



ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING & TECHNOLOGY, NAGPUR

(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

M.Tech. Scheme of Examination & Syllabus 2025-26
STRUCTURAL ENGINEERING

SEMESTER II

Sr. No.	Course Category	Course Code	Course Title	Hours per Week			Credits	Maximum Marks				No of HRS In ESE
				L	T	P		Continual Assessment	End Sem Examination	Minimum Passing Marks	Total	
1	PCC	25SE201T	Finite Element Method	4	-	-	4	40	60	50	100	3
2	PCC	25SE201P	Finite Element Method Lab	-	-	4	2	25	25	25	50	-
3	PCC	25SE202T	Advanced Construction Materials and Techniques	4	-	-	4	40	60	50	100	3
4	PCC	25SE203T	Structural Dynamics	4	-	-	4	40	60	50	100	3
5	PCC	25SE203P	Structural Dynamics Lab	-	-	4	2	25	25	25	50	-
6	ELC	25SE204T	Research Methodology and Intellectual Property Rights	4	-	-	4	40	60	50	100	3
7	PEC	25SE205T	Program Elective - II	4	-	-	4	40	60	50	100	3
Total				20	-	8	24	250	350	-	600	-

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Chairman - BoS	Dean - Academics	Date of Release	Version	



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Basket for Program Elective

Course Code	Name of Course
25SE205T(i)	PE - II Design of High Rise Structures
25SE205T(ii)	PE - II Bridge Engineering
25SE205T(iii)	PE - II Advanced Earthquake Design

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25SE201T	FINITE ELEMENT METHOD	4	-	-	4	40	60	100

Course Objectives	Course Outcomes
<p>1.. To develop the student's knowledge on understanding of ordinary and partial differential equations.</p> <p>2. To provide some knowledge on mathematical concepts of the Finite Element Method for obtaining an approximate solution of ordinary and partial differential equations.</p>	<p>After the completion of this course, the students will be able to</p> <ol style="list-style-type: none"> 1.Have a solid foundation on the theoretical basis of the weighted residual Finite Element Method. 2.Use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems. 3.Use these solutions to guide and validate a Finite Element model using a range of techniques. 4.Communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained 5.Discuss the accuracy of the Finite Element solutions
Unit I	[9 Hrs]
Introduction: Introduction; Basic Concepts of Finite Element Analysis; Introduction to Elasticity; Steps in Finite Element Analysis, Finite Element Formulation Techniques, Virtual Work and Variational Principle; Galerkin Method; Finite Element Method: Displacement Approach; Stiffness Matrix and Boundary Conditions. convergence, patch test	
Unit II	[9 Hrs]
FEM for One Dimensional Elements : BAR element, BEAM element, Curved coordinates,	
Unit III	[9 Hrs]
FEM for Two Dimensional and Three Dimensional Elements: Physical Coordinates system Triangular Elements; Rectangular Elements; Lagrange and Serendipity Elements; Solid Elements; Isoparametric Formulation; Stiffness Matrix of Isoparametric Elements; Numerical Integration: One Dimensional; Numerical Integration: Two and Three Dimensional	
Unit IV	[9 Hrs]
FEM for Two and Three Dimensional Solids: Natural Coordinates system, Constant Strain Triangle; Linear Strain Triangle; Rectangular Elements; Numerical Evaluation of Element Stiffness; Computation of Stresses, Geometric Nonlinearity and Static Condensation; Axisymmetric Element; Finite Element Formulation of Axisymmetric Element; Finite Element Formulation for 3 Dimensional Elements	
Unit V	[9 Hrs]
FEM for Plates: Introduction to Plate Bending Problems; Finite Element Analysis of Thin Plate; Introduction to Analysis of Thick Plates,	

Text Books

S.N	Title	Authors	Edition	Publisher
1	An Introduction to the Finite Element Method	Reddy, J. N.	2nd Ed, 2003	Tata McGraw Hill
2	Finite Elements Analysis: Theory and Programming	Krishnamoorthy, C. S.	2nd Ed, 1994	Tata McGraw Hill
3	Finite Element Method in Structural Analysis	Meghare A. S. Kadam Kshitija N	1 st Edition, 2014	Khanna Publishers New Delhi

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Concepts and Applications of Finite Element Analysis	Cook, R. D., Malkus, D. S., and Plesha, M. E.	4th Ed, 2002	John Wiley & Sons
2	Finite Element Method Its Basis and Fundamentals	Zienkiewicz, O. C., Taylor, R. L., and Zhu, J. Z.	6th Ed, 2005	Elsevier

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25SE201P	Finite Element Method Lab	-	-	4	2	25	25	50

Course Objectives	Course Outcomes
<ol style="list-style-type: none">To understand the fundamentals of finite element modeling in structural analysis.To apply FEM concepts to solve real structural engineering problems.To develop hands-on skills using FEM-based software for analysis and interpretation of results.	<p>At the end of the course, students will be able to:</p> <ol style="list-style-type: none">Identify the necessary information required to conduct a structural analysis using finite element softwareInterpret the solutions obtained from finite element analyses.Communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.

Expt. No.	Title of the experiment
1	Analytical Solution & Computer Simulation of Truss.
2	Analytical Solution & Computer Simulation of Bar.
3	Analytical Solution & Computer Simulation of Beams.
4	Analytical Solution & Computer Simulation of 2D plane stress and strain problem.
5	Analytical Solution & Computer Simulation of 2D Axisymmetric problem.

Text Books

S.N	Title	Authors	Edition	Publisher
1	Introduction to Finite Element Method	P. N. Godbole	2nd Ed, 2003	I. K. International Publishing House Pvt. Ltd.
2	Finite Elements Analysis: Theory and Programming	Krishnamoorthy, C. S.	2nd Ed, 1994	Tata McGraw Hill
			-	

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Introduction to Finite Element Method	Desai C. S. and Abel J. F	-	Van Nostrand Reinhold, New York
2	Finite Element Method Its Basis and Fundamentals	Zienkiewicz, O. C., Taylor, R. L., and Zhu, J. Z.	6th Ed, 2005	Elsevier
3	Finite Element Method in Structural Analysis	Meghare A. S. Kadam Kshitija N	1 st Edition, 2014	Khanna Publishers New Delhi

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25SE202T	Advanced Construction Materials and Techniques	4	-	-	4	40	60	100
Course Objectives		Course Outcomes						
To impart advanced knowledge of modern construction materials, sustainable practices, and innovative construction techniques, enabling students to analyze, design, and implement efficient and future-ready infrastructure solutions.		Upon successful completion of this course, students will be able to: <ol style="list-style-type: none"> 1. Explain the properties, behavior, and applications of advanced cementitious and composite materials. 2. Evaluate sustainable and smart construction materials based on performance, durability, and environmental impact. 3. Apply modern construction techniques such as prefabrication, modular construction, and 3D printing in engineering solutions. 4. Analyze advanced structural systems and recommend appropriate retrofitting techniques for existing structures. 5. Integrate emerging technologies such as BIM, AI, and IoT in planning and execution of construction projects. 						
Unit I		[9 Hrs]						
Advanced Cementitious & Composite Materials: Review of conventional vs modern construction materials, High Performance Concrete (HPC), Ultra High Performance Concrete (UHPC), Self-Compacting Concrete (SCC) – properties, mix design, applications, Fiber Reinforced Concrete (FRC) – steel, glass, polypropylene, basalt fibers, Polymer Concrete and Polymer Modified Concrete, Engineered Cementitious Composites (ECC), Nano materials in concrete (nano silica, nano carbon tubes), Rheological and durability characteristics of advanced concretes								
Unit II		[9 Hrs]						
Sustainable & Smart Construction Materials: Green building materials and sustainability concepts, Geopolymer concrete – materials, production, properties, Industrial by-products in construction (fly ash, GGBS, silica fume, rice husk ash), Recycled aggregate concrete, Phase Change Materials (PCM), Smart materials – shape memory alloys, piezoelectric materials, Self-healing concrete and bacteria-based materials, Life Cycle Assessment (LCA) of construction materials								
Unit III		[9 Hrs]						
Modern Construction Techniques: Prefabrication and modular construction, Precast concrete technology, Slip form and jump form techniques, Tunnel form construction, Rapid construction techniques, 3D concrete printing, Use of robotics and automation in construction, Lean construction principles								
Unit IV		[9 Hrs]						
Advanced Structural Systems & Retrofitting Methods: Light gauge steel framing systems, Composite construction (steel-concrete composite systems), FRP strengthening and retrofitting techniques, Seismic retrofitting methods, Base isolation and damping systems, Use of geosynthetics in construction, Retrofitting of heritage structures								
Unit V		[9 Hrs]						
Emerging Technologies & Future Trends: Building Information Modeling (BIM) for material optimization, Digital twins in construction, Artificial Intelligence and Machine Learning applications, Drones and remote sensing in construction monitoring, Smart infrastructure and IoT, Additive manufacturing in construction, Case studies of landmark projects using advanced materials, Research trends and future scope								

Text Books



S.N	Title	Authors	Edition	Publisher
1	New Materials in Civil Engineering	ijush Samui, Dookie Kim, Sandeep Chaudhary	I	Elsevier / Butterworth-Heinemann (2020).
2	Construction Materials, Methods, and Techniques: Building for a Sustainable Future	Eva Kultermann & William P. Spence	I	Cengage Learning / Delmar Pub (5th Edition, India release about 2022).
3	Modern Methods of Construction and Innovative Materials	Arthur Lyons	-	Routledge (Taylor & Francis Group) (2024).

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Reference Books

S.N	Title	Authors	Edition	Publisher
1	Advances in Engineered Cementitious Composites: Materials, Structures and Numerical Modelling	Y. X. Zhang & Kequan Yu	-	Elsevier / ScienceDirect
2	Modern Building Materials, Structures and Techniques (MBMST 2023)	Joaquim A.O. Barros, Gintaris Kaklauskas & Edmundas K. Zavadskas	-	Springer Cham (Lecture Notes in Civil Engineering)
3	Sustainable Construction Materials: From Paste to Concrete	Yeonung Jeong	-	MDPI Books

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25SE203T	Structural Dynamics	4	-	-	4	40	60	100
Course Objectives		Course Outcomes						
1. To understand the Fundamentals of Structural Dynamics 2. To develop a strong foundation in the basic principles of dynamics, including the study of forces, motion, and vibrations in structures. 3. To apply Advanced Vibration Theory to Real-World Structures		At the end of the course, students will be able to: 1. Understand Single Degree of Freedom System and Dampers 2. Analyse the vibrations using mathematical models for the structure. 3. Analyse Two Degree of Freedom system. 4. Analyse Multi degree of Freedom system. 5. Analyse the continuous system using proper mathematical model.						
Unit I								[8 Hrs]
Single Degree of Freedom System: Free and forced vibrations, Linear Viscous Damper, Coulomb Damper: Response to harmonic excitation, rotating unbalance and support excitations, Vibration isolation and transmissibility, single degree of freedom system as vibro-meter and accelerometer, response to periodic and arbitrary excitation.								
Unit II								[8 Hrs]
Duhamels integral. Impulse response function, Laplace transform Fourier transform methods. Frequency response function. Phase-Plane Techniques. Critical Speed of rotors. Energy methods, Rayleighs method, Equivalent viscous damping								
Unit III								[9 Hrs]
Two Degree of Freedom System. Matrix Formulation, Free Vibration, Beat phenomenon. Principle of damped and un-damped vibration absorber								
Unit IV								[10 Hrs]
Multi Degree of Freedom System: Matrix formulation, stiffness and flexibility influence coefficients, eigenvalue problem, normal modes and their properties. Matrix iteration technique for eigenvalue, and eigen vectors, Free and forced vibration by modal analysis								
Unit V								[10 Hrs]
Continuous System: Axial vibration of bar, torsion of shafts, transverse vibration of strings and bending vibration beams. Forced vibration. Normal mode method. Lagrange's equation. Approximate methods of Rayleigh-Ritz.								

Text Books

S.N	Title	Authors	Edition	Publisher
1	Dynamics of Structures	RW Clough, J Penz		Prentice Hall
2	Dynamics and Vibrations of structures	Fertia D. G.		Prentice Hall
3	Structural Dynamics	Mario Paz		McGraw Hill

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Dynamics of Structure	Timoshenko S.		PHI Eastern Edition

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25SE203P	Structural Dynamics Lab	-	-	4	2	25	25	50
Course Objectives		Course Outcomes						
To Investigate dynamic behavior of single and multi-degree-of-freedom (MDOF) systems. To Apply experimental modal analysis techniques To Develop and simulate structural dynamic models using computational tools.		At the end of the course, students will be able to: 1. Analyse the continuous beam using software and validate the results with manual calculations. 2. Analyse the rigid jointed plane frame using software and validate the results with manual calculations 3. Analyse the pin jointed plane frame using software and validate the results with manual calculations 4. Analyse the grid using software and validate the results with manual calculations.						

Expt. No.	Title of the experiment
1	Study of basic components: accelerometers, displacement transducers, and force sensors Calibration of measurement devices for dynamic response testing Understanding the setup and operation of vibration test equipment Introduction to structural models (beams, plates, frames, etc.)
2	Perform free vibration tests on simple structures Measurement and analysis of natural frequencies and mode shapes Experimental determination of damping ratios using decay curves Comparison of experimental results with theoretical predictions
3	Perform forced vibration tests on simple structures subjected to harmonic excitation Study the resonance phenomenon in structures Determine the response of a structure to various harmonic frequencies Measurement of dynamic amplification factors and resonance
4	Use of impact hammers, shakers, and vibration sensors for modal testing Use of accelerometers and displacement sensors for real-time data acquisition Comparison of experimental modal analysis with computational methods
5	Experimental analysis of multi-degree-of-freedom (DOF) systems Study of coupled vibrations and resonance effects in multi-DOF structures Use of modal superposition and direct integration methods for analyzing complex structures
6	Introduction to software tools for structural dynamics analysis Creation of dynamic models for structures (e.g., beams, frames, trusses) Simulation of dynamic responses to time-varying loads and excitations Modal analysis and time-history analysis using computational software Validation of computational results with experimental data

Text Books

S.N	Title	Authors	Edition	Publisher
1	Structural Dynamics: Theory and Computations	Mario Paz and William Leigh	-	McGraw Hill
2	Introduction to structural Dynamics and Aseismic Design	N. Subramanian	-	TATA McGraw Hill
3	Structural Dynamics: An Introduction to Computational Methods	Roy R. Craig and Andrew J. Kurdila	-	PHI Eastern Edition

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Practical Methods in Structural Dynamics	J. P. Den Hartog	-	Prentice Hall
2	Vibration of Structures: Theory and Applications	J. L. Humphreys	-	Prentice Hall

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
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25SE204T	Research Methodology and Intellectual Property Rights	4	-	-	4	40	60	100
Course Objectives		Course Outcomes						
To impart knowledge and skills in research methodology, data analysis, hypothesis testing, and optimization techniques applicable in engineering research.		At the end of the course: 1. Understand the concept, need, motivation, and various types and approaches of research and the overall research process. 2. Formulate and define a research problem effectively and develop appropriate hypotheses with clarity on testing procedures. 3. Acquire knowledge on primary and secondary data collection methods and apply statistical tools such as regression and correlation for data interpretation. 4. Solve engineering problems using optimization methods including linear programming, simplex method, and evolutionary techniques. 5. Apply model analysis techniques in structural engineering and demonstrate competence in research writing and ethical publishing.						
Unit I		[9 Hrs]						
Introduction to Research and Research Methodology : Introduction to Research, How to do Research, Objectives of Research, Motivation in Research, Types of Research, Various Research Approaches, Significance of Research, Research Methods vs. Research Methodology, Overview of the Research Process.								
Unit II		[9 Hrs]						
Research Problem and Hypothesis Formulation : Introduction to Research Problem, Components of a Research Problem, Identifying and Formulating a Research Problem, Steps in Formulating a Research Problem, Techniques and Feasibility Check in Defining the Research Problem, What is a Hypothesis?, Characteristics, Examples, and Types of Hypothesis, Hypothesis Testing: Concepts and Procedures								
Unit III		[9 Hrs]						
Data Collection and Statistical Analysis : Optimization: Definition and Principles, Linear Programming Techniques, Simplex Method, Evolutionary Programming Techniques (e.g., Genetic Algorithms – brief overview), Application of Optimization in Civil Engineering and Research								
Unit IV		[9 Hrs]						
Intellectual Property Rights : Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.								
Unit V		[9 Hrs]						
Model Analysis and Research Paper Writing : Model Analysis of Structures, Direct and Indirect Methods, Use of Dimensionless Terms and Their Significance, Structural Similitude, Optimization of Physical Models, Structure and Content of a Research Paper, Choosing a Research Topic, Method of Writing a Research Paper, Plagiarism: Definition, Types, and Rules (UGC Guidelines)								

Text Books

S.N	Title	Authors	Edition	Publisher
1	Research Methodology: Methods and Techniques	C. R. Kothari, Gaurav Garg	I	New Age International
2	Optimization in Operations Research	Ronald L. Rardin	I	Pearson Education
3	Operations Research: Principles and Practice	A. Ravindran, D. T. Phillips	-	Wiley India

Research Books

S.N	Title	Authors	Edition	Publisher
1	Research Methods for Engineers	David V. Thiel	-	New Age International
2	Operations Research	S. D. Sharma	-	Kedarnath Ramnath Publications
3	UGC Guidelines on Academic Integrity and Plagiarism	UGC India	-	ugc.ac.in

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						CA	ESE	Total
25SE205T(i)	PE - II Design of High Rise Structures	4	-	-	4	40	60	100
Course Objectives				Course Outcomes				
1. To understand the need for high-rise buildings and the influence of urbanization, land scarcity, and architectural requirements on tall structure design. 2. To study the behavior of tall structures under various loads such as gravity loads, wind loads, and earthquake forces. 3. To develop knowledge of lateral load resisting systems, including shear walls, braced frames, outrigger systems, tubular systems, and core systems.				At the end of the course, students will be able to: 1. Understand and explain the behavior of high-rise structures under gravity, wind, and seismic loads. 2. Identify, analyze, and select appropriate lateral load-resisting systems for tall buildings. 3. Apply wind and earthquake engineering concepts in the analysis and design of high-rise structures. 4. Perform structural analysis of tall buildings using approximate methods and computer-aided tools. 5. Design major structural components and systems of high-rise buildings as per relevant IS codes.				

Unit I	[9 Hrs]
Introduction to High-Rise Structures: Definition and classification of tall buildings, Evolution and historical development of high-rise structures, Functional planning and architectural considerations, Structural planning and layout of tall buildings, Loads on high-rise structures: gravity, wind, seismic, temperature, Serviceability and strength requirements, Codes and standards.	
Unit II	[9 Hrs]
Structural Systems for High-Rise Buildings: Rigid frame systems, Braced frame systems, Shear wall systems, Wall-frame interaction systems, Mega structural systems.	
Unit III	[9 Hrs]
Analysis of High-Rise Structures: Approximate methods of analysis, Portal method, Cantilever method, Shear lag effects, Storey drift and lateral displacement control, Second-order ($P-\Delta$) effects, Computer-based analysis using ETABS / STAAD / SAP2000.s	
Unit IV	[9 Hrs]
Wind Effects on Tall Buildings: Wind characteristics, Along and across wind response, Gust factor method, Wind-induced vibration control.	
Unit V	[9 Hrs]
Analysis and Design of RC cooling tower, Foundation design for varied soil strata.	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Geotechnical Earthquake Engineering	Kramer S.L.	2005	Prentics Hall, New Jersey
2	Earthquake Resistant Design of Structures	Shrikhande & Agrawal	2006	Prentics Hall
3	Earthquake Resistant Design of Structures	S.K.Duggal	2013	OUP India

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Seismic design of R C & masonry Buildings,	Paulay & Prestiley	1992	Wiley
2	Reinforced Concrete Structures,	Park & Paulay	1975	Wiley
3	Foundation systems for High Rise structures	Rolf Kazenbach, Steffen Loppla, Deepankar Choudhary	2016	CRC Press

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