSO1, PSO2		
CO4	Develop a self-learning study on concrete properties, mix design methods, strength behavior, and admixtures.	PO1, PO2, PO3,	PSO1, PSO2		
CO5	Develop a self-learning study on special concretes and concreting methods by investigating their properties, applications, manufacturing processes, and field practices.	PO1, PO2, PO3,	PSO1, PSO2		
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	2	–	3	3	2
CO3	2	1	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Average	2.5	2.33	3	3	2
Activities:					
1.	Industry Case Study Analysis (CO4) Analyze a real construction project employing high-performance concrete, ready-mixed concrete, shotcrete, or underwater concreting and evaluate its performance and challenges.				
2.	Special Concrete Demonstration Activity (CO5) Develop and demonstrate special concrete mixes such as fiber reinforced concrete, lightweight concrete, self-compacting concrete, or fly ash concrete and compare their behavior with conventional concrete.				

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Case Understanding	20	Demonstrates thorough understanding of the industry case, materials, methods, and project context	Shows good understanding with minor gaps	Limited understanding
2.	Technical Analysis	30	provides detailed analysis of concrete materials, methods, performance, and challenges	Good technical analysis with adequate justification	Inaccurate technical analysis
3.	Application & Problem Solving	30	Effectively relates theory to industry practice and proposes suitable solutions/recommendations	Good application of concepts with relevant suggestions	Minimal application
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Mix Preparation & Casting	30	Accurate mix proportioning, proper material handling, and quality casting procedure	Minor errors in preparation or casting	Improper mix preparation and casting procedure
2.	Technical Understanding	20	Demonstrates strong understanding of special concrete type, properties, and applications	Good understanding with minor gaps	Limited understanding of concepts
3.	Performance Evaluation & Analysis	30	Clearly evaluates workability/strength/properties and provides technical interpretation	Good evaluation with reasonable analysis	Inadequate Analysis
4.	Demonstration & Documentation	20	Clear demonstration, effective communication, and well-organized report	Good demonstration and documentation	Poor demonstration and inadequate documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE12	DISASTER RESISTANT STRUCTURES		SEMESTER			
Prerequisites		Category	ES(PE)	Credits		3
Strength of Materials, Structural Analysis Reinforced Cement Concrete, Design Geotechnical, Engineering Geology, Design of Steel Structures		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand the basic philosophy of design of disaster resistant structures and gain knowledge about repair and rehabilitation of disturbed structures, design structures with modern materials and advanced techniques and understand the provision of relevant standard specification, requirements and usage. Also gain knowledge about the ability to conduct damage assessments and write reports.					
2.	Understand the behavior of life-line structures subjected to natural disasters such as earthquakes, cyclones, and floods.					
3.	Acquire knowledge of national and international codes, byelaws, and disaster-resistant design philosophies.					
4.	Analyze the response, safety, reliability, and performance of community structures such as dams, bridges, and buildings.					
5.	Understand the techniques of testing, evaluation, rehabilitation, and retrofitting of structures affected by disasters.					
UNIT - I	BEHAVIOR OF LIFE-LINE STRUCTURES					9
Philosophy for design to resist earthquake, cyclone and flood – National and international codes of practice – Bye law of urban and semi-urban area – Traditional and modern structures						
UNIT - II	COMMUNITY STRUCTURE					9
Response of dams, bridges, buildings – Strengthening measures – Safety analysis and rating – Reliability assessment						
UNIT - III	REHABILITATION AND RETROFITTING					9
Testing and evaluation – Classification of structures for safety point of view – Methods of strengthening for different disasters – Qualification test						
UNIT - IV	DETAILING OF STRUCTURES AND COMPOSITES					9
Use of modern materials and their impact on disaster reduction – Use of modern analysis, Design and construction techniques - Optimization for performance						
UNIT - V	DAMAGE ASSESSMENT OF STRUCTURES					9
Damage surveys – Maintenance and modifications to improve hazard resistance- Different types of foundation and its impact on safety – Ground improvement techniques.						
Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:

1.	Murty, C.V.R., Earthquake Tips: Learning Earthquake Design and Construction, NICEE, IIT Kanpur, Updated Edition, 2021
2.	Agarwal, P. and Shrikhande, M., Earthquake Resistant Design of Structures, 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2020
3.	Murty, C.V.R., Earthquake Tips: Learning Earthquake Design and Construction, NICEE, IIT Kanpur, Updated Edition, 2021
4.	Arya, A.S., Boen, T. and Ishiyama, Y., Guidelines for Earthquake Resistant Non-Engineered Construction, UNESCO Publication, Reprint 2018
5.	Varghese, P.C., Maintenance, Repair and Rehabilitation of Structures, PHI Learning Pvt. Ltd., New Delhi, Reprint 2018.

E-RESOURCES:

1.	https://nptel.ac.in/courses/ -- Video lectures and course materials on earthquake engineering, structural dynamics, and disaster-resistant structures.
2.	https://www.nicee.org - Technical resources, earthquake tips, design manuals, and case studies.
3.	https://ndma.gov.in - Guidelines, policies, and best practices for disaster risk reduction and resilient infrastructure.
4.	https://www.inflibnet.ac.in - Access to e-books, journals, theses, and scholarly resources for civil engineering.
5.	https://shodhganga.inflibnet.ac.in - Research theses and dissertations related to disaster-resistant structures, retrofitting, and structural safety.

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the behavior of life-line structures and the principles of designing structures to resist earthquakes, cyclones, floods, and other natural hazards.	PO1, PO2	PSO1
CO2	Analyze the response of community structures such as dams, bridges, and buildings under disaster loads and assess their safety and reliability	PO1, PO2, PO3	PSO1
CO3	Evaluate existing structures and recommend suitable rehabilitation and retrofitting techniques for disaster mitigation.	PO2, PO3,	PSO1, PSO2
CO4	Apply modern materials, composites, and advanced analysis and design Techniques for enhancing structural performance and disaster resistance.	PO3	PSO1, PSO2
CO5	Assess Structural damage, identify, causes of failure and recommend appropriate maintenance, foundation and ground improvement measures.	PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	—	3	2
CO2	3	3	—	3	3
CO3	2	3	3	3	3
CO4	2	2	3	2	3
CO5	2	3	2	3	2
Average	2.4	3.25	2.0	2.4	2.0

Activities:

1.	Simulation-Solution to application-oriented problems using software (C02) Seismic analysis of a multi-storey building using ETABS/STAAD.Pro and evaluation of structural response. Simulation of bridge response under earthquake loading and assessment of damage-prone components.
2.	Case Study (C03)/ Technical Seminar Presentation (C03) (Independent study) Case Study on the structural performance and lessons learned from the 2001 Gujarat (Bhuj) Earthquake. Case Study on disaster-resistant design features adopted in critical lifeline structures such as hospitals, bridges, and emergency response buildings.

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Problem formulation & boundary conditions	20	Problem and boundary conditions are clearly defined and justified for disaster-resistant structural analysis.	Problem is defined, but some boundary conditions are unclear.	Problem statement is defined, but boundary conditions are unclear.
2.	Simulation & plots	30	Simulation is accurately performed and plots/results are well presented.	Simulation is performed with minor errors in plots or results.	Simulation and plots are incomplete or contain significant errors.
3.	Interpretation of results	20	Results are clearly interpreted, analyzed, and justified with respect to structural safety and performance	Results are interpreted with limited analysis or justification.	Interpretation of results is unclear or inadequate.
4.	Report presentation	10	Report is clear, well-structured, and professionally presented.	Report is structured but requires improvement in presentation.	Report is poorly structured and lacks clarity.
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Understanding of Disaster Resistant Structures	20	Clearly explains disaster-resistant design concepts, structural behavior, and mitigation measures.	Explanation is adequate but needs improvement in technical depth.	Limited understanding of the selected topic
2.	Safety & Economic considerations	30	Clearly discusses safety aspects, disaster mitigation measures, sustainability, and economic considerations.	Safety aspects are discussed, but economic considerations require improvement.	Safety and economic aspects are poorly explained.

3.	Evidence of self-learning	30	Extensive use of relevant journals, codes, technical reports, and credible sources.	Limited use of relevant technical sources.	Very limited evidence of self-learning and source utilization.
4.	Presentation & Communication	20	Presentation is clear, well-structured, and effectively communicates technical content.	Presentation is organized but requires improvement in clarity and delivery.	Poorly structured presentation with inadequate communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE13	WIND AND CYCLONE EFFECTS ON STRUCTURES			SEMESTER			
Prerequisites			Category	ES(PE)	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To Understand the fundamentals of wind engineering and wind characteristics affecting structures.						
2.	To Learn wind tunnel studies, modeling techniques, and interpretation of experimental results.						
3.	To Study the effects of wind on rigid and flexible structures, including tall buildings and chimneys.						
4.	To Explore wind load design principles and codal provisions for buildings, chimneys, and roof structures						
5.	To Understand cyclone effects and design considerations for cladding and window glass systems.						
UNIT - I		INTRODUCTION					9
Introduction, Spectral studies, Gust factor, Wind velocity, Methods of measurements, variation of speed with height, shape factor, aspect ratio and drag effects.							
UNIT - II		WIND TUNNEL STUDIES					9
Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.							
UNIT- III		WIND EFFECT					9
Wind on structures, Rigid structures, Flexible structures, Static and Dynamic effects, Tall buildings, chimneys.							
UNIT- IV		DESIGN PRINCIPLES					9
Application to design, IS 875 code method, Buildings, Chimneys, Roof Shelters							
UNIT - V		CYCLONE EFFECT AND DESIGN OF CLADDING					9
Cyclone effect on structures, cladding design, window glass design							
Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Cook.N.J., The Designer's Guide to Wind Loading of Building Structures, Butterworth’s, 1990						
2.	Kolousek., et.al., Wind Effects on Civil Engineering Structures, Elsevier Publications, 1984.						
3.	Peter Sachs, Wind Forces in Engineering, Pergamon Press, New York, 1978						
4.	Lawson T.V., Wind Effects on Building Vol. I and II, Applied Science Publishers, London, 1980						

E-RESOURCES:

1.	NPTEL – Wind Engineering https://nptel.ac.in (Wind characteristics, wind effects, wind tunnel studies, design concepts)
2.	IS 875 (Part 3): Wind Loads on Buildings and Structures – BIS https://www.services.bis.gov.in (Wind load calculations, design principles, buildings, chimneys, roof shelters)
3.	National Institute of Wind Energy (NIWE), India https://niwe.res.in (Wind measurement, wind studies, wind engineering applications and resources)
4.	ASCE Library / Journal of Wind Engineering & Industrial Aerodynamics https://www.sciencedirect.com/journal/journal-of-wind-engineering-and-industrial-aerodynamics (Wind tunnel studies, cyclone effects, aeroelastic models, cladding research)
5.	FEMA / National Hurricane Center Resources https://www.fema.gov https://www.nhc.noaa.gov (Cyclone/hurricane effects, damage investigations, wind-resistant design, cladding and glazing performance)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamentals of wind engineering, wind characteristics, wind effects, wind tunnel studies, and design principles for structures.	–	–
CO2	Apply wind load assessment methods, wind tunnel concepts, and codal provisions for the design of buildings, chimneys, and roof structures.	PO1, PO3	PSO1, PSO2
CO3	Analyze the static and dynamic effects of wind and cyclone actions on rigid and flexible structures, including tall buildings and chimneys, to assess structural safety and performance.	PO1, PO2, PO3	PSO1, PSO2
CO4	Design a self-learning study/model to investigate wind characteristics, wind tunnel studies, and wind effects on rigid and flexible structures using literature review, simulations, or case analyses.	PO1, PO2, PO3	PSO1, PSO2
CO5	Design a self-learning study on wind load design, cyclone effects, and cladding systems by examining codal provisions, design procedures, and real-time structural applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	2	-	3	3	1
CO3	2	1	3	3	2
CO4	3	3	3	2	3
CO5	3	3	3	3	3
Average	2.5	2..33	3	2.75	2.25

Activities:

1.	Digital Wind Simulation Study (CO4) Perform a computational simulation (ANSYS/STAAD/OpenFOAM/other software) to analyze wind flow around tall buildings, chimneys, or bluff bodies and interpret aerodynamic behavior.
2.	Investigation of Cyclone-Damaged Structures (CO5) Conduct a forensic case study of real cyclone-affected buildings/chimneys/cladding failures, identify causes, and propose improved wind-resistant design solutions.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Model Development & Software Usage	30	Accurate geometry, boundary conditions, meshing, and effective use of simulation software	Minor errors in modeling or software application	incorrect model setup and poor software usage
2.	Technical Analysis & Interpretation	20	Comprehensive analysis of wind flow patterns, pressure distribution, drag effects, and aerodynamic behavior	Good analysis with reasonable interpretation	Weak or incorrect analysis and interpretation
3.	Validation & Engineering Relevance	30	Results are logically validated with theory/literature/code s and linked to structural behavior	Adequate validation and engineering correlation	No validation or weak correlation with engineering concepts
4.	Presentation & Documentation	20	Clear visualization, organized report/presentation, and effective communication of findings	Good presentation with minor issues in clarity/documentation	Poor presentation, visualization, or documentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Case Selection & Problem Understanding	30	Appropriate real case selected; clear understanding of cyclone damage, structural system, and failure context	Relevant case selected with good understanding	Poor case selection or unclear understanding
2.	Technical Failure Analysis	20	Comprehensive analysis of failure causes using wind engineering concepts, codes, and structural behavior	Good technical analysis with minor gaps	Inadequate or inaccurate analysis
3.	Design Improvement & Solution Development	30	Innovative, feasible, and technically justified wind-resistant design recommendations proposed	Suitable solutions with reasonable justification	Weak or impractical recommendations

4.	Presentation / Documentation Quality	20	Well-organized report/presentation with strong evidence, visuals, references, and clear communication	Good organization and communication	Poor organization, insufficient evidence, or unclear communication
	Total	100			

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The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
C01	12	12			12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

26STE14		EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION		SEMESTER			
Prerequisites			Category	ES(PE)	Credits		3
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To Understand the principles, calibration, and applications of force and strain measurement instruments used in structural testing.						
2.	To Study vibration measurement techniques and instrumentation for analyzing structural displacement, velocity, and acceleration.						
3.	To Learn the fundamentals of acoustics, pressure, and wind flow measurements and their applications in structural analysis.						
4.	To Identify, assess, and monitor structural distress through crack measurement, corrosion evaluation, and damage assessment techniques.						
5.	To Acquire knowledge of non-destructive testing methods for evaluating the integrity and performance of engineering structures.						
UNIT - I		FORCE AND STRAIN MEASUREMENTS					9
Strain gauges, Principle, Types, Performance and Uses-Photo elasticity, Principle and applications – Hydraulic jack and pressure gauges – Electronic load cell – Proving rings – Calibration of testing machines							
UNIT - II		VIBRATION MEASUREMENTS					9
Characteristics of structural vibrations – Linear Variable Differential Transducer (LVDT) – Transducers for velocity and acceleration measurements – Vibration meter – Seismographs – Vibration analyzer – Electro dynamicexciters – Display and recording of signals – Cathode Ray Oscilloscope – XY plotters – Chart plotters – Digital and Acquisition systems - Principles and Applications.							
UNIT- III		ACOUSTICS AND WIND FLOW MEASUREMENTS					9
Principles of pressure and flow measurements – Pressure transducer – Sound level meter – Venturi Meter and Flow meters – Wind tunnel and its use in structural analysis – structural modeling - Direct and indirect model analysis							
UNIT- IV		DISTRESS MEASUREMENTS					9
Diagnosis of distress in structures- Crack observation and measurement – Corrosion of reinforcement in concrete– Half cell, construction and use – damage assessment – Controlled blasting for demolition							
UNIT - V		NON DESTRUCTIVE TESTING METHODS					9
Load testing of structures, buildings, bridges and towers – Rebound hammer – Ultrasonic testing, principle and applications – Moiré fringes – brittle coatings – Holography – Use of lasers for structural testing							
Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2009.						
2.	Karthick and Balaji S, "Applications and Techniques for Experimental Stress Analysis", 2019.						
3.	Dalley.J.W.andRiley.W.F., "Experimental Stress Analysis", Tata McGraw Hill Book Co.						
4.	Srinath L.S., et al, Experimental Stress Analysis, Tata McGraw Hill Co., New Delhi, 1984.						
5.	Sironi R.S and Radha Krishna H.C., Mechanical Measurements, New Age International (P) Ltd.						

E-RESOURCES:

1. NPTEL (National Programme on Technology Enhanced Learning) – <https://nptel.ac.in>
2. MIT OpenCourseWare (MIT OCW) – <https://ocw.mit.edu>
3. American Concrete Institute (ACI) – <https://www.concrete.org>
4. American Society for Nondestructive Testing (ASNT) – <https://www.asnt.org>

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the principles, operation, calibration, and applications of force, strain, and pressure measurement instruments used in structural testing.	–	–
CO2	Apply vibration measurement techniques and instrumentation to determine displacement, velocity, and acceleration characteristics of structures.	PO1, PO2, PO3	PSO1, PSO2
CO3	Analyze acoustics, pressure, and wind flow measurements and utilize wind tunnel testing and structural modeling techniques for engineering applications.	PO1, PO2, PO3	PSO1, PSO2
CO4	Demonstrate independent learning by reviewing and presenting recent advancements in structural measurement and instrumentation techniques for force, strain, vibration, and flow measurements.	PO1, PO2, PO3	PSO1, PSO2
CO5	Analyze real-world case studies involving structural distress assessment and non-destructive testing methods, and recommend appropriate evaluation techniques for structural safety.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	—	—	3	—
CO2	3	2	—	3	—
CO3	2	3	—	2	3
CO4	2	2	3	2	3
CO5	1	3	2	-	3
Average	2.2	2.5	2.5	2.5	3.0

Activities:

1. Comparative Study of Structural Measurement Techniques (CO4)
2. Case Study on Structural Health Monitoring and NDT(CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Literature Survey & Information Collection	8	Comprehensive review using recent journals, standards, and technical sources	Limited references and coverage	Minimal information collected
2.	Technical Understanding	8	Demonstrates in-depth understanding of working principles, calibration, and instrumentation	Basic understanding of concepts	Significant conceptual deficiencies

3.	Comparative Analysis	8	Thorough comparison based on accuracy, sensitivity, range, applications, advantages, and limitations	Partial comparison with limited criteria	Poor or superficial comparison
4.	Critical Evaluation & Recommendations	8	Insightful evaluation with well-justified recommendations for structural applications	Limited analysis and justification	Recommendations unsupported or absent
5	Report Quality & Presentation	8	Well-organized report, excellent technical writing, figures/tables, and professional presentation	Acceptable report with minor issues	Poorly organized and difficult to follow
	Total	40			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Case Study Selection and Literature Review	10	Relevant and recent case study selected; extensive review of technical literature and standards	Adequate case study with limited references	Poorly chosen case study with insufficient literature review
2.	Analysis of SHM/NDT Techniques	10	Comprehensive analysis of testing methods, procedures, results, and interpretation	Basic analysis with limited interpretation	Inadequate understanding and analysis of techniques
3.	Critical Evaluation and Recommendations	10	Excellent assessment of effectiveness, limitations, and practical implications; innovative recommendations provided	Limited evaluation and generic recommendations	Minimal evaluation; recommendations absent or poorly justified
4.	Technical Report and Presentation	10	Well-structured report, clear figures/tables, professional presentation, and effective response to questions	Acceptable documentation and presentation	Poor organization, unclear presentation, and weak communication
	Total	40			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the requirements, selection criteria, materials, accessories, and support systems used in formwork construction for concrete structures.	--	--
CO2	Apply the principles of formwork design for foundations, walls, columns, slabs, and beams considering structural safety and construction requirements.	PO1, PO2, PO3	PSO1, PSO2
CO3	Analyse and design formwork systems for special structures such as shells, domes, folded plates, overhead water tanks, cooling towers, bridges, and tunnels.	PO1, PO2, PO3	PSO1, PSO2
CO4	Evaluate modern flying formwork systems including table forms, tunnel forms, slip forms, and precast concrete formwork through self-learning activities and technical assignments	PO1, PO2, PO3	PSO1, PSO2
CO5	Analyse causes of formwork failures and issues in multi-storey building construction through case studies, self-learning activities, and technical report preparation.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	2	3	3	2	3
CO5	3	3	3	2	3
Average	2.7	2.5	3	2.5	2.5

Activities:

1.	<i>Modern Flying Formwork Systems Study (CO4)</i> Students shall study different flying formwork systems such as table forms, tunnel forms, slip forms, and precast concrete formwork through self-learning resources, technical videos, journals, and site observations.
2.	<i>Case Study Analysis on Formwork Failures (CO5)</i> Students shall collect and analyse real-world case studies related to formwork failures in multi-storey building construction through self-learning activities.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Understanding of Flying Formwork Concepts	20	Clearly explains table form, tunnel form, slip form and precast formwork systems with strong conceptual understanding	Explains concepts with minor errors	Basic understanding with incomplete explanation

2.	Technical Analysis and Application	30	Accurately analyses the suitability, advantages and applications of different flying formwork systems	Good analysis with minor gaps	Limited technical analysis and application
3.	Self-Learning and Information Collection	20	Collects relevant technical information from multiple learning resources and industry examples	Uses adequate learning resources	Limited self-learning effort shown
4.	Presentation and Organization	20	Well-organized, neat and technically structured presentation/report	Organized work with minor presentation issues	Poor organization and unclear presentation
5	Innovation and Practical Understanding	10	Includes practical insights, recent technologies or innovative construction practices	Includes some practical understanding	Minimal practical understanding shown
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Identification of Formwork Failure Causes	20	Clearly identifies structural, material and safety-related causes of failures	Identifies most causes with minor omissions	Limited understanding of failure causes
2.	Case Study Analysis	30	Performs detailed analysis of real case studies with proper engineering interpretation	Adequate analysis with minor gaps	Basic analysis with limited understanding
3.	Preventive Measures and Safety Practices	30	Suggests effective preventive measures and safety recommendations with technical clarity	Provides suitable measures with limited detail	General suggestions with weak technical basis
4.	Self-Learning and Technical Understanding	20	Demonstrates strong independent learning through technical references and practical observations	Adequate self-learning effort	Minimal self-learning effort shown
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE16	DESIGN OF HIGH RISE STRUCTURES (IS 4998: 2015, SP7-2016 IS SP 7-NBC may be permitted)			SEMESTER			
Prerequisites				Category	ES(PE)	Credits	3
				Hours/ Semester	L	T	P
					45	0	0
COURSE OBJECTIVES							
1.	To understand the design philosophy, essential amenities, and service systems of high rise structures to achieve both safety and economy.						
2.	To analyze and design transmission and TV towers under various vertical, transverse, and longitudinal loads.						
3.	To evaluate and design RC chimneys and their foundations for varied soil strata.						
4.	To comprehend the behavior of various structural systems including shear walls, braced frames, and tubular systems.						
5.	To perform accurate 3D analysis, design, and stability checks of tall structures including firefighting provisions.						
UNIT – I		INTRODUCTION					9
Design Philosophy History advantages and disadvantages Vertical city concepts essential amenities fire safety - water supply - drainage and garbage disposal - service systems - structural and foundation systems. Factors affecting height, growth and form - Human comfort criteria.							
UNIT - II		DESIGN OF TRANSMISSION/TV TOWER					9
Mast and trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads.							
UNIT- III		ANALYSIS AND DESIGN OF RC CHIMNEY					9
RC Chimney-analysis and design, Foundation design for varied soil strata.							
UNIT- IV		BEHAVIOR OF STRUCTURAL SYSTEMS					9
Factors affecting the height and structural form, Behavior of Braced frames, Rigid frames, In filled frames, Shear walls, Coupled shear walls, Wall-Frames, Tubular. Outrigger braced, Hybrid systems.							
UNIT – V		ANALYSIS AND DESIGN OF TALL STRUCTURES					9
Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of structures as an integral unit, Analysis for member forces, drift and twist, Computerized 3D analysis, Firefighting design provisions.							
L:45, Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Taranath B. S., "Structural Analysis and Design of Tall Buildings: Steel and Composite Construction", CRC Press, 2011.						
2.	Smith Byran S. and Coull Alex, "Tall Building Structures: Analysis and Design", Wiley India, 2011.						
3.	Varyani U. H., "Structural Design of Multi-storeyed Buildings", 2nd Ed., South Asian Publishers, New Delhi, 2002 (Reprint 2014).						
4.	Shah V. L. & Karve S. R., "Illustrated Design of Reinforced Concrete Buildings", Structures Publications, Pune, 2015.						
5.	CPWD Publications, "Design of Multi Storeyed Buildings", Vol. 1 & 2.						

E-RESOURCES:

1.	NPTEL – Structural Systems in Tall Buildings https://nptel.ac.in (Design philosophy, structural forms, behavior of tall structures)
2.	Bureau of Indian Standards (BIS) https://www.services.bis.gov.in (IS 4998: 2015, SP 7-2016 NBC guidelines)
3.	ASCE Library / Journal of Structural Engineering https://ascelibrary.org/journal/jsendh (Tall building stability, 3D analysis, hybrid systems)
4.	Council on Tall Buildings and Urban Habitat (CTBUH) https://www.ctbuh.org (Vertical city concepts, human comfort criteria, tall structure case studies)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the design philosophy, essential amenities, and behavior of tall structures.	–	–
CO2	Analyze, design, and detail transmission and TV towers.	PO1	PSO1
CO3	Analyze, design, and detail RC chimneys and their foundations.	PO1, PO2	PSO1
CO4	Evaluate the structural behavior and performance of various tall building forms such as shear walls and tubular systems.	PO1, PO2, PO3	PSO1, PSO2,
CO5	Carry out stability analysis and computerized 3D modeling of tall structures as an integral unit.	PO1, PO2, PO3	PSO1, PSO2,

The Course Articulation Matrix (CAM) for defined COs

COs / Pos	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	2	-	-	3	-
CO3	2	1	-	3	-
CO4	3	3	3	2	2
CO5	3	3	3	3	3
Average	2.5	2.33	3	2.75	2.5

Activities:

	Structural Form Comparative Study (CO4)
1.	Use structural analysis software (STAAD.Pro or ETABS) to model a high-rise building using two different systems (e.g., rigid frame vs. shear wall) and compare their drift and twist behaviors under lateral loads.
	3D Stability Analysis (CO5)
2.	Perform a computerized 3D analysis on a multi-storey structure to evaluate wind and seismic responses, ensuring compliance with stability and firefighting design provisions as per NBC 2016.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	System Selection & Modeling	30	Accurate geometry, boundary conditions, meshing, and effective use of simulation software	Minor errors in modeling or software application	incorrect model setup and poor software usage

2.	Technical Analysis & Interpretation	20	Comprehensive analysis of wind flow patterns, pressure distribution, drag effects, and aerodynamic behavior	Good analysis with reasonable interpretation	Weak or incorrect analysis and interpretation
3.	Validation & Engineering Relevance	30	Results are logically validated with theory/literature/code s and linked to structural behavior	Adequate validation and engineering correlation	No validation or weak correlation with engineering concepts
4.	Presentation & Documentation	20	Clear visualization, organized report/presentation, and effective communication of findings	Good presentation with minor issues in clarity/documentation	Poor presentation, visualization, or documentation
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Codal Compliance & Fire Safety	30	Appropriate real case selected; clear understanding of cyclone damage, structural system, and failure context	Relevant case selected with good understanding	Poor case selection or unclear understanding
2.	Computerized 3D Analysis	20	Comprehensive analysis of failure causes using wind engineering concepts, codes, and structural behavior	Good technical analysis with minor gaps	Inadequate or inaccurate analysis
3.	Stability & Force Evaluation	30	Innovative, feasible, and technically justified wind-resistant design recommendations proposed	Suitable solutions with reasonable justification	Weak or impractical recommendations
4.	Drafting / Result Presentation	20	Well-organized report/presentation with strong evidence, visuals, references, and clear communication	Good organization and communication	Poor organization, insufficient evidence, or unclear communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE17		DESIGN OF MASONRY STRUCTURES			SEMESTER		
Prerequisites				Category	ES(PE)	Credits	3
				Hours/ Semester	L	T	P
					45	0	0
COURSE OBJECTIVES							
1.	To impart knowledge to the students about masonry materials and to gain knowledge in determining the flexural and shear strength of the structure. This also guides to know its behaviour and to study its modeling techniques						
UNIT - I INTRODUCTION							
Introduction Historical Perspective, Masonry Materials, Masonry Design Approaches, Overview of Load Conditions, Compression Behavior of Masonry, Masonry Wall Configurations, Distribution of Lateral Forces.							
UNIT - II FLEXURAL STRENGTH							
Flexural strength of Reinforced Masonry Members: In plane and Out-of-plane Loading.							
UNIT - III INTERACTIONS							
Structural Wall, Columns and Pilasters, Retaining Wall, Pier and Foundation.							
UNIT - IV SHEAR STRENGTH							
Shear Strength and Ductility of Reinforced Masonry Members, Prestressed Masonry - Stability of Walls, Coupling of Masonry Walls, Openings, Columns, Beams							
UNIT - V ELASTIC AND INELASTIC ANALYSIS							
Modelling Techniques, Static Push Over Analysis and use of Capacity Design Spectra.							
Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	<i>Design of Reinforced Masonry Structures, NarendraTaly, ICC, 2nd Edn,</i>						
2.	<i>Masonry Structures: Behavior and Design, Hamid Ahmad A. and Drysdale Robert G., Pearson College Div; 2nd edition (May 1, 1993).</i>						
3.	<i>Mechanics of Masonry Structures, Editor: Maurizio Angelillo, Springer; 2014 edition (March 21, 2014) India, 1986.</i>						
4.	<i>Earthquake-resistant Design of Masonry Buildings, TomaeviMiha, Imperial College Press, 1999.</i>						
E-RESOURCES:							
1.	NPTEL – Energy Management and Audit						
2.	Bureau of Energy Efficiency (BEE) Learning Resources						
3.	International Energy Agency (IEA) Publications						
4.	Ministry of Power Energy Conservation Resources						

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the behavior of masonry materials, masonry wall systems, load transfer mechanisms, and design approaches used in masonry structures.	--	--
CO2	Analyze the flexural performance of reinforced masonry members subjected to in-plane and out-of-plane loading conditions.	PO1, PO2, PO3	PSO1, PSO2
CO3	Evaluate the structural behavior and design requirements of masonry walls, columns, pilasters, retaining walls, piers, and foundations.	PO1, PO2, PO3	PSO1, PSO2
CO4	Investigate recent advancements, innovative materials, and contemporary applications in reinforced and prestressed masonry through literature review and technical assignments.	PO1, PO2, PO3	PSO1, PSO2
CO5	Develop and present a case study or analytical project using modeling and performance assessment techniques for masonry structures subjected to gravity and lateral loads.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / Pos	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	3	3	3	2	3
CO5	3	3	3	3	3
Average	3	2.5	3	2.75	2.5

Activities:

1.	Study on Recent Advances in Reinforced and Prestressed Masonry (CO4) Students shall investigate recent advancements, innovative materials, and modern construction techniques in reinforced and prestressed masonry through self-learning resources, technical journals, research articles, conference papers, and industry case studies
2.	Case Study and Performance Assessment of Masonry Structures (CO5) Students shall select a masonry structure and perform a case study involving structural modeling, performance evaluation under gravity and lateral loads, and assessment of failure mechanisms.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Understanding of Advanced Masonry Concepts	20	Clearly explains recent advancements, innovative materials, and modern masonry techniques with strong conceptual understanding	Explains concepts with minor errors	Basic understanding with incomplete explanation
2.	Technical Analysis and Application	30	Accurately analyzes advantages, limitations, and practical applications of advanced masonry systems	Good analysis with minor gaps	Limited technical analysis and application

3.	Self-Learning and Information Collection	20	Collects relevant information from multiple technical journals, codes, and industry resources	Uses adequate learning resources	Limited self-learning effort shown
4.	Presentation and Organization	20	Well-organized, neat and technically structured presentation/report	Organized work with minor presentation issues	Poor organization and unclear presentation
Total		100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Case Study Selection and Problem Identification	20	Clearly identifies structural issues, loading conditions, and objectives of the selected masonry structure	Identifies most aspects with minor omissions	Limited understanding of the selected case
2.	Structural Analysis and Performance Evaluation	30	Performs detailed analysis and assessment with proper engineering interpretation	Adequate analysis with minor gaps	Basic analysis with limited understanding
3.	Application of Modeling and Assessment Techniques	30	Effectively applies modeling, performance evaluation, and interpretation techniques	Applies techniques with limited detail	Limited application of analytical methods
4.	Self-Learning and Technical Understanding	20	Demonstrates strong independent learning through technical references, codes, software tools, and case studies	Adequate self-learning effort	Minimal self-learning effort shown
Total		100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);

Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE18	THEORY AND APPLICATIONS OF CEMENT COMPOSITES			SEMESTER		
Prerequisites		Category	ES(PE)	Credits		3
- Renewable Energy Systems - Heat Transfer - Basic Electrical Engineering		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	To understand composites, multi-phase materials, classifications, structure, models and theories of cement composites.					
2.	To study the mechanical behaviour of concrete-like composites, interfaces, ferrocement and textile reinforced cement matrices.					
3.	To learn the types, terminology, constituent materials, reinforcement systems and construction techniques of cement composites.					
4.	To examine the mechanical properties, durability, corrosion behaviour and applications of FRC and ferrocement in civil engineering structures.					
5.	To introduce the analysis and design concepts of ferrocement, SIFCON and fibre reinforced concrete structural elements.					
UNIT - I	INTRODUCTION					9
Composites and Multi-phase materials - Components of Composite materials - Classifications - Structure of Composite materials - Models and Theories.						
UNIT - II	MECHANICAL BEHAVIOUR					9
Concrete like Composites - Kinds - Ordinary Concrete - Fiber Reinforced Cement Matrices - Ferrocement and Textile Reinforcement - Components and Applications - Interfaces in Cement Composites - Kinds of Interfaces - Aggregate Cement paste interface - Fiber Cement paste interface - Interface between old and new composites.						
UNIT - III	CEMENT COMPOSITES					9
Types of Cement Composites, Terminology, Constituent Materials and their Properties, Reinforcement of Cement based Composites - Glass fiber - Steel fiber - Synthetic Polymeric fiber - Carbon fiber - Vegetable fiber - Textile fiber, Construction Techniques for Fibre Reinforced Concrete - Ferrocement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.						
UNIT - IV	MECHANICAL PROPERTIES OF CEMENT COMPOSITES					9
Behavior of Ferrocement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion. Application of Cement Composites: FRC and Ferrocement - Housing, Water Storage, Boats and Miscellaneous Structures. Composite Materials - Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants.						
UNIT - V	ANALYSIS AND DESIGN OF CEMENT COMPOSITE STRUCTURAL ELEMENTS					9
Ferrocement, SIFCON and Fibre Reinforced Concrete.						
Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						

REFERENCE BOOKS:			
1.	Brandt, Andrzej M., Cement-Based Composites: Materials, Mechanical Properties and Performance, 2nd Edition, Taylor and Francis, CRC Press, 2017.		
2.	Jones, R. M., Mechanics of Composite Materials, 2nd Edition, Taylor and Francis, BSP Books, 2015.		
3.	Pama, R. P., Ferrocement - Theory and Applications, International Ferrocement Information Centre, 1987.		
4.	Swamy, R. N., New Concrete Materials, 1st Edition, Blackie Academic and Professional, Chapman & Hall, 1983.		
5.	Naaman, A. E., Ferrocement and Laminated Cementitious Composites, Techno Press, Ann Arbor, Michigan, USA.		
E-RESOURCES:			
1.	NPTEL - Concrete Technology https://nptel.ac.in (Concrete materials, cement composites, durability and performance characteristics)		
2.	NPTEL - Composite Materials and Structures https://nptel.ac.in (Composite materials, orthotropic and anisotropic behaviour, elastic constants and structural applications)		
3.	American Concrete Institute (ACI) https://www.concrete.org (Fibre reinforced concrete, ferrocement, durability and cement composite guidelines)		
4.	ScienceDirect - Cement and Concrete Composites Journal https://www.sciencedirect.com/journal/cement-and-concrete-composites (Research articles on FRC, SIFCON, textile reinforced concrete and cement-based composites)		
5.	International Ferrocement Information Centre / Ferrocement resources https://www.ait.ac.th (Ferrocement materials, construction techniques and applications)		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			
CO1	Explain the fundamentals, classification, structure, models and theories of composite and multi-phase cement-based materials.	–	–
CO2	Apply the concepts of mechanical behaviour to analyze concrete-like composites, ferrocement, textile reinforcement and interface behaviour in cement composites.	PO1, PO3	PSO1, PSO2
CO3	Evaluate the constituent materials, reinforcement systems, construction techniques, mechanical properties and durability performance of cement composites.	PO1, PO2, PO3	PSO1, PSO2
CO4	Develop and present a technical study on the properties, behaviour and applications of FRC, ferrocement, SIFCON and polymer concretes through self-learning activities.	PO1, PO2, PO3	PSO1, PSO2
CO5	Develop and present a design-based activity on cement composite structural elements using ferrocement, SIFCON and fibre reinforced concrete.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	2	-	3	3	2
CO3	2	1	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Average	2.5	2.33	3	3	2

Activities:

1.	Technical Report Preparation (CO4)
2.	Design-Based Self-Learning Activity (CO5) Analyze and prepare a conceptual design/model study related to ferrocement, SIFCON or fibre reinforced concrete structural elements.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Relevant Content	20	Good and clear	Average	Poor
2.	Methodology, Advantages and disadvantages	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Report and presentation	30	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Design Concept / Model Study	30	Good and clear	Average	Poor
2.	Methodology and material used	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

E-RESOURCES:

1.	NPTEL - Design of Steel Structures https://nptel.ac.in (Structural steel design, composite construction concepts and design provisions)
2.	NPTEL - Advanced Structural Analysis https://nptel.ac.in (Behaviour and analysis of composite members and structural systems)
3.	INS DAG Teaching Resources for Structural Steel Design https://www.steel-insdag.org (Teaching resources, steel tables and structural steel design guidance)
4.	Bureau of Indian Standards - IS 11384 and IS 800 https://www.services.bis.gov.in (Code provisions for composite construction and general construction in steel)
5.	Eurocode 4 - EN 1994-1-1 https://eurocodes.jrc.ec.europa.eu (Design of composite steel and concrete structures: general rules and rules for buildings)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the fundamentals of steel-concrete composite construction, theory of composite structures, steel-concrete-steel sandwich construction, composite members, bridges and seismic behaviour of composite structures.	–	–
CO2	Apply design principles and relevant code provisions to design composite beams, composite columns, composite trusses and connections in steel-concrete composite structures.	PO1, PO3	PSO1, PSO2
CO3	Analyze and evaluate the behaviour and performance of composite members, shear connections and composite box girder bridge systems under different loading conditions.	PO1, PO2, PO3	PSO1, PSO2
CO4	Develop and present a technical study on composite members, connections and bridge systems through self-learning and case-based investigation activities.	PO1, PO2, PO3	PSO1, PSO2
CO5	Develop and present a case-study based activity on seismic behaviour and modern applications of steel-concrete composite structures using literature review and self-learning activities.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	2	-	3	3	2
CO3	2	1	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Average	2.5	2.33	3	3	2

Activities:

1.	Technical Report Preparation (CO4)
2.	Case Study and Literature Exploration Activity (CO5) Analyze seismic behaviour and real-world applications of steel-concrete composite structures through journal papers, technical reports and case studies.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Relevant Content	20	Good and clear	Average	Poor
2.	Methodology, Design Procedure and Discussion	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Report and presentation	30	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14-20)	Good (7-13)	Satisfactory (1-6)
1.	Case Study Analysis	30	Good and clear	Average	Poor
2.	Methodology and Structural Evaluation	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

REFERENCE BOOKS:

1.	Rajagopalan, N., Prestressed Concrete, Narosa Publishing House, New Delhi, 2nd Edition, Reprint 2017.
2.	Krishna Raju, N., Prestressed Concrete, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 6th Edition, 2018
3.	Pandit, G.S. and Gupta, S.P., Prestressed Concrete, CBS Publishers & Distributors Pvt. Ltd., New Delhi, Latest Reprint Edition, 2021
4.	IS :3370 (Part III)-1967- Indian standard code of practice for concrete structures for the storage of liquids part III prestressed concrete structures
5.	IS : 1343-2012- Indian standard prestressed concrete – code of practice

E-RESOURCES:

1.	NPTEL – Prestressed Concrete Structures https://nptel.ac.in <i>(Principles of prestressing, prestressing systems, losses of prestress.)</i>
2.	NPTEL – Advanced Prestressed Concrete Design https://nptel.ac.in <i>(Advanced PSC design, limit state concepts, flexural behavior, shear and torsion design)</i>
3.	Precast/Prestressed Concrete Institute (PCI) https://www.pci.org <i>(Prestressed concrete manuals, bridge design, precast systems, technical reports)</i>
4.	ScienceDirect – Engineering Structures Journal https://www.sciencedirect.com/journal/engineering-structures <i>(Research articles on prestressed concrete members, composite structures, partial prestressing)</i>
5.	MIT OpenCourseWare – Structural Engineering https://ocw.mit.edu <i>(Structural analysis and design concepts, prestressed concrete applications)</i>

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the principles of prestressing, prestressing systems, losses of prestress, and analyze the flexural behavior and deflection of prestressed concrete members.	–	–
CO2	Apply limit state and allowable stress design concepts to design prestressed concrete members for flexure under service and ultimate load conditions.	PO1, PO2, PO3	PSO1
CO3	Design prestressed concrete members for shear, torsion, bending, and anchorage zone requirements in accordance with relevant code provisions.	PO1, PO2, PO3	PSO1
CO4	Analyze statically indeterminate prestressed concrete structures including continuous beams and rigid frames using appropriate analytical methods.	PO1, PO2, PO3	PSO1, PSO2
CO5	Evaluate and design special prestressed concrete structures such as pipes, water tanks, poles, piles, composite members, and partially prestressed elements.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	–	–	–	–	–
CO2	2	2	3	3	–
CO3	3	2	3	3	–
CO4	3	2	3	3	2
CO5	3	2	3	3	2
Average	2.75	2	3	3	2

Activities:

1.	Computer-Aided Analysis of Prestressed Concrete Members (CO4)
2.	Case Study of Prestressed Concrete in Modern Infrastructure Projects. (CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Structural Modelling & Inputs	20	Complete Model	Minor Errors	Incomplete Model
2.	Prestress Analysis & Results	30	Accurate Analysis	Partial Analysis	Inadequate Analysis
3.	Engineering Interpretation	20	Critical Evaluation	Basic Evaluation	Limited Evaluation
4.	Presentation & Documentation	30	Well-Structured	Needs Improvement	Poor Documentation
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Project Investigation	30	Detailed Investigation	Adequate Investigation	Limited Investigation
2.	Understanding of Prestressing Concepts	30	Strong Correlation	Partial Correlation	Weak Correlation
3.	Technical Evaluation	20	Comprehensive Assessment	Basic Assessment	Limited Assessment
4.	Presentation & Report Quality	20	Professional Presentation	Acceptable Presentation	Poor Presentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE21		THEORY OF STRUCTURAL STABILITY			SEMESTER		
Prerequisites				Category	ES(PE)	Credits	3
				Hours/ Semester	L	T	P
					45	0	0
COURSE OBJECTIVES							
1.	To impart knowledge to the students on the behavior of structural elements under compression, the stability of columns and plates, lateral buckling of beam and column design formula.						
UNIT - I		STABILITY OF COLUMNS					9
Concepts of Elastic Structural stability- Analytical approaches to stability - characteristics of stability analysis- Elastic Buckling of columns- Equilibrium; Energy and Imperfection approaches – Non-prismatic columns- Built up columns- Buckling modes- Effect of shear on buckling load - Large deflection theory.							
UNIT - II		METHODS OF ANALYSIS AND IN ELASTIC BUCKLING					9
Approximate methods – Rayleigh and Galerkin methods – numerical methods – Finite difference and finite Element - analysis of columns – Experimental study of column behavior – South well plot - Column curves - Derivation of Column design formula - Effective length of Columns - Inelastic behavior- Tangent modulus and Double modulus theory.							
UNIT - III		BEAM COLUMNS AND FRAMES					9
Beam column behavior- standard cases- Continuous columns and beam columns – Columns on elastic foundation – Buckling of frames – Single storey portal frames with and without side sway – Classical and stiffness methods – Use of Wood’s charts.							
UNIT - IV		BUCKLING OF BEAMS					9
Lateral buckling of beams – Energy method- Application to Symmetric and single symmetric I beams – simply supported and Cantilever beams - Narrow rectangular cross sections- – Numerical solutions – Torsional buckling – Uniform and non-uniform Torsion on open cross section - Flexural torsional buckling – Equilibrium and energy approach.							
UNIT - V		BUCKLING OF THIN PLATES					9
Isotropic rectangular plates - Governing Differential equations - Simply Supported on all edges – Use of Energy methods –Numerical Techniques.							
Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Chajes A, <i>Principles of Structural Stability Theory</i> , Prentice Hall, Inc., New Jersey 1974						
2.	Ashwini kumar, <i>Stability of Structures</i> , Allied Publishers Ltd, 1998						
3.	Iyengar N.G.R, <i>Structural Stability of Columns and Plates</i> , Affiliated East- West Press Pvt. Ltd., 1988						
4.	Stephen P. Timoshenko and Gere, <i>Theory of Elastic Stability</i> , McGraw-Hill Company 2012						
5.	Allen H.G and Bulson P.S., <i>Background to Buckling</i> , McGraw-Hill Book Company, 1980						
6.	Smitzes, <i>Elastic Stability of Structures</i> , Prentice Hall, 1998						
7.	Brush and Almoth, <i>Buckling of Bars, Plates and Shells</i> , McGraw-Hill Book Company, 1975						

E-RESOURCES:

1.	https://nptel.ac.in/courses/105104693
2.	NPTEL : NOC:Stability of Structures (Civil Engineering)

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Understand the basic concepts of structural stability and analytical approaches	----	----
CO2	Apply the theory to investigate the inelastic behavior of columns, lateral and torsional buckling of beams and buckling of thin plates.	PO1	PSO1
CO3	Analyse the inelastic behavior of columns, lateral and torsional buckling of beams and buckling of thin plates.	PO1	PSO1
CO4	Analyse the basic frames and plate using numerical methods	PO2, PO3	PSO2
CO5	Case study on frame analysis, Plate theory	PO2	---

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	---	---	---	---	---
CO2	3	---		3	3
CO3	3	---		3	---
CO4	---	3	---	—	2
CO5	---	3	---	---	---
Average	3.0	3.0	---	3	2.5

Activities:

1.	Software Simulation (CO4) • Analyse the basic frames and plate using numerical methods
2.	Case Study (CO5) • Case study on frame analysis, Plate theory

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Mathematical modelling	25	Deriving complete Equation	Partially Complete	Incomplete
2.	Creating proper Boundary Conditions	25	Boundary Conditions are correct	Partial Complete	Boundary condition adopted but wrong
3.	Programming	25	Program completed with proper procedure	Program completed and procedure is partial	Incomplete program and the procedure is not correct.
4.	Presentation	25	Neat presentation and accurate results	Presentation is not proper but results are accurate	Presentation is completed and the results are wrong
	Total	100			

Rubrics for evaluation: CO5					
Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Mathematical modelling	25	Deriving complete Equation	Partially Complete	Incomplete
2.	Creating proper Boundary Conditions	25	Boundary Conditions are correct	Partial Complete	Boundary condition adopted but wrong
3.	Programming	25	Program completed with proper procedure	Program completed and procedure is partial	Incomplete program and the procedure is not correct.
4.	Presentation	25	Neat presentation and accurate results	Presentation is not proper but results are accurate	Presentation is completed and the results are wrong
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:						
	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	
Note: Purely as an Example: Strength = 3 (if percentage >20%); Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);						

26STE22	ADVANCED DESIGN OF FOUNDATIONS			SEMESTER			
Prerequisites			Category	ES(PE)	Credits	3	
			Hours/ Semester	L	T	P	TH
				45	0	0	45
COURSE OBJECTIVES							
1.	To design various types of foundations based on soil data and structural requirements.						
2.	To understand the basic philosophy of planning of Soil Exploration for Different Projects and gain knowledge about the Settlement of Footings and Rafts.						
3.	To estimate Load Transfer of Piles, Settlement of Pile Foundations and Pile Groups.						
4.	Examine and discuss various machine foundations.						
5.	To understand the provision of IS and IRC Design Code and gain knowledge of Sheet piling and Bracing Systems.						
UNIT - I		SOIL EXPLORATION					9
Scope-Objective –Methods of exploration-Penetration tests (SPT and SCPT) – Data interpretation- Evaluation of all geotechnical parameters- Evaluation of liquefaction potential – Selection of foundation based on soil conditions- Bore log report- Location and depth of foundation – Codal provisions.							
UNIT - II		SHALLOW FOUNDATIONS					9
Bearing capacity of shallow foundation on homogeneous and layered deposits- Terzaghi’s Analysis- Meyerhof’s formula- BIS formula- Bearing capacity from in-situ tests (SPT, SCPT)- Allowable bearing pressure- Determination of settlement of foundation in homogeneous and layered deposits –Codal provisions. Structural design and detailing of isolated footing, strip footing, Strap footing, rectangular and trapezoidal combined footings and raft foundation for concentric load, eccentric loads and Moments.							
UNIT- III		PILE FOUNDATIONS					9
Types of Piles- Pile axial capacity evaluation from insitu tests (SPT, SCPT) –Negative skin friction – Uplift capacity- Settlement of pile group- Interpretation of pile load test- Under reamed pile – Codal provision – Lateral load on pile- Bromhead method- Structural design of piles and pile caps- underreamed pile foundation- Pile cap Well foundation – Grip length – Construction of well- failure and remedial methods- Lateral stability-Structural design of well foundation.							
UNIT- IV		MACHINE FOUNDATIONS					9
Types- General requirements and design criteria- General analysis of machine foundation – soil system-Stiffness and damping parameters- Test for design parameters- design of foundation for reciprocating engines, impact type machines and rotary machines.							
UNIT - V		SPECIAL FOUNDATIONS					9
Foundation for towers, chimneys and silos- design of anchors- Reinforced earth retaining walls. Floating foundation. Shell foundation- Bucket foundation- Monopile foundation for offshore earthquake effects- Codal Provisions.							
Total:45 Hours							
Weightage: Continuous Assessment 40% End Semester Examinations 60%							

REFERENCE BOOKS:

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

E-RESOURCES:

1.	NPTEL – https://archive.nptel.ac.in/content/storage2/courses/105108069/mod09/lec09.pdf
2.	NPTEL – https://archive.nptel.ac.in/content/storage2/courses/105108069/mod02/lec02.pdf
3.	SWAYAM - https://onlinecourses.nptel.ac.in/noc25_ce01/preview
4.	https://www.youtube.com/watch?v=e6WSpYP7rAw

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the concepts of soil exploration, site investigation, penetration tests and selection of suitable foundations based on soil conditions.	---	---
CO2	Apply the principles of shallow foundation design to determine bearing capacity, settlement and structural detailing of footings and raft foundations.	PO1, PO2, PO3	PSO1, PSO2
CO3	Analyze pile foundations, pile groups and well foundations under axial and lateral loads using Codal provisions.	PO1, PO2, PO3	PSO1, PSO2
CO4	Study Design special foundations such as tower foundations, retaining structures, shell and bucket foundations considering Codal provisions and practical requirements.	PO1, PO2, PO3	PSO1, PSO2
CO5	Perform self-learning activities , case studies and design assignments related to advanced foundation systems and present technical findings effectively.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	---	---	---	---	---
CO2	3	1	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	3
CO5	2	3	2	2	3
Average	2.2	1.6	2.2	2.2	2.0

Activities:

1.	Design of special foundations considering codal provisions and practical requirements (CO4)
2.	Self-learning, case studies, design assignments, and effective presentation of technical findings (CO5)

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Foundation Selection & Design Approach	30	Appropriate selection of special foundation type with complete design methodology based on site conditions and codal provisions.	Suitable foundation selected with minor deficiencies in design approach.	Inappropriate foundation selection or incomplete design procedure.
2.	Technical Analysis & Codal Application	20	Accurate design calculations, proper application of IS/IRC codes, and sound engineering judgment.	Good analysis with minor errors in calculations or codal application.	Inadequate analysis and poor application of codal provisions.
3.	Engineering Evaluation & Practical Feasibility	30	Thorough evaluation of stability, settlement, constructability, and economic feasibility with justified recommendations.	Adequate evaluation with reasonable engineering interpretation.	Limited evaluation and weak engineering justification.
4.	Presentation & Documentation	20	Well-organized report with detailed calculations, drawings, references, and professional presentation.	Good documentation with minor issues in clarity or presentation.	Poor documentation, incomplete drawings, and ineffective presentation.
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Case Study / Self-Learning Understanding	30	Demonstrates comprehensive understanding of advanced foundation systems, design concepts, and practical applications.	Shows good understanding with minor conceptual gaps.	Limited understanding of advanced foundation systems.
2.	Technical Analysis & Interpretation	20	Provides detailed analysis of the selected case/design assignment with accurate interpretation of technical findings.	Good analysis with reasonable interpretation.	Inadequate or inaccurate technical analysis.

3.	Problem Solving & Recommendations	30	Develops innovative, feasible, and technically justified solutions or recommendations based on engineering principles and codal provisions.	Provides suitable recommendations with adequate justification.	Weak, impractical, or poorly justified recommendations.
4.	Report & Presentation Quality	20	Professional report and presentation with strong evidence, references, figures, and effective communication of findings.	Well-organized report and presentation with minor deficiencies.	Poor organization, inadequate documentation, and weak communication.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12			12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	3
CO5				40	20	3
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

[illegible]

REFERENCE BOOKS:

1.	Procs. of advanced course on Industrial Structures, Structural Engineering Research Center, 1982.
2.	Design of steel structures, Bunmia P.C., Jain Ashok Kr., Jain Arun Kr., 2nd edition, Lakshmi publishers, 2012.
3.	Shiyekar M R, "Limit State Design in Structural Steel", PHI Learning private limited, New Delhi, 2017.
4.	Subramanian N, "Design of Steel Structures", Oxford university press, New Delhi, 2016.
5.	Manohar S.N, Tall Chimneys – Design and Construction, Tata McGrawHill, 1985.

E-RESOURCES:

1.	NPTEL – Design of Steel Structures https://nptel.ac.in (Design of industrial steel buildings, structural members, connections and codal provisions)
2.	NPTEL – Advanced Structural Analysis https://nptel.ac.in (Analysis of industrial structural systems, frames, trusses and stability considerations)
3.	INSDAG – Institute for Steel Development & Growth https://www.steel-insdag.org (Teaching resources, steel design manuals, industrial building design guides and case studies)
4.	ScienceDirect – Engineering Structures Journal https://www.sciencedirect.com/journal/engineering-structures (Research articles on steel structures, industrial buildings, structural behaviour and design innovations)
5.	ASCE Library – Journal of Structural Engineering https://ascelibrary.org/journal/jsendh (Research papers on structural analysis, design and performance of industrial structures)

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs**

CO1	Explain the planning aspects, functional requirements, loading conditions, and structural systems adopted in industrial structures.	---	---
CO2	Apply relevant design principles, codal provisions, and engineering practices for the design of industrial structural components.	PO1, PO3	PSO1
CO3	Analyze industrial structures subjected to dead loads, live loads, wind loads, crane loads, seismic loads, and operational effects.	PO1, PO3	PSO1
CO4	Evaluate industrial structural systems, design methodologies, and published technical studies considering safety, economy, serviceability, and constructability requirements.	PO1, PO2	PSO1, PSO2
CO5	Develop and present a seminar on emerging technologies, innovative construction practices, advanced materials, or recent developments related to industrial structures.	PO2, PO3	PSO2

The Course Articulation Matrix (CAM) for defined Cos

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	-	2	3	-
CO3	3	-	3	3	-
CO4	3	3	3	2	2
CO5	-	3	2	-	3
Average	1.80	1.20	2.00	1.60	1.00

Activities:

1.	Activity I – Journal Article Review and Presentation on Industrial Structures (CO4) Students shall review a recent journal article related to industrial structures, critically evaluate the methodology, structural system, design approach, findings, and conclusions, and present the review through a seminar and technical report.
2.	Activity II – Emerging Technology Seminar on Industrial Structures (CO5) Students shall prepare and deliver a seminar on emerging technologies such as Pre-Engineered Buildings (PEB), BIM applications in industrial construction, modular industrial structures, smart monitoring systems, advanced steel construction techniques, or sustainable industrial infrastructure and submit a summary report.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Understanding of Industrial Structural System	25	Demonstrates comprehensive understanding of industrial building components, framing systems, and loading requirements discussed in the article	Demonstrates good understanding with minor gaps	Demonstrates Limited understanding
2.	Evaluation of Structural Design Concepts	30	Critically evaluates structural design methodologies, codal provisions, and engineering decisions adopted in the study	Provides reasonable evaluation with adequate justification	Limited evaluation of loading and design aspects
3.	Analysis of Structural Behaviour	25	Effectively analyzes behaviour under wind, crane, seismic, and operational loads and interprets findings accurately	Provides acceptable analysis with minor omissions	Limited analysis and interpretation
4.	Technical Report and Presentation	20	Presents findings professionally with strong technical documentation and supporting references	Presentation and documentation are satisfactory	Presentation lacks clarity and completeness
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Relevance of Emerging Technology	20	Selects a highly relevant topic such as PEB systems, BIM, modular construction, advanced steel systems, or smart industrial facilities	Topic is relevant with adequate justification	Topic relevance is limited

2.	Technical Knowledge and Application	35	Demonstrates strong understanding of the technology and industrial applicability of the selected technology	Demonstrates good technical understanding	Technical understanding is limited
3.	Evaluation of Engineering Benefits and Challenges	25	Clearly evaluates structural, operational, economic, environmental, and sustainability aspects	Provides reasonable Evaluation	Evaluation lacks depth
4.	Seminar Delivery and Documentation	20	Professional presentation with excellent communication and documentation	Good presentation with minor shortcomings	Poor presentation and documentation
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE24		SUBSTRUCTURE DESIGN		SEMESTER		
Prerequisites		Category	ES(PE)	Credits		3
		Hours/ Semester	L	T	P	TH
			45	0	0	45
COURSE OBJECTIVES						
1.	Understanding soil investigation reports and principles of selection, loading, and design of shallow and deep foundations.					
2.	Knowledge of design concepts and analysis of shallow foundations including footings, rafts, buoyancy, and elastic behavior of soil.					
3.	Familiarity with design and load carrying capacity of deep foundations including piles, pile caps, and lateral and uplift resistance.					
4.	Awareness of foundation systems for bridges, machines, towers, and special structures including caisson, pier, and anchor foundations.					
UNIT - I		INTRODUCTION				9
Design of soil investigation report for design of foundation structure-Types-Selection of foundation-Basic requirement of Foundation-Computation of loads-General principle of design of reinforced concrete shallow and deep foundation.						
UNIT - II		DESIGN OF SHALLOW FOUNDATION				9
Shallow foundation-bearing capacity of footings-floating raft-Capacity of footing-Beams on Elastic foundation-Design of raft and buoyancy-Rail and basement design.						
UNIT- III		DESIGN OF DEEP FOUNDATION				9
Deep foundation-Load carrying capacity of different types of piles and detailing of reinforcement according to IS 2911-Design of pile caps-Uplift capacity of piles-Lateral pile load test						
UNIT- IV		FOUNDATION FOR BRIDGES AND MACHINES				9
Foundation for bridges – Well and caisson foundation – Design of pier cap –Design of pier-General principles, planning and design of machine foundation.						
UNIT - V		TOWER FOUNDATIONS				9
Introduction- Design of foundation for towers – forces on tower foundation – General design criteria – Structural design of supports for foundation excavation – Design of ground anchors.						
Total:45 Hours						
Weightage:						
Continuous Assessment 40%						
End Semester Examinations 60%						
REFERENCE BOOKS:						
1.	Tomlinson M.J and Boorman R, Foundation design and construction, ELBS longman VI Edition, 1995.					
2.	Swami Saran, Analysis and design of substructures, Limit state design, Oxford and IBH Publishing Co. Pvt. Lt, NewDelhi, 1996.					
3.	Nayak N.V, Foundation design manual for practicing engineers, DhanpatRai& sons,1982.					

E-RESOURCES:					
1.	NPTEL – Civil Engineering Courses https://nptel.ac.in				
2.	American Society of Civil Engineers (ASCE) Library https://ascelibrary.org				
3.	ScienceDirect – Geotechnical Engineering Resources https://www.sciencedirect.com				
4.	Geo-Institute (ASCE) https://www.geoinstitute.org				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs	Mapping PSOs
CO1	Explain soil investigation methods, foundation types, load computation, and principles governing the selection and design of foundations.			–	–
CO2	Analyze the behavior and design of shallow foundations including isolated footings, raft foundations, buoyancy effects, and beams on elastic foundations.			PO1, PO2, PO3	PSO1, PSO2
CO3	Evaluate load carrying capacity and structural design of deep foundations including piles, pile caps, and uplift and lateral load resistance as per relevant codes.			PO1, PO2, PO3	PSO1, PSO2
CO4	Design and assess foundation systems for bridges and machines including caisson foundations, pier caps, and machine foundation principles.			PO1, PO2, PO3	PSO1, PSO2
CO5	Analyze and design tower foundations and anchorage systems considering structural forces, excavation supports, and ground anchor systems.			PO1, PO2, PO3	PSO1, PSO2
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	--	--	--	--	--
CO2	3	3	3	3	--
CO3	3	3	3	3	1
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Average	3	3	3	3	1.67
Activities:					
1.	Geotechnical Investigation and Foundation Selection				
2.	Foundation Design Using Structural Software/Spreadsheet				
Rubrics for evaluation: CO4					
Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Interpretation of Soil Investigation Data	30	Correctly interprets all soil investigation data and identifies key geotechnical parameters.	Interprets most data correctly with minor errors.	Interprets basic data but misses important parameters.
2.	Selection of Suitable Foundation	20	Selects the most appropriate foundation with clear technical justification based on soil and loading conditions.	Selects a suitable foundation with adequate justification.	Foundation selection is acceptable but justification is weak.

3.	Engineering Calculations & IS Code Application	30	Calculations are accurate and appropriate IS code provisions are correctly applied.	Minor calculation or code application errors.	Basic calculations performed with noticeable errors.
4.	Technical Report Presentation	20	Report is well-organized, neat, includes sketches / tables, and uses proper engineering terminology.	Report is organized with minor formatting issues.	Report is understandable but lacks clarity or completeness
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Problem Definition & Input Data	30	Correctly identifies loads, soil parameters, and design assumptions.	Minor omissions in input data or assumptions.	Basic inputs provided but lacks clarity.
2.	Modeling / Spreadsheet Setup	20	Correctly defines geometry, loads, soil parameters, and boundary conditions	Good technical analysis with minor gaps	Inadequate or inaccurate analysis
3.	Design Improvement & Solution Development	30	Innovative, feasible, and technically justified wind-resistant design recommendations proposed	Suitable solutions with reasonable justification	Weak or impractical recommendations
4.	Presentation / Documentation Quality	20	Well-organized report/presentation with strong evidence, visuals, references, and clear communication	Good organization and communication	Poor organization, insufficient evidence, or unclear communication
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

UNIT - V		FERROCEMENT CONSTRUCTIONS		9
Applications in building construction: Parabolic foundations, under-reamed piles, Panelled cavity walls and box-sectioned hollow floors, hollow beams. Stiffened plates as slabs. Design and construction of multi-storied buildings and mass scale housing using in-situ mortaring method and method of joining precast walling and floor panels. Water and soil retaining structures: Applications in water treatment and effluent treatment plants and in Irrigation, Highways and Bridges.				
				Total:45 Hours
Weightage: Continuous Assessment 40% End Semester Examinations 60%				
REFERENCE BOOKS:				
1.	Ferrocement, Authors: B R Paul and R P Pama, Published by International Ferrocement Information Centre, A.I.T. Bangkok, Thailand.			
2.	Ferrocement and Laminated Cementitious Composites, Author: A. E. Naaman, Publisher: Techno-press, Ann Arbor, Michigan, U.S.A.			
3.	State-of-the-Art Report and Guide for Design, Construction and Repairs of Ferrocement; ACI Committee Report No. ACI 549R-88 and ACI 549.1R-88, American Concrete Institute, Detroit, USA.			
4.	Chapter titled Ferrocement by S. P. Shah and P. N. Balaguru, in Concrete Technology and Design Vol. II, Editor: R. N. Swamy.			
5.	Divekar, B. N., Ferrocement Technology - A Construction Manual, Published by the Author.			
E-RESOURCES:				
1.	NPTEL - Concrete Technology https://nptel.ac.in (Ferrocement materials, cement composites, structural behaviour and construction applications)			
2.	NPTEL - Composite Materials and Structures https://nptel.ac.in (Composite action, structural forms, thin reinforced composites and design concepts)			
3.	American Concrete Institute (ACI) https://www.concrete.org (Ferrocement design, construction, repair guidelines and ACI 549 committee resources)			
4.	ScienceDirect - Cement and Concrete Composites Journal https://www.sciencedirect.com/journal/cement-and-concrete-composites (Research articles on ferrocement, thin reinforced composites, durability and structural applications)			
5.	International Ferrocement Information Centre / Ferrocement resources https://www.ait.ac.th (Ferrocement materials, construction techniques, applications and design information)			
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs
CO1	Explain the fundamentals, constituent materials, characteristics, mechanical properties, construction methods and design parameters of ferrocement as a structural material.		—	—
CO2	Apply analysis methods to determine reinforcement effectiveness, moment-curvature behaviour, bending resistance and deflection of ferrocement structural elements.		PO1, PO3	PSO1, PSO2
CO3	Evaluate crack width control, ductility, shaped ferrocement forms, composite construction systems and their performance under static and dynamic loading conditions.		PO1, PO2, PO3	PSO1, PSO2

CO4	Develop and present a technical study on analysis, design methods and structural behaviour of ferrocement components through self-learning activities.	PO1, PO2, PO3	PSO1, PSO2
CO5	Develop and present a design-based case study activity on ferrocement constructions, precast elements, water retaining systems, bridges and retrofitting applications.	PO1, PO2, PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	2	-	3	3	2
CO3	2	1	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Average	2.5	2.33	3	3	2

Activities:

1.	Technical Report Preparation (CO4)
2.	Design-Based Case Study Activity (CO5) Analyze and prepare a conceptual design/model study related to ferrocement buildings, water retaining structures, precast panels, bridges or retrofitting applications.

Rubrics for evaluation: CO4

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Relevant Content	20	Good and clear	Average	Poor
2.	Methodology, Advantages and disadvantages	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Report and presentation	30	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

Rubrics for evaluation: CO5

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Design Concept / Model Study	30	Good and clear	Average	Poor
2.	Methodology and material used	30	Clearly explained	Important aspects are missing	Poorly explained
3.	Evidence of Self learning	20	Use of relevant journals/sources	Limited sources	Very limited sources
4.	Presentation & Communication	20	Presentation is clear and well-structured	Presentation needs improvement	Poorly presented
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

E-RESOURCES:					
1.	NPTEL – Advanced Structural Analysis https://nptel.ac.in/courses				
2.	NPTEL – Finite Element Analysis https://nptel.ac.in/courses				
3.	International Association for Shell and Spatial Structures (IASS) https://iass-structures.org				
4.	Bureau of Indian Standards (BIS) https://www.bis.gov.in				
5.	Springer – Design of Plate and Shell Structures Resources https://link.springer.com				
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to			Mapping POs	Mapping PSOs	
CO1	Explain the fundamental concepts, structural behaviour, design philosophy, and applications of thin plates and shell structures.		-	–	
CO2	Apply analytical methods, design principles, and relevant codal provisions for the design of thin plates, folded plates, cylindrical shells, and doubly curved shell structures.		PO1, PO2, PO3	PSO1, PSO2	
CO3	Evaluate the structural performance of plate and shell systems using modern computational techniques, finite element methods, and engineering design standards.		PO1, PO2, PO3	PSO1, PSO2	
CO4	Develop a software-based design and analysis model of a selected plate or shell structure, evaluate its structural behaviour, and prepare a comprehensive technical report.		PO1, PO2, PO3	PSO1, PSO2	
CO5	Prepare and present a case study or technical seminar on advanced plate and shell structures, critically evaluating their design methodology, construction practices, applications, and recent technological developments.		PO1, PO2, PO3	PSO1, PSO2	
The Course Articulation Matrix (CAM) for defined COs					
COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	-	-	-
CO2	3	2	3	3	2
CO3	3	3	3	3	2
CO4	3	2	3	3	3
CO5	2	3	2	3	3
Average	2.75	2.50	2.75	3.0	2.50
Activities:					
1.	Technical Report Preparation (CO4)				
2.	Design-Based Case Study Activity (CO5) Analyze and prepare a conceptual design/model study related to ferrocement buildings, water retaining structures, precast panels, bridges or retrofitting applications.				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Understanding of Cylindrical Shell Behaviour	25	Demonstrates comprehensive understanding of shell action, membrane forces and design concepts	Demonstrates good understanding with minor omissions	Demonstrates basic understanding with limited explanations
2.	Technical Analysis	30	Detailed and accurate structural analysis with appropriate interpretations	Analysis is mostly accurate with adequate interpretations	Analysis is basic with limited technical depth
3.	Evaluation and Discussion	25	Critically evaluates behaviour and design aspects with clear conclusions	Provides reasonable evaluation and conclusions	Provides limited evaluation and conclusions
4.	Report and Presentation	20	Well-organized report and professional presentation	Adequately organized report and presentation	Basic report and presentation with deficiencies
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Selection of Topic and Relevance	20	Highly relevant topic with strong engineering significance	Relevant topic with adequate engineering significance	Moderately relevant topic
2.	Technical Knowledge	30	Demonstrates in-depth understanding of shell geometry, behaviour and design	Demonstrates good understanding with minor gaps	Demonstrates basic understanding of concepts
3.	Critical Evaluation of Applications	25	Comprehensive evaluation of applications, advantages and limitations	Adequate evaluation with reasonable discussion	Critical Evaluation of Applications
4.	Presentation Skills	15	Excellent communication, organization and visual aids	Good communication and organization	Presentation Skills
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
C01	12	12	-	-	12	2
C02	24	24			24	3
C03	24	24			24	3
C04			40		20	2
C05				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26STE27		DESIGN OF BRIDGES			SEMESTER		
Prerequisites				Category	ES(PE)	Credits	3
Engineering Mechanics, Strength of Materials, Structural Analysis, Reinforced Cement Concrete Design, Fluid Mechanics and Hydraulics.				Hours/ Semester	L	T	P
					45	0	0
COURSE OBJECTIVES							
1.	At the end of the course the students shall have knowledge about design of long and short span bridges, prestressed concrete bridges and also about bearing, substructures and footings for bridges.						
2.	Acquire knowledge of IRC bridge codes and evaluate the different loads and forces acting on bridges.						
3.	Apply design principles for slab bridges, skew slab culverts, box culverts, and T-beam bridges.						
4.	Gain knowledge of the design of bridge bearings, piers, abutments, trestles, and expansion joints.						
5.	Develop the ability to design safe, economical, and durable bridge structures considering practical engineering requirements.						
UNIT - I		INTRODUCTION					9
Components of bridge - Classification - Need for investigation Data collection - design discharge - linear waterway - economical span scour depth - traffic projection - choice of bridge type.							
UNIT - II		LOADS ON BRIDGES					9
Indian Road Congress (IRC) bridge codes - dimensions - dead and live loads - impact effect - wind and seismic forces - longitudinal and centrifugal forces - hydraulic forces - earth pressure - temperature effect and secondary stresses.							
UNIT - III		SLAB AND T-BEAM BRIDGES					9
Design of slab bridges - skew slab culverts - box culverts. T - Pigeaud's curves - Courbon's theory - Hendry Jaeger method design of T - beam bridges.							
UNIT - IV		LONG SPAN GIRDER BRIDGES					9
Design principles of continuous bridges, box girder bridges, and balanced cantilever bridges.							
UNIT - V		BEARINGS, SUBSTRUCTURES AND FOOTINGS FOR BRIDGES					9
Design of bearings for slab, girder, skew bridges - Design of piers abutments - trestles, Joints - expansion joints							
Total:45 Hours							
Weightage:							
Continuous Assessment 40%							
End Semester Examinations 60%							
REFERENCE BOOKS:							
1.	Tim Huff, LRFD Bridge Design: Fundamentals and Applications, CRC Press, Taylor & Francis Group, 2024.						
2.	Rangwala S. C., Bridge Engineering, 17th Revised and Enlarged Edition, Charotar Publishing House, 2023						
3.	Gerard Parke and Nigel Hewson, ICE Manual of Bridge Engineering, 3rd Edition, Thomas Telford Ltd., 2022.						
4.	M. A. Jayaram and T. R. Jagadeesh, Design of Bridge Structures, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2018						
5.	Weiwei Lin and Teruhiko Yoda, Bridge Engineering: Classifications, Design Loading and Analysis Methods, 1st Edition, Butterworth-Heinemann (Elsevier), 2017.						

E-RESOURCES:

1.	https://nptel.ac.in/courses/ - Video lectures and learning materials on structural and bridge engineering.
2.	https://www.irc.nic.in - IRC bridge codes, standards, specifications, and technical publications related to bridge engineering.
3.	https://link.springer.com
4.	https://www.inflibnet.ac.in
5.	https://www.sciencedirect.com

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the components, classification, planning, investigation procedures, and selection of suitable bridge types for different site conditions.	PO1, PO2	PSO1
CO2	Analyze various loads and forces acting on bridges and apply IRC provisions in bridge design.	PO1, PO2,	PSO1
CO3	Design slab bridges, skew slab culverts, box culverts, and T-beam bridges using standard design methods.	PO2, PO3,	PSO1, PSO2
CO4	Apply the design principles of continuous bridges, box bridges and balanced cantilever bridges.	PO2, PO3	PSO1, PSO2
CO5	Design bridge bearing, piers, abutment, trestles and expansion joints for safe and efficient bridge performance.	PO3	PSO1, PSO2

The Course Articulation Matrix (CAM) for defined COs

COs / POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	–	3	–
CO2	3	3	2	3	2
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	-	3
Average	3.0	2.6	2.2	3	2.2

Activities:

1.	Simulation-Solution to application-oriented problems using software (CO2)
	➤ Modeling and analysis of a simply supported RCC slab bridge using STAAD.Pro/MIDAS Civil. ➤ Design and load analysis of a T-beam bridge under IRC loading conditions using bridge design software. ➤ Finite Element Analysis (FEA) of a box culvert bridge to determine stress distribution and deflection. ➤ Simulation of bridge bearings and support reactions under dead load and live load combinations using structural analysis software. ➤ Analysis and design of bridge substructures (piers and abutments) subjected to earth pressure and hydraulic forces using STAAD.Pro.

2.	Case Study (C03)/ Technical Seminar Presentation (C03) (Independent study)				
	➤ Case Study on the design and construction features of the Pamban Bridge and its engineering challenges. ➤ Technical Seminar on modern long-span bridge systems such as cable-stayed and balanced cantilever bridges. ➤ Case Study on bridge failures due to hydraulic scour, overloading, or inadequate maintenance and the lessons learned. ➤ Technical Seminar on the application of advanced materials and technologies in bridge construction and rehabilitation. ➤ Case Study on sustainable bridge engineering practices, life-cycle assessment, and durability enhancement techniques.				

Rubrics for evaluation: C04

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Problem formulation & boundary conditions	20	Problem and boundary conditions are clearly defined and justified.	Problem is defined, but some boundary conditions are unclear.	Problem statement is defined, but boundary conditions are unclear.
2.	Simulation & plots	30	Simulation is accurately performed and plots/results are well presented.	Simulation is performed with minor errors in plots or results.	Simulation and plots are incomplete or contain significant errors.
3.	Interpretation of results	20	Results are clearly interpreted, analyzed, and justified.	Results are interpreted with limited analysis or justification	Interpretation of results is unclear or inadequate.
4.	Report presentation	10	Report is clear, well-structured, and professionally presented.	Report is structured but requires improvement in presentation.	Report is poorly structured and lacks clarity.
	Total	100			

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (14–20)	Good (7–13)	Satisfactory (1–6)
1.	Understanding of Bridge Engineering Concepts	20	Clearly explains the selected bridge engineering concept, design principles, and applications.	Explanation is adequate but lacks depth in some aspects.	Limited understanding of the selected topic.
2.	Safety & Economic considerations	30	Clearly discusses safety aspects, durability, sustainability, and economic considerations of the bridge system.	Safety and economic aspects are discussed but require further analysis	Safety and economic considerations are poorly explained.

3.	Evidence of self-learning	30	Extensive use of relevant journals, codes, technical reports, and other credible sources.	Limited use of relevant technical sources.	Very limited evidence of self-learning and source utilization.
4.	Presentation & Communication	20	Presentation is clear, well-structured, and effectively communicates technical content.	Presentation is organized but requires improvement in clarity and delivery.	Poorly structured presentation with inadequate communication.
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

	Test I	Test II	Activity I	Activity II	Percentage Allocation	Mapping Strength
CO1	12	12	-	-	12	2
CO2	24	24			24	3
CO3	24	24			24	3
CO4			40		20	2
CO5				40	20	2
Total	60	60	40	40	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26AC001	ENGLISH FOR RESEARCH PAPER WRITING M.E. (Common to all Branches)			SEMESTER		I/II
Prerequisites			Category	AC	Credits	0
Basic proficiency in English and familiarity with academic and technical writing.			Hours/ Semester	L	T	P
				30	0	0
COURSE OBJECTIVES						
1.	To develop awareness of the importance of English in academic and research communication.					
2.	To familiarize learners with the structure and organization of research papers.					
3.	To improve learners' ability to use appropriate academic language and expressions in research writing.					
4.	To help learners avoid common language errors and improve the quality of their research papers.					
5.	To enable learners to write and present research work using accepted academic conventions.					
UNIT - I						
FUNDAMENTALS OF RESEARCH AND ACADEMIC WRITING						6
Research and its significance. Purpose, characteristics, and structure of a research paper. Types of research publications. Identifying research problems and defining objectives. Features of academic English, including formal and objective style. Academic vocabulary, clear and concise sentence construction, and avoidance of redundancy and common grammatical errors. Selection of appropriate journals and conferences for publication.						
UNIT - II						
LANGUAGE PATTERNS IN RESEARCH WRITING						6
Common phrases for introducing research problems, stating objectives, describing methods, and presenting results. Use of active and passive voice. Appropriate tense forms in research writing. Cohesion and coherence through linking words and transitions.						
UNIT - III						
IMPROVING RESEARCH WRITING						6
Hedging in academic writing. Paraphrasing and summarizing techniques. Plagiarism and ethical writing practices. Identifying and correcting common language mistakes. Editing and proof reading strategies.						
UNIT - IV						
REVIEW WRITING AND REVIEW OF LITERATURE						6
Purpose and structure of review articles. Review of Literature (RoL): literature search, synthesis of findings, and identification of research gaps. Citation practices and avoidance of plagiarism. Practical exercises in organizing literature and drafting literature review sections.						
UNIT - V						
WRITING RESEARCH PAPER SECTIONS						6
Writing effective titles, abstracts, introductions and conclusions. Presenting findings and discussions clearly. Language for oral presentation of research. Useful phrase banks for different sections of a research paper and research presentations.						
L:30, Total:30 Hours						
Weightage: Continuous Assessment - 100%						

REFERENCE BOOKS:	
1.	Wallwork, Adrian. English for Writing Research Papers. 3 rd ed., Springer, 2023.
2.	Swales, John M., and Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills. 4 th ed., University of Michigan Press, 2020.
3.	Glasman-Deal, Hilary. Science Research Writing for Non-Native Speakers of English. 2 nd ed., Imperial College Press, 2020.
4.	Cargill, Margaret, and Patrick O'Connor. Writing Scientific Research Articles: Strategy and Steps. 3 rd ed., Wiley-Blackwell, 2021.
5.	Day, Robert A., Barbara Gastel, and Michelle Prince. How to Write and Publish a Scientific Paper. 9 th ed., Greenwood, 2022.

E-RESOURCES:

1.	Author Academy – https://authoracademy.springernature.com
2.	Researcher Academy – https://researcheracademy.elsevier.com
3.	Learn English (British Council) - https://learnenglish.britishcouncil.org/skills/writing
4.	Academic Phrase bank – https://www.phrasebank.manchester.ac.uk
5.	Committee on Publication Ethics (COPE) – https://publicationethics.org

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Explain the significance of research communication and describe the structure, purpose, and types of research publications.	PO1, PO2	
CO2	Apply appropriate academic vocabulary, sentence structures, and language conventions in research writing.	PO1, PO2	
CO3	Use academic language patterns, cohesive devices, and appropriate grammatical structures to communicate research ideas effectively.	PO1, PO2	
CO4	Analyze research papers to identify writing styles, language patterns, and common grammatical error	PO1, PO2	
CO5	Demonstrate ethical research writing practices through effective paraphrasing, citation, referencing, and avoidance of plagiarism.	PO1, PO2	

The Course Articulation Matrix (CAM) for defined COs

	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2			
CO2	3	3			
CO3	2	3			
CO4	2	3			
CO5	3	3			

Activities:

1.	(i) Assignment 1: Research Paper Analysis and Language Evaluation Select a published research paper from your discipline and analyze its structure, purpose, and major components. Evaluate the use of academic vocabulary, sentence structures, language patterns, cohesive devices, and grammatical conventions. Comment on the effectiveness of the writing and identify areas for improvement. (ii) Assignment 2: Academic Rewriting and Editing Choose a technical text or an excerpt from a research article and revise it using appropriate academic vocabulary, formal style, cohesive devices, and correct grammatical structures. Explain the revisions made and discuss how they improve the quality and clarity of research communication. (iii) Assignment 3: Review of Literature and Research Gap Identification Select a research topic related to your specialization and review at least five recent research articles. Summarize the major findings using appropriate academic language and transitions, compare the studies, identify research gaps, and present the review in a coherent academic format. (iv) Assignment 4: Analysis of Research Writing Conventions Analyze two published research papers from your discipline and compare their writing conventions, language patterns, organization, and presentation of research findings. Examine the use of academic expressions, cohesion, citation practices, and ethical writing principles. Suggest improvements where necessary.
2.	PRESENTATION: (i) Presentation 1: Ethical Issues in Research Writing Discuss plagiarism, self-plagiarism, authorship issues, citation ethics, and the responsibilities of researchers in academic publishing. Illustrate the discussion with examples from published research articles and explain strategies for maintaining academic integrity. (ii) Presentation 2: Paraphrasing, Citation, and Referencing in Research Writing Present effective techniques for paraphrasing and summarizing research literature. Demonstrate the use of citation and referencing styles commonly adopted in academic publications and discuss methods for avoiding plagiarism. (iii) Presentation 3: Review of Literature and Research Gap Identification Select a research topic from your area of specialization and present a brief review of relevant literature. Summarize key findings from published studies, compare their contributions, identify research gaps, and explain how ethical citation practices are followed in the review process. (iv) Presentation 4: Presenting Research Paper Sections Prepare and present the title, abstract, introduction, methodology, findings, and conclusion of a selected research paper. Highlight the language conventions, organization, and presentation strategies used for effective research communication. (v) Presentation 5: Research Conference and Poster Presentation Design and deliver a short conference-style or poster presentation based on a research article or review paper. Demonstrate effective presentation techniques, audience engagement, response to questions, and adherence to ethical practices in reporting and acknowledging sources.

Rubrics for evaluation: C05

Sl. No.	Criterion	Marks	Excellent (3)	Good (2)	Satisfactory (1)
1.	Understanding and Application of Concepts	25	Shows excellent understanding of the topic	Shows good understanding with minor gaps	Shows basic understanding with several gaps

2.	Analysis and Critical Observation	25	Presents clear and relevant analysis	Adequate analysis with minor omissions	Limited analysis and observations
3.	Organization, Clarity and Coherence	25	Well-organized and easy to follow	Generally organized with minor issues	Organization is weak or inconsistent
4.	Academic Language and Accuracy	25	Accurate academic language with minimal errors	Few language errors that do not affect clarity	Frequent language errors but meaning is understandable
	Total	100			

The Internal Assessment Matrix (IAM) for the defined COs:

CO	Assignment	Presentation	Percentage allocation	Mapping Strength
CO1	25		12.5	2
CO2	25		12.5	2
CO3	25		12.5	2
CO4	25		12.5	2
CO5		50	50	3
Total	100	100	100	

Note: Purely as an Example: Strength = 3 (if percentage >20%);
Strength = 2 (if percentage 10% to 20%); Strength = 1 (if percentage <10%);

26AC002		DISASTER MANAGEMENT			SEMESTER		I/II
Prerequisites				Category	AC	Credits	
				Hours/ Semester	L	T	P
					30	0	0
0							
TH							
30							
COURSE OBJECTIVES							
1.	To have a critical understanding of key concepts in disaster risk reduction and humanitarian response and critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations and evaluate the strengths and weaknesses of disaster management approaches. Planning and programming in different countries, particularly their home country or the countries they work in.						
UNIT - I		INTRODUCTION					6
Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Disaster Prone Areas in India: Study of Seismic Zones; Area Prone to floods and droughts, Landslides and avalanches; Areas prone to cyclonic and coastal hazards with special reference to Tsunami; Post- Disaster diseases and epidemics.							
UNIT - II		REPERCUSSIONS OF DISASTERS AND HAZARDS					6
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.							
UNIT - III		DISASTER PREPAREDNESS AND MANAGEMENT					6
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.							
UNIT - IV		RISK ASSESSMENT					6
Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.							
UNIT - V		DISASTER MITIGATION					6
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.							
L:30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							

REFERENCE BOOKS:

- | | |
|----|---|
| 1. | R. Nishith, Singh AK 2012 Disaster Management in India: Perspectives, issues and strategies New Royal Book Company, Lucknow |
| 2. | Sahni, PardeepEt.Al. (Eds.) 2002 Disaster Mitigation Experiences and Reflections. Prentice Hall Of India, New Delhi |

COURSE OUTCOMES (COs) /**At the end of the course, the students will have the ability to****Mapping
POs****Mapping
PSOs****CO1**

Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2

Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3

develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

CO4

Critically understand the strengths and weaknesses of disaster management approaches

26AC003	SANSKRIT FOR TECHNICAL KNOWLEDGE			SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning Sanskrit to improve brain functioning. Learning Sanskrit to develop logic in mathematics, science & other subjects enhances the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.						
UNIT - I		ALPHABETS					10
Alphabets in Sanskrit –Past/Present/Future Tense –Simple Sentences							
UNIT - II		LITERATURE					10
Order –Introduction of roots –Technical information about Sanskrit Literature							
UNIT - III		CONCEPTS					10
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics							
L:30, Total: 30 Hours							
Weightage:							
Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	"AbhyasaPustakam"- Dr.Vishwas, Samskrita- Bharati Publication,New Delhi						
2.	"Tech Yourself Sanskrit" PrathamaDeeksha-Vempatikutumbshastri,Rashtriya Sanskrit Sansthan,New Delhi Publication						
3.	India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Understanding basic Sanskrit language.						
CO2	Ancient Sanskrit literature about science & technology can be understood.						
CO3	Being a logical language will help to develop logic in students						

26AC004		VALUE EDUCATION		SEMESTER		I/II	
Prerequisites			Category	AC	Credits		0
			Hours/ Semester	L	T	P	TH
				30	0	0	30
COURSE OBJECTIVES							
1.	To understand the Importance of value education and self-development. To imbibe good values in students and also know about the importance of character.						
UNIT - I		BASIC VALUES					7
Values and self-development- Social values and individual attitudes-Work ethics, Indian vision of Humanism Moral and Non Moral valuation-Standards and principles-Value judgments.							
UNIT - II		CONFIDENCE					7
Importance of cultivation of values- Sense of Duty-Devotion-Self-reliance-Confidence-Concentration-Truthfulness-CleanlinesHonesty-Humanity-Power of faith-National Unity-Patriotism-Love for nature-Discipline.							
UNIT - III		PERSONALITY DEVELOPMENT					8
Personality and Behavior Development-Soul and Scientific attitude - Positive – Thinking - Integrity and discipline -Punctuality – Love and Kindness - Avoid fault Thinking - Free from anger - Dignity of labor - Universal brotherhood and religious tolerance – True friendship – Happiness Vs. suffering – love for truth – Aware of self-destructive habits- Association and Cooperation – Doing best for saving nature.							
UNIT - IV		LOVE AND COMPASSION					8
Character and Competence –Holy books Vs. Blind faith –Self –management and Good health – Science of reincarnation –Equality – NonViolence –Humility -Role of Women –All religions and same message –Mind your Mind –Self -control –Honesty –Studying effectively.							
L:30, Total: 30 Hours							
Weightage: Continuous Assessment - 100%							
REFERENCE BOOKS:							
1.	Chakraborty, S.K. "Values and Ethics for Organization Theory and Practice", Oxford University Press, New Delhi, 1998.						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to				Mapping POs		Mapping PSOs	
CO1	Knowledge of self-development.						
CO2	Learn the importance of Human values.						
CO3	Developing the overall personality.						

26AC005		CONSTITUTION OF INDIA		SEMESTER		I/II
Prerequisites			Category	AC	Credits	0
			Hours/ Semester	L	T	P
				30	0	0
TH						
30						
COURSE OBJECTIVES						
1.	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.					
UNIT - I	HISTORY OF MAKING OF INDIAN CONSTITUTION					5
History, Drafting Committee (Composition & working)						
UNIT - II	PHILOSOPHY OF THE INDIAN CONSTITUTION					5
Preamble, Salient Features						
UNIT - III	CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES					5
Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and education rights, right to constitutional remedies, directive principles of state policy, fundamental duties.						
UNIT - IV	ORGANS OF GOVERNANCE					5
Parliament, composition, qualifications and disqualifications, powers and functions, executive, president, governor, council of ministers, judiciary, appointment and transfer of judges, qualifications, powers and functions.						
UNIT - V	LOCAL ADMINISTRATION					5
Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zila panchayat. Elected officials and their roles, CEO zila panchayat: position and role. Block level: organizational hierarchy (different departments), village level: role of elected and appointed officials, importance of grass root democracy.						
UNIT - VI	ELECTION COMMISSION					5
Election Commission: role and functioning. Chief election commissioner and election commissioners. State election commission: role and functioning. Institute and bodies for the welfare of SC/ST/OBC and women.						
L:30, Total: 30 Hours						
Weightage: Continuous Assessment - 100%						
REFERENCE BOOKS:						
1.	The Constitution of India, 1950 (Bare Act), Government Publication					
2.	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.					
3.	M. P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.					
4.	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015					

COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics		
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.		
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution		
CO4	Discuss the passage of the Hindu Code Bill of 1956		

26AC006		PEDAGOGY STUDIES			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.	To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers. Identify critical evidence gaps to guide the development.							
UNIT - I		INTRODUCTION AND METHODOLOGY						6
Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching								
UNIT - II		THEMATIC OVERVIEW						6
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.								
UNIT - III		EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES						6
Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.								
UNIT - IV		PROFESSIONAL DEVELOPMENT						6
Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.								
UNIT - V		RESEARCH GAPS AND FUTURE DIRECTIONS						6
Research design, Contexts, pedagogy, teacher education, curriculum and assessment, dissemination and research impact.								
L:30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								

REFERENCE BOOKS:			
1.	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.		
2.	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) 361-379.		
3.	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID		
4.	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic math and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282.		
5.	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?		
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?		
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?		

26AC007		STRESS MANAGEMENT BY YOGA			SEMESTER		I/II	
Prerequisites				Category	AC	Credits		0
				Hours/ Semester	L	T	P	TH
					30	0	0	30
COURSE OBJECTIVES								
1.		To create a healthy, strong willed and intelligent young society through yoga practices						
UNIT - I		PHYSICAL AND MENTAL HEALTH						6
Pain and disease - free life, Simplified Physical Exercise- Pranayama. Concentration on Pituitary gland- Practical, Goal fixing								
UNIT - II		REJUVENATION OF LIFE FORCE AND WILL POWER						6
Principle of kayakalpa yoga, mind, life force and Biomagnetism, Practical, Concentration on Muladhara- Practical, Analysis of thought –Will power								
UNIT - III		DEVELOPMENT OF VIRTUES						6
Activation of Dormant Brain cells- Practical, Moralization of dezire and its classification, Neutralization of Anger, Results of anger								
UNIT - IV		STREAM LINING OF MIND						6
Definition of Mind-Worries, Eradication of Worries. The science behind blessings. Blessing techniques. Benefits, five basic duties								
UNIT - V		CAUSE AND EFFECT SYSTEM						6
Law of nature, Hereditary Imprints, Fivefold and Two-fold culture, good values and Resolution for world peace								
L:30, Total: 30 Hours								
Weightage: Continuous Assessment - 100%								
REFERENCE BOOKS:								
1.		"Thirukkural", Pearls of Inspiration, Translation by Rajaram, Publisher: RUPA						
2.		"Bharathiyar Poems", Amazon Asia – Pacific Holdings Private Limited						
3.		"Yoga for Humane Excellence", Vethathiri Maharishi, Vision for Wisdom, Vethathiri Publications						
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to					Mapping POs		Mapping PSOs	
CO1		Maintain good Physical health.						
CO2		Develop will power.						
CO3		Take quick and right decisions.						
CO4		Maintain good relationship with everyone around them his creating a Health Society						

26AC008	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS		SEMESTER		I/II	
Prerequisites		Category	AC	Credits		0
		Hours/ Semester	L	T	P	TH
			30	0	0	30
COURSE OBJECTIVES						
1.	To learn to achieve the highest goal happily,					
2.	To become a person with stable mind, pleasing personality and determination,					
3.	To awaken wisdom in students.					
UNIT - I	NEETISATAKAM – HOLISTICS DEVELOPMENT OF PERSONALITY					6
Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)						
UNIT - II	NEETISATAKAM— HOLISTIC DEVELOPMENT OF PERSONALITY (CONT'D)					6
Verses 52, 53, 59 (don'ts) - Verses 71.73.75 & 78 (do's) - Approach to day to day works and duties.						
UNIT - III	INTRODUCTION TO BHAGAVADGEETHA FOR PERSONALITY DEVELOPMENT					6
Shrimad Bhagavadgeetha: Chapter 2 - Verses 41, 47, 48 - Chapter 3 - Verses 13,21,27,35 - Chapter 6 - Verses 5,13,17,23,35 - Chapter 18 - Verses 45,40,48 Chapter - 6: Verses 5, 13, 17, 23, 35; Chapter - 18: Verses 45, 46, 48						
UNIT - IV	STATEMENTS OF BASIC KNOWLEDGE - SHRIMAD BHAGAVADGEETHA					6
Chapter 2- Verses 56, 62,68 - Chapter 12 — Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.						
UNIT - V	ROLE OF BHAGAVADGEETHA IN THE PRESENT SCENARIO					6
Chapter 2 - Verses 17 - Chapter 3 - Verses 36, 37, 42 - Chapter 4 - Verses 18, 38, 39 - Chapter 18 - Verses 37, 38, 63.						
L:30, Total: 30 Hours						
Weightage: Continuous Assessment - 100%						
REFERENCE BOOKS:						
1.	“Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata					
2.	Bhartrihari’s Three Sataskam (Niti- Sringar – Vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.					

E-RESOURCES:			
1.	NTPEL: http://nptel.ac.in/downloads/109104115		
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to		Mapping POs	Mapping PSOs
C01	Develop their personality and achieve their highest goal of life.		
C02	Lead the nation and mankind to peace and prosperity.		
C03	Practice emotional self-regulation.		
C04	Develop a positive approach to work and duties.		
C05	Develop a versatile personality.		

26AC009	SUSTAINABLE DEVELOPMENT GOALS		SEMESTER		I/II	
PREREQUISITES		Category	AC	Credits		0
		Hours/ Semester	L	T	P	TCP
			30	0	0	30
COURSE OBJECTIVES						
1.	To understand the concepts of Sustainable Development Goals					
2.	To study sustainability assessment methods, education for sustainable development					
3.	To analyze the problems and solution in environmental management.					
4.	To analyze the issues related to resource utilization.					
5.	To explore knowledge about life cycle assessment.					
UNIT - I	INTRODUCTION TO SUSTAINABLE DEVELOPMENT					6
Need and Importance of Sustainable Development - Historical & Policy perspectives of Sustainable Development - Sustainable Development: World and India Perspective - Introduction to 17 SDGs - Specific learning objectives for different SDGs - Challenges & strategies of attaining SDGs in developed and developing nations.						
UNIT - II	SDG QUALITY EDUCATION					6
Focus of NEP-2020 on SDG - Education for Sustainable Development - Berlin Declaration 2021 on ESD - Integration of ESD - Tools, Systems, and Innovation for Sustainability - Measuring Sustainability.						
UNIT - III	SUSTAINABLE COMMUNITIES AND RESOURCE CONSERVATION					6
Circular economy (basic model of reuse, recycle, and reduce) - Rural & urban Problems & Challenges - Sustainable production and consumption - Renewable energy - Health & Hygiene, water, sanitation & water management - Waste Management.						
UNIT - IV	CLIMATE CHANGE, ENERGY AND SUSTAINABLE DEVELOPMENT					6
The greenhouse effect: Causes and Consequences - Climate Change: A Threat to Sustainable Development - Adaptation to Current and Future Climate Regimes - Consequences: crop failure - Solutions technology and lifestyle changes - Mitigating Climate Change.						
UNIT - V	SUSTAINABLE BUSINESS PRACTICES					6
Corporate Social Responsibility - Sustainable products and services - Business and Environment - Corporations and Ecological Sustainability - Life Cycle Assessment: LCA Overview and Application - World peace and justice: United nations goals for peace and justice - World Government for peace.						
L:30, Total:30 Hours						
Weightage:						
Continuous Assessment - 100%						

REFERENCE BOOKS:	
1.	Onyeka Osuji, "Corporate Social Responsibility in Developing and Emerging Markets", Cambridge, 2022.
2.	Ram Kumar, Ch Lakshmi, Sandee, Janaki, "Smart Cities for Sustainable Development", Springer Switzerland, 2022.
3.	Surender Kumar and Shunsuke Managi, "The Economics of Sustainable Development: The Case of India (Natural Resource Management and Policy)", Springer Switzerland, 2009.
4.	Sushma Goyal, "Management of Resources for Sustainable Devpt", The Orient Blackswan, 2016.
5.	S. Ramaswamy Sathis G. Kumar, "Energy, Environment and Sustainable Development: Issues and Policies", Regal Publications, 2009.
E-RESOURCES:	
1.	https://www.un.org/sustainabledevelopment/
2.	https://www.aiu.ac.in/documents/AIU_Publications/UN-SDG goals
3.	https://www.unesco.org/en/education-sustainable-development
4.	https://onlinecourses.nptel.ac.in/noc23_hs57/preview
5.	https://www.iau-hesd.net/news/5180-berlin-declaration-education-sustainable development-adopted-unesco-esd-conference-17-19
COURSE OUTCOMES (COs) / At the end of the course, the students will have the ability to	
CO1	Explain the concepts of Sustainable Development and United Nations Sustainable Development Goals (SDGs), sustainability assessment methods, and their significance in national and global contexts.
CO2	Apply the challenges related to resource utilization, circular economy, renewable energy, sustainable production and consumption, environmental management, climate change, and their impact on society and sustainable development.
CO3	Analyze the sustainable business practices, corporate social responsibility, ecological sustainability, life cycle assessment, and global initiatives for achieving environmental protection, social equity, peace, and sustainable growth.
CO4	Design and develop a sustainability assessment project, case study, field survey, or community-based solution for a selected SDG.
CO5	Demonstrate professional competency through technical seminar presentations/group discussions, or preparation of technical reports on emerging trends, innovations, policies, and best practices related to SDG.