M.E. Degree

in

STRUCTURAL ENGINEERING

CURRICULUM & SYLLABUS (CBCS)

(Innovation and Product Development for Sustainability)

(For students admitted from the Academic Year 2026-2027)

DEPARTMENT OF CIVIL ENGINEERING

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING
CHUNKANKADAI, NAGERCOIL – 629 003.
KANYAKUMARI DISTRICT, TAMILNADU, INDIA

VISION OF THE INSTITUTION

To be an institution of eminence of optimal human development, excellent engineering education and pioneering research towards developing a technically-empowered humane society.

MISSION OF THE INSTITUTION

To transform the (rural) youth into top class professionals and technocrats willing to serve local and global society with ethical integrity, by providing vibrant academic experience of learning, research and innovation and stimulating opportunities to develop personal maturity and professional skills, with inspiring and high caliber faculty in a quality and serene infrastructural environment.

VISION OF THE PROGRAMME

To be a department of eminence in producing Civil Engineers that serve people with technical expertise, groundbreaking innovations and productive entrepreneurial initiatives with high ethical standards and commitment in green and sustainable development.

MISSION OF THE PROGRAMME

M 1	To provide quality teaching in order to transform students into Civil Engineers with academic excellence and technical expertise with outstanding faculty and excellent infrastructure.
M 2	To develop leadership qualities and managerial skills of the students to become productive entrepreneurs.
M 3	To create awareness on recent technologies through innovative research and industry institute collaboration.
M 4	To inculcate human values within the students and inspire them to create a sustainable ecofriendly society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Gain knowledge and skills in structural engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations.

PEO2: Become consultants in Structural Engineering and solve complex real life issues related to analysis, design and maintenance of structures under various environmental conditions.

PEO3: Contribute to the enhancement of knowledge in Structural Engineering by performing quality research in institutions of international repute or in Research organizations or Academia.

PEO4: Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible, and socially acceptable.

PEO5: Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation.

PROGRAMME OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the techniques in the area of Structural Engineering.

PO4: Analyze, design and create novel products and solutions for the real life problems in Structural Engineering.

PO5: Solve problems in Structural design using modern Engineering equipments and software tools by applying appropriate techniques.

PO6: Function effectively as a professional with ethical attitude, effective communication skills, team work skills, leadership skills and multi-disciplinary approach to solve Structural Engineering issues to broader social context.

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PEOs – POs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	-	-
CO2	2	2	-	-	3	3
CO3	1	1	-	3	3	2
CO4	-	-	1	-	2	-
CO5	-	3	2	-	-	-

PROGRAMME ARTICULATION MATRIX

Year	Semester	Course Name	PO					
			1	2	3	4	5	6
I	I	IP26C07	2	-	2	-	-	-
		MA26104	2	-	1	3	1	-
		SE26101	2	-	2	2	-	2
		SE26102	3	-	3	3	-	2
		SE26103	2	-	3	2	2	2
		RM26C01	3	3	2	2	2	2
		RM26C02	2	2	2	2	3	2
		SE26104	2	2	2	2	2	2
		SE26105	3	3	2	-	-	3
I	II	SE26201	3	2	3	2	2	2
		SE26202	3	2	2	3	2	3
		SE26203	3	-	3	3	2	2
		SE26204	1	3	3	2	2	2
		SE26205	3	-	3	3	2	2

SUMMARY

Name of the Programme						
S.No	Subject Area	Credits per Semester				Total Credits
		I	II	III	IV	
1	FC	6	-	-	-	6
2	BSC	4	-	-	-	4
3	PCC	12	15	-	-	27
4	PEC	3	6	3	-	12
5	OEC	-	3	-	-	3
6	EEC	1	-	8	12	21
7	IEC	-	1	1	-	2
Total		26	25	12	12	75

SUSTAINABLE DEVELOPMENT GOALS

SDG 1: No Poverty
End poverty in all its forms everywhere

SDG 2: Zero Hunger
End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG 3: Good Health and Well-being
Ensure healthy lives and promote well-being for all at all ages

SDG 4: Quality Education
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 5: Gender Equality
Achieve gender equality and empower all women and girls

SDG 6: Clean Water and Sanitation
Ensure availability and sustainable management of water and sanitation for all

SDG 7: Affordable and Clean Energy
Ensure access to affordable, reliable, sustainable and modern energy for all

SDG 8: Decent Work and Economic Growth
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG 9: Industry, Innovation and Infrastructure
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG 10: Reduced Inequality
Reduce inequality within and among countries

SDG 11: Sustainable Cities and Communities
Make cities and human settlements inclusive, safe, resilient and sustainable

SDG 12: Responsible Consumption and Production
Ensure sustainable consumption and production patterns

SDG 13: Climate Action
Take urgent action to combat climate change and its impacts

SDG 14: Life Below Water

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

SDG 15: Life on Land
Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

SDG 16: Peace and Justice Strong Institutions
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG 17: Partnerships to achieve the Goal
Strengthen the means of implementation and revitalize the global partnership for sustainable development.

SEMESTER: I

Number of Courses :8
Total Credits : 23

Course Code	Course Title	Course Type	Classroom Instruction (CI) (in Hours per Semesters)		Lab Instruction (LI) (in Hours per Semesters)	Term Work(TW) and Self Learning (SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)=(Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
IP26C07	Induction Programme*		24	0	0	6	30	0	4,8,9, 16,17	IP
MA26104	Optimization Techniques and Statistical Modeling for Structural Engineers	TC	45	15	0	60	120	4	4,7,9, 12,13	BSC
SE26101	Theory of Elasticity and Plasticity	TC	45	0	0	45	90	3	7,9, 11, 12, 13	PCC
SE26102	Advanced Concrete Structures	TC	45	0	0	45	90	3	9,11, 12	PCC
SE26103	Structural Dynamics and Earthquake Engineering (Lab Integrated)	TCPC	45	0	30	45	120	4	9,11, 12, 13	PCC
RM26C01	Research Methodology And Intellectual Property Rights	TC	45	15	0	60	120	4	1,2,3, 7	FC
RM26C02	Research Tools Laboratory	PC	0	0	60	0	60	2	4,9, 16,17	FC
SE26104	Advanced Structural Engineering and Experimental	PC	0	0	60	0	60	2	4,7,9, 11, 12, 13	PCC

	Techniques Laboratory									
SE26105	Technical Seminar**	PC	0	15	0	0	15	1	4,8,9,13,17	EEC
Total			249	45	150			23		

* - Refer clause 21 in regulation 2026. The evaluation procedure is detailed in the syllabus.
** - Internally Evaluated Course. The evaluation procedure is detailed in the syllabus.

SEMESTER: II

Number of Courses: 9
Total Credits: 23

Course Code	Course Title	Course Type	Classroom Instruction (CI) (in Hours per Semesters)		Lab Instruction (LI) (in Hours per Semesters)	Team Work(TW) and Self Learning (SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)= (Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
SE26201	Advanced Steel Structures	TC	45	0	0	45	90	3	9,11,12	PCC
SE26202	Stability of Structures	TC	45	0	0	45	90	3	3,9,11	PCC
SE26203	Prestressed Concrete Structures	TC	45	0	0	45	90	3	3,9,11	PCC
	Open Elective I	TC	45	0	0	45	90	3		OEC
	Professional Elective I	TC	45	0	0	45	90	3		PEC
SE26204	Finite Element Analysis of Structures (Lab Integrated)	TCPC	45	0	30	45	120	4	9,4,11,12	PCC
SE26205	Structural Design Studio	PC	0	0	60	0	60	2	4,9,	PCC

									11	
	Industry Collaborated Course I*	PC	0	0	30	0	0	1		ICC
	Self-Learning Course *							1		SLC
Total			270	0	120			23		

* - Evaluation and certification by course offering body.

PROFESSIONAL ELECTIVE I – SEMESTER II

Course Code	Course Title	Course Type	Classroom Instruction (CI) (in Hours per Semesters)		Lab Instruction (LI) (in Hours per Semesters)	Team Work(TW) and Self Learning (SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)= (Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
SE26111	Advanced Concrete Technology	TC	45	0	0	45	90	3	9,11, 12, 13	PEC
SE26112	Prefabricated Structures	TC	45	0	0	45	90	3	4,9, 11, 12, 17	PEC
SE26113	Safety in Construction	TC	45	0	0	45	90	3	3,8,9, 11	PEC
SE26114	Design of Steel Concrete Composite Structures	TC	45	0	0	45	90	3	9, 11	PEC

OPEN ELECTIVE I – SEMESTER II

Course Code	Course Title	Course Type	Classroom Instruction (CI) (in Hours per Semesters)		Lab Instruction (LI) (in Hours per Semesters)	Team Work(TW) and Self Learning (SL) (in Hours per Semesters)	Total Number of Hours (in Hours per Semesters)	Total Credits (C)= (Total Hours/30)	SDG Goal Mapped	Category
			L	T	P					
SE26901	Strategies for Sustainable Design	PE	45	0	0	45	90	3	6, 7, 9, 11, 12, 13	PEC
SE26902	Structural Inspection and Health Assessment	PE	45	0	0	45	90	3	9,11	PEC

SEMESTER I

IP26C07	INDUCTION PROGRAMME	L	T	P	TW/SL	Total	C	SDG
		24	0	0	6	30	0	4,8,9, 16,17

COURSE OBJECTIVES:

- To familiarize students with institutional policies, academic regulations, and programme structure.
- To introduce research methodology, ethical practices, and emerging engineering trends.
- To develop communication, technical writing, and presentation skills.
- To create awareness about career opportunities, higher education, and industry expectations.
- To inculcate professional ethics, teamwork, and leadership qualities.

COURSE CONTENT:

Unit 1	Institutional Orientation	4	0	0	1	5		4

Vision, Mission, and Quality Policy – Organizational structure – Campus facilities – Library, laboratory, and IT infrastructure – Student support systems – Interaction with faculty and peers.
Activity: Campus Resource Mapping and Group Presentation.

Unit 2	**Academic Regulations & Programme Structure**	**4**	**0**	**0**	**1**	**5**		**4,9**
Choice Based Credit System (CBCS) – Curriculum framework – Credit requirements – Evaluation and assessment procedures – Attendance norms – Examination system – Academic integrity guidelines. **Activity:** Preparation of Individual Academic Plan.								
Unit 3	**Research Methodology & Emerging Technologies**	**8**	**0**	**0**	**2**	**10**		**4**
Research process – Problem identification – Literature review – Research ethics and plagiarism – Overview of emerging technologies (AI, Data Science, IoT, etc.) – Interdisciplinary research opportunities. **Activity:** Mini Research Problem Identification and Presentation.								
Unit 4	**Skill Development & Career Planning**	**4**	**0**	**0**	**1**	**5**		**8**
Communication skills – Technical writing – Presentation skills – Resume preparation – Career opportunities – Higher studies – Competitive exams – Internship and placement readiness. **Activity:** Resume Preparation and Elevator Pitch Presentation.								
Unit 5	**Professional Development & Well-Being**	**4**	**0**	**0**	**1**	**5**		**16,17**
Engineering ethics – Professional values – Teamwork and leadership – Innovation and entrepreneurship – Startup ecosystem – Time management – Stress management – Counselling and mentoring support. **Activity:** Case Study Analysis on Ethics and Teamwork.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: CO1: Apply institutional policies and academic regulations to manage postgraduate studies effectively. CO2: Apply research methodologies and ethical principles to identify research problems. CO3: Demonstrate communication, technical writing, and presentation skills. CO4: Analyze career opportunities and industry expectations for informed decision-making. CO5: Apply professional ethics and teamwork skills in academic and organizational environments.								
Weightage: Continuous Assessment: 100%								
Assessment Methodology: ActiveParticipation (40%), Assignments(30%), Quiz(30%)								

REFERENCES:	
1.	Johri A., “International Handbook of Engineering Education Research”, Taylor & Francis, 2023.
2.	Murthy D. N. P., & Page, N. W., “Education and Research for the Future”, Springer, 2023.
3.	Oliveira T. A., & Hebebci, M. T. (Eds.), “Current Academic Studies in Technology and Education 2024”, ISRES Publishing, 2024.
4.	Kannan R., Thirumalai P., & Geetha T. V. (Eds.), “Proceedings of the International Conference on Technology for Education (T4E 2024)”, Springer, 2024.
5.	Rajesh S., Raghu Prasad B. K., & Praveen K. V. (Eds.), “Recent Advances in Sustainable Construction Technology, Geotechnics and Structural Engineering”, Springer, 2026.
E resources/E materials:	
1.	https://alison.com/course/essentials-of-research-methodology
2.	https://www.coursera.org/learn/research-methodologies

Mapping of Course Outcomes to Programme Outcomes

CO	**PO**		
	PO1 (Research Capability)	**PO2 (Technical Communication)**	**PO3 (Domain Mastery)**
CO1	1	-	-
CO2	1	-	-
CO3	2	-	-
CO4	2	-	-
CO5	-	-	2
CO	**2**	**-**	**2**

<table>
<tr><td rowspan="2">MA26104</td><td rowspan="2">OPTIMIZATION TECHNIQUES AND STATISTICAL MODELLING FOR STRUCTURAL ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>TW/SL</td><td>Total</td><td>C</td><td>SDG</td></tr>
<tr><td>45</td><td>15</td><td>0</td><td>60</td><td>120</td><td>4</td><td>4,7,9, 12,13</td></tr>
<tr><td colspan="9">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="9">• To familiarize the students with the formulation and construction of mathematical models for a linear programming problem in real life situations.
• To develop student’s ability to formulate and solve real-world optimization problems using transportation and assignment models.
• To enable students to understand the concepts of correlation, regression and curve fitting.
• To acquaint the student with mathematical tools needed in evaluating Statistical quality control and to apply in the manufacturing industry.
• To acquaint the student with the basic concept of Tensor analysis and its applications.</td></tr>
<tr><td colspan="9">COURSE CONTENT:</td></tr>
<tr><td>Unit 1</td><td>Linear Programming</td><td>9</td><td>3</td><td>0</td><td>12</td><td>24</td><td></td><td>4,7,9</td></tr>
<tr><td colspan="9">Formulation of linear programming problems – Graphical solution method – Canonical and standard form of linear programming problem – Simplex method – Artificial variables: Big-M method.
Activity: Formulate and solve a linear programming problem to minimize the cost of reinforcement steel while satisfying strength and serviceability constraints for a beam section.</td></tr>
<tr><td>Unit 2</td><td>Transportation and Assignment Models</td><td>9</td><td>3</td><td>0</td><td>12</td><td>24</td><td></td><td>4,9, 13</td></tr>
<tr><td colspan="9">Definition of the transportation model – Mathematical formulation of transportation models – Basic feasible solution: Vogel’s approximation method – Optimal solution by modified distribution (MODI) method – Definition of the assignment model – Mathematical formulation of assignment models – Hungarian method for solving assignment problems.
Activity: Create a transportation model to minimize the cost of transporting construction materials (cement, steel, aggregates) from suppliers to different construction sites (bridge site, high-rise building site, industrial shed).</td></tr>
<tr><td>Unit 3</td><td>Correlation, Regression and Model Fitting</td><td>9</td><td>3</td><td>0</td><td>12</td><td>24</td><td></td><td>9, 12</td></tr>
<tr><td colspan="9">Correlation (discrete case) – Karl Pearson's coefficient of correlation and Spearman’s rank correlation – Linear regression – Regression coefficients – Definitions: Unbiased estimators, Efficiency, Consistency, Sufficiency – Curve fitting by the method of least squares (linear and quadratic forms).</td></tr>
</table>

Activity: Fit linear and quadratic models to the relationship between applied load and mid-span deflection in reinforced concrete beams.								
Unit 4	**Statistical Quality Control**	9	3	0	12	24		9, 12
The Control Chart – Nature of the Control limits – Control charts for variables or measurements – $\bar{X}$ and R charts for variables – Control charts for attributes – The p -chart for fraction defective – Control Charts for Number of Defectives – (c and np charts). **Activity:** Create control charts for precast beam defect inspection (cracks, honeycombing, misalignment).								
Unit 5	**Tensor Analysis**	9	3	0	12	24		4,9
Summation convention – Contravariant and covariant vectors – Inner product – Quotient law – Metric tensor – Christoffel symbols. **Activity:** Perform stress–strain analysis of a thin cylindrical shell demonstrating covariant/contravariant components and Christoffel symbols for a given displacement field.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1**: Apply graphical, simplex and Big-M methods to solve linear programming problems and obtain optimal solutions. **CO2**: Solve transportation problems using modified distribution method and assignment problems using Hungarian Method to obtain optimal allocation results. **CO3**: Apply curve fitting, regression and correlation techniques to analyze and interpret experimental data. **CO4**: Construct control charts to analyze quality in manufacturing and management processes. **CO5**: Utilize tensor analysis to interpret problems in applied sciences and engineering.								
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%								
Assessment Methodology: Internal Assessment Test (70%) and Activity (30%).								
REFERENCES:								
1.	Taha. H.A., “Operation Research: An Introduction”, Eleventh edition, Pearson Education, New Delhi, Reprint 2023.							
2.	Johnson. R.A., Miller. I.R and Freund. J.E, "Miller and Freund’s Probability and Statistics for Engineers", Ninth edition, Pearson Education, Asia, Ninth edition, Reprint 2024.							
3.	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outline of Theory and							

	Problems of Probability and Statistics", Fourth edition, Tata McGraw-Hill, Reprint 2023.
4.	Gupta. S.C. and Kapoor. V. K., “Fundamentals of Statistics”, Eighth edition, Himalaya Publishing House, Mumbai, 2023.
5.	Kay. D. C., "Tensor Calculus”, Schaum's Outline Series, Tata McGraw Hill, Reprint 2022.
E resources/E materials:	
1.	https://nptel.ac.in/courses/110106062
2.	https://www.itl.nist.gov/div898/handbook/
3.	https://math.haifa.ac.il/ROVENSKI/rovenski/S_TC.pdf

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	1	3	1	-
CO2	2	-	1	3	1	-
CO3	2	-	1	3	1	-
CO4	2	-	1	3	1	-
CO5	2	-	1	3	1	-
CO	**2**	**-**	**1**	**3**	**1**	**-**

SE26101	**THEORY OF ELASTICITY AND PLASTICITY**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	4,9,11 ,12
COURSE OBJECTIVES:								
• To develop a comprehensive understanding of elasticity, torsion, beams on elastic foundations, and plasticity for analyzing stress–strain behavior and structural response in engineering materials and components.								
COURSE CONTENT:								
Unit 1	**Elasticity**	**9**	**0**	**0**	**9**	**18**		**4,9**
Analysis of stress and strain, Equilibrium Equations - Stress Strain Relationship - Generalized Hooke’s law, Compatibility Equations: Beltrami Michell Equation - Navier’s Equation, Case								

Study: Stress Analysis of an Underground Tunnel.
Activity: Group discussion on ''Why compatibility equations are necessary''

Unit 2	**2D Stress Strain Problems**	**9**	**0**	**0**	**9**	**18**		**9,11**

Plane stress and plane strain - Formulation- Boundary condition - examples - polynomials - Direct method of determining Airy's stress functions - solution of Biharmonic equation - -bending of cantilever loaded at end - Simple two dimensional problems in Cartesian and Polar Co- ordinates
Activity: Plane stress/strain modelling in software (ANSYS/Staad).

Unit 3	**Torsion of Non-Circular Section**	**9**	**0**	**0**	**9**	**18**		**9,12**

St.Venant's approach - Prandtl's approach – Membrane analogy - Torsion of thin rectangular section and hollow thin-walled sections: open, closed and multicellular section, Torsion of non-circular sections (Ellipse, triangle and rectangle)- Case study on Torsion in a rectangular reinforced concrete beam.
Activity: Case studies on ''Failure of shafts and beams under torsion''

Unit 4	**Beams on Elastic Foundations**	**9**	**0**	**0**	**9**	**18**		**9,12**

Beams on Elastic foundation – Methods of analysis – Elastic line method – Idealization of soil medium – Winkler model – Infinite beams and Semi-infinite subjected to point load, UDL and moment – Solution by Finite Differences, Boundary conditions - Applications to elasticity problems.
Activity: Problem Solving Assignment

Unit 5	**Plasticity**	**9**	**0**	**0**	**9**	**18**		**4,9,11**

Physical assumptions – Yield criteria – Failure theories – Applications of thick cylinder – Plastic stress strain relationship. Elasto-Plastic problems in bending and torsion. Case study: Burst failure in thick-walled pressure vessels.
Activity: Quiz on Failure theories and yield criteria

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Apply the fundamental concepts of 3D stress, strain, equilibrium, compatibility, and generalized Hooke's law to analyze elastic behavior of materials.
CO2: Solve plane stress and plane strain problems using Airy's stress function and apply 2D elasticity principles in Cartesian and polar coordinates.
CO3: Analyze torsional behavior of circular, thin-walled, and non-circular sections using St. Venant's and Prandtl's approaches.
CO4: Analyze beams resting on elastic foundations using Winkler idealization, elastic line theory, and finite difference methods for real engineering applications.
CO5: Apply plasticity principles, including yield criteria, plastic stress–strain relationships, and elasto-plastic bending and torsion to practical structural problems.

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

Assessment Methodology: Activity (30%) & Internal Examinations (70%)	
REFERENCES:	
1.	Jane Helena H, "Theory of Elasticity and Plasticity", PHI Learning Pvt. Ltd., 2017.
2.	Chakrabarty J., "Theory of Plasticity", Elsevier Butterworth-Heinemann, Oxford, 2022.
3.	Ansel C. Ugural and Saul K. Fenster, Advanced Mechanics of Materials and Applied Elasticity, Sixth Edition, Pearson, 2023.
4.	Stephen P. Timoshenko and J. N. Goodier, "Theory of Elasticity", McGraw Hill Education, New york, 2021.
5.	Martin H. Sadd, "Elasticity: Theory, Applications and Numerics", Academic Press, 2022.
6.	T. G. Sitharam and L. Govindaraju, 'Theory of Elasticity', Springer Singapore Pvt. Limited, 2021.
E resources/E materials:	
1.	NPTEL - Theory of Elasticity, By Prof. Amit Shaw, Prof. Biswanath Banerjee, IIT Kharagpur. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-ce45/
2.	NPTEL – Applied Elasticity for Engineers, By Dr. L. Govindaraju, Dr. T.G. Sitharam IISc Bangalore. https://archive.nptel.ac.in/courses/105/105/105105217/#
3.	NPTEL – Course name: Advanced Foundation Engineering, Topic: Beams on Elastic Foundation, Dr. Kousik Deb, IIT Kharagpur, https://archive.nptel.ac.in/content/storage2/courses/105106049/lecnotes/mainch11.html

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	1	-	-
CO2	1	-	-	1	-	-
CO3	2	-	-	3	-	2
CO4	2	-	-	3	-	-
CO5	-	-	2	2	-	-
CO	**2**	**-**	**2**	**2**	**-**	**2**

SE26102	ADVANCED CONCRETE STRUCTURES	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	4,9,11,12

COURSE OBJECTIVES:

- To analyze and design reinforced concrete elements considering strength, serviceability, and ductility requirements.

COURSE CONTENT:

Unit 1	Design of Reinforced Concrete Members	9	0	0	9	18		4,9

Properties and behaviour of concrete and steel - Review of limit state of collapse–limit state of serviceability - behaviour and design of flanged beams - Calculation of deflection and crack width according to IS Code.
Activity: Group discussion on limit state of collapse and serviceability

Unit 2	Design of Special RC Elements	9	0	0	9	18		9,11

Design of slender columns - Design of plain concrete and RC walls. Strut and tie method of analysis for corbels and deep beams - Design of corbels, design of simply supported and continuous deep beams and grid floors.
Activity: Case studies on failure of deep beams

Unit 3	Flat Slabs and Yield Line Based Design	9	0	0	9	18		9,12

Design of flat slabs according to IS method - Design of spandrel beams - Yield line theory and design of slabs – rectangular, circular and square slabs – virtual work method and equilibrium method - Hillerborg's strip method of design of slabs.
Activity: Problem solving assignment

Unit 4	Inelastic Behaviour of Concrete Beams	9	0	0	9	18		9,12

Inelastic behaviour of reinforced concrete beams –stress strain characteristics of concrete and steel – Moment curvature relations - Baker's method for plastic analysis of beams -Moment Redistribution.
Activity: Quiz on inelastic behaviour of concrete structures

Unit 5	Ductile Detailing	9	0	0	9	18		4,9,11

Concept of Ductility –factors that increase ductility –Ductile detailing for design of beams, columns and frame members with axial load and moment as per IS13920: 2016 - Design of cast-

in-situ joints.
Activity: Seminar on ductile detailing of RC members

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Apply limit state design to reinforced concrete beams for strength and serviceability as per IS 456.
CO2: Design special reinforced concrete elements such as slender column, walls, corbels, deep beams, and grid floors.
CO3: Apply yield line theory, strip method and IS methods for design of slabs and flat slabs.
CO4: Execute inelastic analysis and moment redistribution in reinforced concrete beams.
CO5: Integrate ductile detailing principles in reinforced concrete members as per IS 13920.

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

Assessment Methodology: Internal Examinations (70%), Activity (30%)

REFERENCES:

1.	Varghese, P. C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2020.
2.	Unni Krishnan Pillai and Devdas Menon, "Reinforced Concrete Design", Fourth edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2021.
3.	Gambhir. M. L., "Design of Reinforced Concrete Structures", Prentice Hall ofIndia, 2012 (Reprint 2024).
4.	IS 13920:2016(Reaffirmed 2021), "Ductile Design and Detailing of Reinforced Concrete Structures subjected to Seismic Forces", Bureau of Indian Standard, New Delhi.
5.	IS 456:2000 (Reaffirmed 2021 with latest Amendment No. 6, 2024), "Plain and Reinforced Concrete - Code of Practice".
6.	SP 16:1980, Design Aids for Reinforced Concrete to IS456, Bureau of Indian Standard, New Delhi, Eleventh Reprint, 1999.

E resources/E materials:

1.	NPTEL, Advanced Reinforced Concrete Design, Prof. S. Suriya Prakash, IIT Hyderabad, https://onlinecourses.nptel.ac.in/noc23_ce109
2.	https://content.kopykitab.com/ebooks/2016/06/7419/sample/sample_7419.pdf

3.	https://api.pageplace.de/preview/DT0400.9781683929062_A49425217/preview-9781683929062_A49425217.pdf

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	-
CO2	3	-	3	3	-	2
CO3	3	-	3	3	-	2
CO4	3	-	3	3	-	2
CO5	3	-	3	3	-	2
CO	**3**	**-**	**3**	**3**	**-**	**2**

SE26103	STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING	L	T	P	TW/SL	Total	C	SDG
		45	0	30	60	120	4	9,11, 12,13

COURSE OBJECTIVES:

- To introduce the principles and methods of dynamic analysis of structures under earthquake and other dynamic loads.
- To equip students with the capability to formulate mathematical models of SDOF, MDOF and continuous systems.
- To enable students to evaluate structural response using analytical and numerical methods.
- To provide an understanding of engineering seismology, earthquake characteristics, and codal provisions.
- To prepare students for the earthquake-resistant design of masonry and reinforced concrete structures.

COURSE CONTENT:

Unit 1	Principles of Vibration Analysis	9	0	3	12	24		9,11

Mathematical models of single-degree-of-freedom systems – Free and forced vibration – Response to harmonic, periodic and impulsive loading – Damping and evaluation of damping – Transmissibility – Vibration control – Tuned Mass Dampers.
Activity: Compute free and forced vibration response of an SDOF system (with/without damping) using analytical and numerical methods.

Unit 2	Dynamic Response of Multi-Degree of Freedom Systems	9	0	3	12	24		9,11

Mathematical models of two-degree and multi-degree-of-freedom systems – Free and forced vibration – Normal modes – Orthogonality of modes – Mode superposition technique – Applications in dynamic analysis.
Activity: Determine natural frequencies, mode shapes, and modal participation factors of a 2-DOF and MDOF system using Python Coding/Excel.

Unit 3	**Dynamic Response of Continuous Systems**	**9**	**0**	**3**	**12**	**24**		**9,13**

Continuous system modeling – Free and forced vibration of beams and shafts – Rayleigh–Ritz method using energy principles – Generalized SDOF system – Step-by-step integration methods (Newmark, Wilson-θ) – Applications in seismic response of SDOF/MDOF systems – Case studies using Indian earthquakes.
Activity: Perform step-by-step numerical integration of a SDOF/MDOF system subjected to a real Indian ground motion record using Prism software/Excel.

Unit 4	**Introduction to Earthquake Engineering**	**9**	**0**	**3**	**12**	**24**		**12,13**

Engineering seismology – Seismo tectonics and seismic zoning of India – Earthquake monitoring and instrumentation – Strong ground motion characteristics – Estimation of earthquake parameters – Microzonation – Effects on structures – Lessons from past earthquakes – Response spectra and design spectra – Codal evaluation of earthquake forces.
Activity: Construct design response spectra using IS 1893:2025 and compare with recorded ground motion spectra.

Unit 5	**Earthquake Resistant Design of Masonry and RC Structures**	**9**	**0**	**3**	**12**	**24**		**9,11, 13**

Structural systems – Types of buildings – Causes of structural damage – Planning and architectural considerations – Material behavior under earthquakes – Philosophy and principles of earthquake-resistant design – Codal guidelines – Masonry and RC building design – Shear walls – Rigid frames – Lateral load analysis – Capacity-based design and detailing.
Activity: Perform lateral load analysis of a RC frame building and prepare a capacity-based design detailing sheet.

List of Experiments:

1. Calculation damping ratio and natural frequency of a SDOF system for the data given from the free as well as forced vibration.
2. Calculation of dynamic response of a SDOF subjected periodic load using Fourier series concept and rectangular pulse load using Duhamel's integral concept.
3. Calculation of linear and nonlinear seismic response of SDOF systems using numerical algorithms in Excel and comparison with Prism software.
4. Construction of elastic and inelastic response spectra for Indian earthquakes using Prism software.
5. Use of Python Coding for calculating natural frequencies, mode shapes, base shear, base moment and roof displacement of MDOF systems.

6. Response spectrum analysis of systems with distributed mass and stiffness.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Compute the response of single-degree-of-freedom systems under free and forced vibrations with and without damping.
CO2: Evaluate natural frequencies, mode shapes, and dynamic response of multi-degree-of-freedom systems using modal analysis.
CO3: Perform dynamic analysis of continuous systems using energy methods and numerical integration techniques.
CO4: Interpret seismic data and response spectra to assess earthquake effects on structures as per codal provisions.
CO5: Design earthquake-resistant masonry and RC structures using codal guidelines and capacity-based principles.

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

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Anil K. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Pearson Education, Sixth edition, 2025.
2.	Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill, 1986, IOS Press, Second edition (reprint) 2019.
3.	Mario Pazv and William Leigh, Structural Dynamics: Theory and Computation, Springer; Sixth edition, 2019.
4.	Chopra, A.K., "Dynamics of Structures: Theory and Applications to Earthquake Engineering", Fifth Edition, Pearson Education, 2020.
5.	Brebbia C. A., ''Earthquake Resistant Engineering Structures XIV", WIT Press, 2025.

E resources/E materials:

1.	NPTEL, NOC: Dynamics of Structures, Manish Kumar, IIT Bombay, https://archive.nptel.ac.in/courses/105/106/105106151/
2.	NPTEL, NOC: Dynamics of Structures, P. Banerji, IIT Bombay, https://archive.nptel.ac.in/courses/105/101/105101006/

3.	NPTEL, Introduction to Earthquake Engineering, R.S. Jangid, IIT Bombay, https://archive.nptel.ac.in/courses/105/101/105101004/

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	2	3	1
CO2	1	-	3	2	1	1
CO3	2	-	3	2	3	2
CO4	3	-	3	3	-	2
CO5	2	-	3	2	3	2
CO	**2**	**-**	**3**	**2**	**2**	**2**

RM26C01	**RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	15	0	60	120	4	1,2,3, 7

COURSE OBJECTIVES:

- To understand modern research processes, ethics, and data-driven decision making.
- To familiarize students with research design, data collection, and analysis methods.
- To develop skills in technical writing, publication, and presentation.
- To create awareness on Intellectual Property Rights and patent systems.
- To introduce contemporary research tools and innovation protection mechanisms.

COURSE CONTENT:

Unit 1	**Research Design and Modern Research Approaches**	**9**	**3**	**0**	**12**	**24**		**1**

Research ecosystem and lifecycle, types of research, problem identification, literature gap analysis, research questions and hypotheses, AI-assisted literature review tools, research design frameworks, qualitative and quantitative research, experimental and survey methods, research ethics and plagiarism awareness.
Activity: Literature gap identification, ethics discussion.

Unit 2	**Data Collection, Sources and Preparation**	**9**	**3**	**0**	**12**	**24**		**3**

Primary and secondary data sources, digital and open datasets, measurement scales, questionnaire design, sampling techniques, sample size estimation, data preprocessing, cleaning, transformation, and basic data visualization.

Activity: Questionnaire design, data visualization exercise.

Unit 3	**Data Analysis, Interpretation and Scientific Communication**	**9**	**3**	**0**	**12**	**24**		**2**

Descriptive and inferential statistics, hypothesis testing, correlation and regression basics, introduction to multivariate analysis, use of analytical tools (Excel/SPSS/Python – overview), interpretation of results, technical report writing, journal and conference paper formats (IEEE/IET), presentation techniques.
Activity: Data analysis demo, paper formatting.

Unit 4	**Intellectual Property Rights and Innovation Ecosystem**	**9**	**3**	**0**	**12**	**24**		**7**

Concept, meaning, and significance of Intellectual Property Rights (IPR); types of IPR including patents, copyrights, trademarks, industrial designs, and geographical indications; role of IPR in innovation, research, and economic development; overview of national IPR framework with reference to Indian Patent Office and international agreements under World Intellectual Property Organization; importance of IPR in academia, industry, and technology-driven entrepreneurship.
Activity: IPR case study.

Unit 5	**Patents and Technology Protection**	**9**	**3**	**0**	**12**	**24**		**2,7**

Patent concepts and objectives, patentability criteria, novelty and inventive step, patent specifications, prior art search, types of patent applications, patent filing process, examination and grant, licensing and technology valuation, career opportunities in patent and innovation management.
Activity: Patent search exercise.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Apply suitable research methodologies to formulate research problems.
CO2: Design data collection instruments and choose appropriate sampling methods.
CO3: Analyze and interpret research data using basic analytical tools.
CO4: Apply appropriate IP strategies for safeguarding innovations and research outputs..
CO5: Apply principles of IPR, patents, and ethical research practices in research and innovation activities.

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

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Pamela S. Schindler, ‘’Business Research Methods’’, Fourteenth Edition, McGraw Hill, 2025.
2.	Deborah E. Bouchoux, ‘’Intellectual Property: Patents, Trademarks, Copyrights and Trade Secrets’’, Fifth Edition, Cengage Learning, 2021.
3.	David Hitchcock , ‘’Patent Searching Made Easy’’, Second Edition, Routledge, 2020.
4.	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald , ‘’The Craft of Research, Fifth Edition’’, University of Chicago Press, 2024.
5.	V.K. Ahuja, ‘’Intellectual Property Rights: Law and Practice’’, Third Edition, LexisNexis, 2022.
E resources/E materials:	
1.	WIPO IP Portal – Online learning modules on Intellectual Property Rights and patents. (https://www.wipo.int/academy)
2.	Google Scholar – Scholarly literature search and citation tracking platform. (https://scholar.google.com)
3.	Indian Patent Office (IPO) Website – Patent search, filing procedures, and legal guidelines. (https://ipindia.gov.in)

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	1	1
CO2	3	3	3	2	2	1
CO3	3	3	2	3	3	1
CO4	2	2	3	2	2	3
CO5	2	2	2	2	1	3
CO	**3**	**3**	**2**	**2**	**2**	**2**

RM26C02	RESEARCH TOOLS LABORATORY	L	T	P	TW/SL	Total	C	SDG
		0	0	60	0	60	2	4,9,16, 17

COURSE OBJECTIVES:

- To provide hands-on training in modern research and project management tools.
- To develop skills in literature review, reference management, and plagiarism checking.
- To train students in research paper formatting, writing, and publication workflow.
- To introduce data analysis and visualization tools for research applications.
- To enable preparation of professional research reports and technical presentations.

LIST OF ACTIVITY:

1. Research Planning and Project Management
    - 1.1 Research lifecycle, milestones, and project planning
    - 1.2 Gantt chart preparation using MS Project / Notion / OneNote

2. Literature Review and Reference Management
    - 2.1 Advanced literature search using Google Scholar / Scopus
    - 2.2 Reference management using Mendeley / Zotero

3. Research Problem Identification
    - 3.1 Literature gap analysis, AI-assisted literature gap analysis
    - 3.2 Research problem, objectives, and hypothesis formulation

4. Research Paper Formatting
    - 4.1 IEEE / IET journal and conference templates
    - 4.2 Professional writing using Overleaf , Grammarly

5. Publication Workflow
    - 5.1 Journal selection using Elsevier Journal Finder
    - 5.2 Peer review process and reviewer response simulation

6. Data Analysis – Basic Tools
    - 6.1 Data entry, cleaning, and preprocessing
    - 6.2 Descriptive statistics and graphical visualization

7. Data Analysis – Advanced Tools
    - 7.1 Introduction to SPSS / MATLAB for research analysis
    - 7.2 Interpretation of results and inference

8. Plagiarism Detection and Research Ethics
    - 8.1 Plagiarism checking using Turnitin / Urkund
    - 8.2 Ethical paraphrasing and citation practices

9. Referencing and Citation Standards
    - 9.1 IEEE, APA referencing styles
    - 9.2 Automated citation generation and consistency check

10. AI in Research and Automation

10.1 AI tools for research assistance, ChatGPT ,Perplexity AI -Automated summarization, idea generation

10.2 Ethical use of AI in research

COURSE OUTCOMES:

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

CO1: Plan and manage research activities using modern research tools.
CO2: Conduct systematic literature review and manage references effectively.
CO3: Analyze and interpret research data using suitable software tools.
CO4: Prepare plagiarism-free research papers and technical reports.
CO5: Present research findings professionally through reports and presentations.

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

Assessment Methodology: Evaluation of Student's work, Observation, Record, Activities etc.(75%), Model Practical Exam (25%)

REFERENCES:

1.	Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, Joseph Bizup, William T. FitzGerald , "The Craft of Research", Fifth Edition, University of Chicago Press, 2024.
2.	John W. Creswell, J. David Creswell, "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches", Fifth Edition, SAGE Publications, 2023.
3.	Mark N. K. Saunders, Philip Lewis, Adrian Thornhill, "Research Methods for Business Students" , Ninth Edition, Pearson Education, 2023.
4.	Herman Aguinis, "Research Methodology: Best Practices for Rigorous, Credible, and Impactful Research", SAGE Publications, 2025.
5.	Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Third Edition, 2025

E resources/E materials:

1.	Reference organization, citation generation, PDF management https://www.mendeley.com
2.	Collaborative LaTeX writing for research papers https://www.overleaf.com
3.	Plagiarism detection and originality reports https://www.turnitin.com

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	3	1
CO2	2	3	2	3	3	1
CO3	3	3	2	3	3	1
CO4	2	2	3	2	2	3
CO5	2	2	2	2	2	2
CO	**2**	**2**	**2**	**2**	**3**	**2**

SE26104	**ADVANCED STRUCTURAL ENGINEERING AND EXPERIMENTAL TECHNIQUES LABORATORY**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		0	0	60	0	60	2	4,7,9,11,12,13

COURSE OBJECTIVES:

- To introduce standard concrete mix design methods and their application to fresh and hardened concrete properties.
- To understand the flow behavior of self-compacting concrete and factors affecting its performance.
- To study the influence of mineral and chemical admixtures on concrete strength, workability, and durability.
- To familiarize students with non-destructive testing techniques for assessing hardened concrete.
- To develop skills in analyzing and interpreting experimental data from various material and structural tests

LIST OF EXPERIMENTS

1. Mix design of concrete as per IS, ACI & BS methods for high performance concrete.
2. Mix design of concrete as per ACI & BS methods for high performance concrete.
3. Flow Characteristics of Self Compacting concrete.
4. Effect of minerals and chemical admixtures in concrete at fresh and hardened state with relevance to workability, strength and durability.
5. NDT on hardened concrete - UPV
6. NDT on hardened concrete - Rebound hammer test.
7. NDT on hardened concrete - core test.
8. Permeability test on hardened concrete– Demonstration.
9. Ultrasonic interferometer – ultrasonic velocity in liquids.
10. Electrical conductivity of metals and alloys with temperature-four probe method.
11. Deflection test on RCC Beam with two points loading.
12. Compression test on RCC column.

LIST OF EQUIPMENTS

- Strong Floor
- Loading Frame
- Hydraulic Jack
- Load Cell
- Proving Ring
- Demec Gauge
- Rebound Hammer
- Ultrasonic Pulse Velocity Tester
- Dial Gauges
- Four probe apparatus
- Compression testing machine
- L box apparatus
- J box apparatus
- LVDT

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Design concrete mix which will satisfy the fresh and hardened concrete properties
CO2: Use the experimental methods to find the material properties.
CO3: Apply suitable non-destructive testing for checking the strength of concrete.
CO4: Apply the analytical techniques and graphical analysis to interpret the experimental data
CO5: Evaluate the effect of mineral admixtures in fresh and hardened concrete property

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

Assessment Methodology: Observation and Record (50%) &Model Examinations (50%)

REFERENCES:

1.	Sanjivkumar Harinkhede, Komal Bedi, Trushna D. Patle, Abdul Ghaffar, Syed Aamir Hussain, "Concrete Technology: Fundamentals to Future Applications", RK Publication, 2025.
2.	Gambhir, M.L, "Concrete Technology", Third Edition, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2025.
3.	"1S10262-2019: Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standards, New Delhi, 2019.
4.	"ACI 211.1:2022 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete", 2022.

5.	Shetty M.S., "Concrete Technology", Revised Edition, S.Chand and Company Ltd. Delhi, 2025.
6.	Dally J W, and Riley W F, "Experimental Stress Analysis", McGraw-Hill Inc. New York,2000.
E resources/E materials:	
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/

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	-	2
CO2	3	-	2	-	2	2
CO3	1	2	2	2	3	2
CO4	3	3	2	2	-	2
CO5	2	1	2	2	2	2
CO	**2**	**2**	**2**	**2**	**2**	**2**

SE26105	**TECHNICAL SEMINAR**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		0	0	30	0	30	1	4,8,9,13,17

COURSE OBJECTIVES:

- To work on a specific technical topic in Structural Engineering in order to acquire the
- skills of oral presentation and to acquire technical writing abilities for seminars and conferences

COURSE CONTENT

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Structural Engineering and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as

audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.
COURSE OUTCOMES:
At the end of the course, the students will be able to: CO1: Identify latest developments in the field of Structural Engineering CO2: Develop technical writing abilities for seminars, conferences and journal publications CO3: Make use of modern tools to present the technical details
Weightage: Continuous Assessment: 100%, End Semester Examinations: 0%
Assessment Methodology: Internal Examinations (70%), Activity (30%)

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	-	-	3
CO2	-	3	1	-	-	3
CO3	-	-	1	-	-	3
CO	**3**	**3**	**2**	**-**	**-**	**3**

SEMESTER II

SE26201	**ADVANCED STEEL STRUCTURES**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	9,11, 12
COURSE OBJECTIVES:								
• To study the behaviour of members and connections, analysis and design of Industrial buildings and roofs, chimneys. Study the design of with cold formed steel and plastic analysis of structures.								
COURSE CONTENT:								
Unit 1	**Design Philosophies, Codes, and Structural Systems**	**9**	**0**	**0**	**9**	**18**		**9,11**

Design Philosophies and Design Codes (IS, EC, AISC), Failure Criteria for Steel-Structural Configurations- Functional and Serviceability Requirements, Estimation of wind load as IS code. Global StabilityCriteria, Beam, Columns and Frames (Sway and Non-Sway)
Activity: Group discussion on structural system and design philosophies

Unit 2	**Design of Connections**	**9**	**0**	**0**	**9**	**18**		**9,12**

Types of connections – Welded and Bolted – Throat and Root Stresses in Fillet Welds – Column splices-Tension Splices -- Seated Connections – Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections HSFG bolted connections.
Activity: Develop models of types of connections

Unit 3	**Analysis and Design of Industrial Buildings**	**9**	**0**	**0**	**9**	**18**		**9,11**

Analysis and design of industrialbuildings- Selection of bay width - Structural framing - Knee bracing of columns- Design of purlins, girts, rafter, tie runner, side runner, eaves strut and truss members - Design of vierendeel girder.
Activity: Quiz on industrial structural elements

Unit 4	**Plastic Analysis of Structures**	**9**	**0**	**0**	**9**	**18**		**9**

Introduction, Shape factor, Moment redistribution, Combined mechanisms, Analysis of portal frames, Effect of axial force-Effect of shear force on plastic moment, Connections–Requirement-Moment resisting connections. Design of Straight Corner Connections – Hunched Connections-Design of continuous beams.
Activity: Problem solving assignment

Unit 5	**Design of Light Gauge Steel Structures**	**9**	**0**	**0**	**9**	**18**		**9,12**

Introduction to Direct Strength Method - Cold formed light gauge section –Applications-Type of cross sections - stiffened - multiple stiffened and unstiffened element. - Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members – Wall Studs.
Activity: Case study on cold-formed steel buildings

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Utilize relevant design philosophies and provisions from codes to analyze wind loads, stability criteria, and design basic steel members and frames.
CO2: Apply principles of design to develop different types of steel connections and joints.
CO3: Apply structural analysis and design procedures to industrial steel buildings, including selection and design of framing components such as purlins, rafters, and truss members.

CO4: Use plastic analysis principles to industrial and light gauge steel structures for the design of structural elements under various loading conditions. **CO5**: Assess and design composite and cold formed steel structural elements using concepts such as effective width, direct strength method, and composite action.	
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Internal Examinations (70%), Activities (30%)	
REFERENCES::	
1.	Subramanian.N, "Design of Steel Structures", Oxford University Press, 2019.
2.	Duggal, "Design of Steel Structures", Tata McGraw-Hill Education, 2019.
3.	Srinivasan Chandrasekaran, "Advanced steel design of structures", CRC Press, Florida, 2019.
5.	Yu, W. W., "Design of cold-formed steel structures", McGraw Hill, 2019.
6.	"IS: 800 - 2007 - Indian Standard Code of Practice for general construction in steel (Limit State)''.
7.	''IS: 875 (Part I to V) - Code of Practice for Design loads".
8.	"IS: 801 - 1975(Reaffirmed 2010) - Code of practice for use of cold formed light gauge steel structural members in general building construction".
9.	"IS: 811 – 1987(Reaffirmed 2004) - Cold formed light gauge structural steel sections".
10.	"SP: 6(l) -1964 (Reaffirmed 2003)-Handbook on Structural Steel Section".
E resources/E materials:	
1.	Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing,2000
2.	https://onlinecourses.nptel.ac.in/noc22_oe02/preview

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	2	-
CO2	2	2	2	3	2	-
CO3	3	2	3	3	3	2
CO4	3	-	3	2	2	-
CO5	3	2	3	2	3	2
CO	**3**	**2**	**3**	**2**	**2**	**2**

SE26202	STABILITY OF STRUCTURES	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	9, 11

COURSE OBJECTIVES:

- To develop the ability to apply stability theories and analytical methods in assessing the buckling response of structural components under different support and loading conditions.

COURSE CONTENT:

Unit 1	Buckling Of Columns	9	0	0	9	18		9, 11

States of equilibrium and stability concepts - Classification of buckling problems - Basic approaches to stability analysis: equilibrium and energy methods - Governing equation for column buckling - Critical load of columns for standard boundary conditions (simply supported, fixed, cantilever) using: Equilibrium method, Energy method - Introduction to approximate methods: Rayleigh–Ritz method, basic concept only - Effect of shear deformation on buckling, overview

Activity: Model preparation of column buckling for different end conditions.

Unit 2	Buckling of Beam-Columns and Frames	9	0	0	9	18		9

Theory of beam–columns - Stability analysis of beam–columns subjected to single and multiple concentrated loads, uniformly distributed load, and end moments. Analysis of rigid jointed frames with and without sway-Introduction to stability functions and determination of critical load.

Activity: Group discussion on the stability behavior of beam columns and rigid frames under different loading conditions.

Unit 3	Torsional and Lateral Buckling	9	0	0	9	18		9

Torsional buckling of columns - Combined flexural–torsional buckling - Local buckling and buckling of open sections - Introduction to numerical solutions - Lateral buckling of beams under pure bending for simply supported and cantilever beams - St. Venant torsion and non-uniform torsion - Introduction to Rayleigh–Ritz method for flexural–torsional buckling of columns.
Activity: Seminar on torsional and lateral buckling behavior of structural members.

Unit 4	**Buckling of Plates And Shell**	**9**	**0**	**0**	**9**	**18**		**9**

Governing differential equation for plate buckling. Buckling behaviour of thin plates with different edge conditions. Analysis by equilibrium and energy methods. Finite difference method for plate analysis. Fundamentals of shell buckling including Donnell's equation and finite deflection theory.
Activity: Chart preparation on plate and shell buckling behavior under different edge conditions.

Unit 5	**Inelastic Buckling**	**9**	**0**	**0**	**9**	**18**		**9, 11**

Double modulus theory and tangent modulus theory. Shanley's model. Inelastic buckling of columns including eccentrically loaded columns. Inelastic buckling and post-buckling behavior of plates. Basic concepts of linear and nonlinear eigenvalue problems in inelastic stability.
Activity: Seminar on elastic and inelastic buckling behavior of structural elements.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Apply stability concepts to analyze the buckling behavior of structural members and systems.
CO2: Compute the critical loads of columns, beam–columns, and frames under different boundary conditions.
CO3: Implement analytical and numerical techniques to evaluate torsional and lateral buckling behavior.
CO4: Solve stability problems of plates and shells using equilibrium and energy methods.
CO5: Assess inelastic buckling theories to evaluate the stability performance of structural elements.

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

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	C. Ganapathy, "Stability of Structures", Eswar Press, 2023
2.	Anders Eriksson, Arne Nord mark, "Structural Stability and its Computational Modelling", Springer Nature, 2024.

3.	Shamsher Bahadur Singh, Sudhir Kumar V. Barai, "Stability and Failure of High Performance Composite Structures", Springer Nature, 2022
4.	Sukhvarsh Jerath, "Structural Stability Theory and Practice: Buckling of Columns, Beams, Plates, and Shells", John Wiley & Sons, 2021.
5.	Christian Mittelstedt, "Buckling of Beams, Plates and Shells", Kine Edition, 2024.
esources/E materials:	
1.	NPTEL - https://nptel.ac.in/courses/105104693
2.	NPTEL - https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ce91

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	1	3	-	-
CO2	3	2	3	3	1	-
CO3	3	3	3	3	1	-
CO4	3	1	3	3	2	-
CO5	3	1	1	3	3	3
CO	**3**	**2**	**2**	**3**	**2**	**3**

SE26203	**PRESTRESSED CONCRETE STRUCTURES**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	4,9,11,12,17
COURSE OBJECTIVES:								
• To study the principle of prestressing, analysis and design of prestressed concrete Structures								
COURSE CONTENT:								
Unit 1	**Principles of Prestressing**	**9**	**0**	**0**	**9**	**18**		**4,9**
Basic concepts of Prestressing – Types and systems of prestressing – Constituent materials and their properties, Analysis methods, losses of prestress – Statistical Evaluation of Losses- Short and Long term deflections – Cable layouts – Camber								

Activity: Prepare report on 6 major losses (Creep, Shrinkage, etc.) and rank them from "Happens Instantly" to "Takes 50 Years."								
Unit 2	**Design of Flexural Members**	**9**	**0**	**0**	**9**	**18**		**9,12**
Behaviour of flexural members, determination of ultimate flexural strength – Various Codal provisions – Design of flexural members, Design for shear, bond and torsion. Transfer of prestress – Design of end blocks- Strut-and-Tie Method (STM) for End Zones **Activity:** Quiz on Codal provisions.								
Unit 3	**Design of Continuous Beams**	**9**	**0**	**0**	**9**	**18**		**9,12**
Analysis and design of continuous beams – Methods of achieving continuity – concept of linear transformations, concordant cable profile and gap cables- Concept of primary/secondary moments and shifting the cable profile (Linear Transformation). **Activity:** Analyze a beam using Software computing tool.								
Unit 4	**Design of Tension and Compression Members**	**9**	**0**	**0**	**9**	**18**		**9,12**
Design of tension members – application in the design of prestressed pipes and prestressed concrete cylindrical water tanks – Design of compression members with and without flexure – its application in the design piles, flag masts and similar structures. **Activity:** Report submission on Field Visit								
Unit 5	**Design of Composite Members**	**9**	**0**	**0**	**9**	**18**		**4,9,11,17**
Composite beams – analysis and design, ultimate strength – their applications. Partial prestressing – its advantages and applications- Segmental Post-Tensioned Construction. **Activity:** Observation report on how tension holds segments together.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1**: Apply the principles of prestressing to analyze stress states and compute short-term and long-term losses using deterministic and statistical methods. **CO2**: Design prestressed concrete flexural members for strength and serviceability requirements, including the use of Strut-and-Tie Methods (STM) for anchorage zone safety. **CO3**: Analyze indeterminate prestressed structures to determine primary and secondary moments and optimize cable layouts through Linear Transformations.								

CO4: Apply prestressing design procedures to axial members, such as high-pressure pipes, liquid-retaining tanks, and slender piles under flexural-compression. **CO5**: Evaluate the structural performance of composite members and partial prestressing systems, while identifying the mechanical requirements for Segmental Construction.	
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Internal Assessment Test (70%), Activities (30%)	
REFERENCES:	
1.	Muthu, K. U., Janardhana, M., et al., "Prestressed Concrete", Second Edition, PHI Learning, 2022.
2.	Devdas Menon and Madhav Rao, S., "Prestressed Concrete", Second Edition, Tata McGraw-Hill, 2020.
3.	Naaman, A. E., "Prestressed Concrete Analysis and Design: Fundamentals", Fourth Edition, Techno Press 3000, 2023.
4.	Krishna Raju, N., "Prestressed Concrete", Sixth Edition (with 2012 code updates), Tata McGraw Hill, 2018 (Reprinted 2021).
5.	Nawy, E. G., "Prestressed Concrete: A Fundamental Approach", Sixth Edition, Pearson, 2023.
esources/E materials:	
1.	NPTEL - Advanced Prestressed Concrete Design, IIT Hyderabad, Prof. S. Suriya Prakash, https://nptel.ac.in/courses/105106686.
2.	NPTEL – Pre-stressed Concrete Structures, IIT Madras, Prof. Devdas Menon, Dr. Amlan Kumar Sengupta. https://nptel.ac.in/courses/105106117
3.	NPTEL –Pre-stressed Concrete Structures, IIT Madras, Prof. Devdas Menon, Dr. Amlan Kumar Sengupta, https://nptel.ac.in/courses/105106118

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	3	2	-
CO2	3	-	3	3	2	-
CO3	3	-	3	3	-	2

CO4	3	-	3	3	-	2
CO5	3	-	3	3	-	2
CO	**3**	**-**	**3**	**3**	**2**	**2**

SE26204	**FINITE ELEMENT ANALYSIS OF STRUCTURES**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	30	45	120	4	9,11, 12,13

COURSE OBJECTIVES:

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

COURSE CONTENT:

Unit 1	**Introduction**	**9**	**0**	**3**	**12**	**24**		**9**

Introduction - Basic Concepts of Finite Element Analysis - Introduction to Elasticity- Steps in Finite Element Analysis - Finite Element Formulation Techniques - Virtual Work and Variational Principle-Galerkin Method-Finite Element Method: Displacement Approach-Stiffness Matrix and Boundary Conditions.
Activity: Quiz on 'Fundamentals of Finite Element Analysis and other approximate methods'.

Unit 2	**Element Properties**	**9**	**0**	**3**	**12**	**24**		**12**

Theory of beam–columns - Stability analysis of beam–columns subjected to single and multiple concentrated loads, uniformly distributed load, and end moments. Analysis of rigid jointed frames with and without sway-Introduction to stability functions and determination of critical load.
Activity: Group discussion on the stability behavior of beam columns and rigid frames under different loading conditions.

Unit 3	**Analysis of Frame Structures**	**9**	**0**	**3**	**12**	**24**		**9,11**

Torsional buckling of columns - Combined flexural–torsional buckling - Local buckling and buckling of open sections - Introduction to numerical solutions - Lateral buckling of beams under pure bending for simply supported and cantilever beams - St. Venant torsion and non-uniform torsion - Introduction to Rayleigh–Ritz method for flexural–torsional buckling of columns.
Activity: Seminar on torsional and lateral buckling behavior of structural members.

Unit 4	**Two and Three Dimensional Solids**	**9**	**0**	**3**	**12**	**24**		**9**

Governing differential equation for plate buckling. Buckling behaviour of thin plates with different edge conditions. Analysis by equilibrium and energy methods. Finite difference method for plate

analysis. Fundamentals of shell buckling including Donnell's equation and finite deflection theory.
Activity: Chart preparation on plate and shell buckling behavior under different edge conditions.

Unit 5	**Applications of FEM**	**9**	**0**	**3**	**12**	**24**		**11,13**

Double modulus theory and tangent modulus theory. Shanley's model. Inelastic buckling of columns including eccentrically loaded columns. Inelastic buckling and post-buckling behavior of plates. Basic concepts of linear and nonlinear eigenvalue problems in inelastic stability.
Activity: Seminar on elastic and inelastic buckling behavior of structural elements.

LIST OFEXPERIMENT

1. Dynamic analysis of frame using mathematical computational software.
2. Finite Element Analysis of 2D truss and 3D space trusses.
3. Finite Element Analysis of Continuous Beams and Rigidly Jointed Plane Frame.
4. Modelling and Finite Element Analysis of RC beams and slabs using ABQCUS software.
5. Stability analysis of structure using FEM.
6. Finite Element Analysis of a Retaining Wall.

COURSE OUTCOMES:

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

CO1: Formulate governing equations for structural problems by applying Variational principles and Galerkin's method to establish the fundamental displacement-based FEM framework.

CO2: Construct shape functions and stiffness matrices for axial and truss members using natural coordinate systems and Isoparametric formulations.

CO3: Analyze the behavior of complex skeletal systems, including grids and space frames, by synthesizing global stiffness matrices and applying boundary conditions.

CO4: Examine the stress and strain distributions in 2D and 3D solids (CST, LST, and Axisymmetric) by analyzing the effects of geometric nonlinearity and static condensation.

CO5: Assess the response of plates, shells, and skew structures under static and dynamic loading scenarios to predict elastic stability and structural performance.

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

Assessment Methodology: Internal Assessment Test (70%), Activities (30%)

REFERENCES:

1.	Jalaluddin, A., "Introduction to Finite Element Analysis", Second Edition, Anuradha Publications, Chennai, 2021.
2.	Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Fifth Edition, Cambridge University Press, 2022.

3.	C. Krishnamoorthy, “Finite Element Analysis :Theory and Programming”, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2017.
4.	Logan D. L., "A First Course in the Finite Element Method", Seventh Edition, Cengage Learning, 2022.
5.	Zienkiewicz, O.C., Taylor, R.L. and Zhu, J.Z., "The Finite Element Method: Its Basis and Fundamentals", Eighth Edition, Elsevier, 2024.
6.	Fagan, M. J., "Finite Element Analysis: Theory and Practice", Second Edition, Pearson Education (World Student Series), 2020.
E resources/E materials:	
1.	NPTEL - https://nptel.ac.in/courses/105104693
2.	NPTEL - https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ce91
3.	Buckling of plate and shell (https://www.sciencedirect.com/science/chapter/bookseries/abs/pii/B978044876409500023X)

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	3	1	-	1
CO2	1	-	3	1	-	1
CO3	1	3	3	2	1	3
CO4	1	3	3	2	1	3
CO5	3	3	3	3	3	3
CO	**1**	**3**	**3**	**2**	**2**	**2**

SE26205	**STRUCTURAL DESIGN STUDIO**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		60	0	0	-	60	2	4,9,11,12

COURSE OBJECTIVES:

- To design a structure using modern software tools available like ETABS, STAAD, STRAP, etc. and present it in the form of a complete detailed drawing.

COURSE CONTENT:

Analysis and Design of Concrete/ Steel Structures
Prepare a design basis report for a project. Develop a model of a structure such as residential building, Commercial buildings, Industrial buildings etc., for analysis. Calculate and apply the loads on the structure as per relevant standards. Analyze the structure. Design the structural elements and connections as per relevant standards. Check for safety and optimization. Prepare a detail structural drawing. Prepare the report. A detailed report on the work done shall be submitted by individual students in the form of a report and presentation.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Design framed structure subjected to combined forces.
CO2: Choose an appropriate method to analyze and design the structural elements and connections.
CO3: Analyze the structure for various loads and load combination according to the relevant IS Codes.
CO4: Determine the forces acting, design strength and failure stress in the structural elements.
CO5: Design and detail structures using computer software/tools and check the correctness using manual approximate methods.

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

Assessment Methodology: Project (40%), Practical (30%), Internal Examinations (30%)

REFERENCES:

1.	B. C. Punmia, A. K. Jain and A. K. Jain, "Design of Reinforced Concrete", Laxmi Publications, Tenth Edition, reprint 2025.
2.	S. K. Duggal, "Design of Steel Structures", Tata McGraw-Hill, Third Edition, 2023.
3.	IS 875 (Part 1–5):1987, (Reaffirmed 2018), "Code of Practice for Design Loads", Bureau of Indian Standard, New Delhi.
4.	IS 800:2007 (Reviewed/Reaffirmed 2022), "General Construction in Steel – Code of Practice", Bureau of Indian Standard, New Delhi.
5.	IS 13920:2016 (Reaffirmed 2021), "Ductile Design and Detailing of Reinforced Concrete Structures subjected to Seismic Forces", Bureau of Indian Standard, New Delhi.
6.	IS 456:2000 (Reaffirmed 2021 with latest Amendment No. 6, 2024), "Plain and Reinforced Concrete - Code of Practice".

7.	SP 16:1980, Design Aids for Reinforced Concrete to IS 456, Bureau of Indian Standard, New Delhi, Eleventh Reprint, 1999.
E resources/E materials:	
1.	https://docs.bentley.com/LiveContent/web/STAAD.Pro%20Help-v21/en/GUID-B41046F2-C88C-403F-BEE8-D3ABD47D4750.html
2.	https://uomustansiriyah.edu.iq/media/lectures/5/5_2023_04_19!10_18_41_PM.pdf
3.	https://images.autodesk.com/adsk/files/autocad_aca_user_guide_english.pdf

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	3	2	-
CO2	3	-	3	3	2	-
CO3	3	-	3	3	-	2
CO4	3	-	3	3	-	2
CO5	3	-	3	3	-	2
CO	**3**	**-**	**3**	**3**	**2**	**2**

PROFESSIONAL ELECTIVE I

SE26111	**ADVANCED CONCRETE TECHNOLOGY**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	9,11, 12,13

COURSE OBJECTIVES:

- To understand the properties and behavior of fresh and hardened concrete.
- To study the effects of creep, shrinkage, and microstructure on concrete performance.
- To learn durability aspects and causes of deterioration in concrete structures.
- To introduce sustainable and eco-friendly concrete materials and practices.
- To understand special concretes and modern construction techniques.

COURSE CONTENT:

Unit 1	**Properties of Fresh and Hardened Concrete**	**9**	**0**	**0**	**9**	**18**		**9,11**

Workability-Factors affecting workability- tests to measure workability, Compressive strength,

spilt tensile strength, flexural strength, modulus of elasticity-Test procedures effect of w/c ratio. **Activity:** Demonstration on Concrete Properties in the Laboratory.

Unit 2	**Creep and Shrinkage of Concrete**	**9**	**0**	**0**	**9**	**18**		**9,11**

Factors affecting creep – effects of concrete, Factors affecting shrinkage – Plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage –effects,Microstructure of concrete – ITZ, porosity, permeability - Rheology of concrete
Activity: Quiz on Shrinkage of Concrete.

Unit 3	**Durability of Concrete**	**9**	**0**	**0**	**9**	**18**		**11,12**

Permeability-Correction-Carbonation-Chloride Penetration-Sulphate attack–acid attack– Fire resistance – Frost damage – alkali silica reaction – Penetration test – Rebound hammer test – Ultra pulse velocity method, Pull out test.
Activity: Group Discussion on Durability of Concrete.

Unit 4	**Sustainable and Green Concrete**	**9**	**0**	**0**	**9**	**18**		**9,12,13**

Environmental impact of cement and concrete industry- Use of recycled aggregates, construction & demolition waste- Alkali-activated materials and geopolymer concrete - Carbon capture and utilization in concrete - Life Cycle Assessment (LCA) of concrete - IS/ASTM/EN standards for sustainable concrete.
Activity: Case study report on the feasibility of using Construction &Demolition waste in concrete for a sampleproject.

Unit 5	**Special Topic In Concrete Technology**	**9**	**0**	**0**	**9**	**18**		**9,11**

Special concrete: Self Compaction concrete-Fibre reinforced concrete-Ready mix concrete -Green concrete-lightweight concrete-Smart concrete – self-healing, piezoelectric, 3D printable concrete.
Special Process: Under water concreting-cold weather concrete-hot weather concreting mass concrete.
Activity: Demonstration on Self-Compacting Concrete Preparation and Workability Test.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Examine and evaluate the workability and strength properties of fresh and hardened concrete.
CO2: Analyze the effects of creep and shrinkage on the deformation behavior of concrete.
CO3: Assess durability principles to identify and assess deterioration in concrete.
CO4: Implement sustainable materials and practices in concrete construction.
CO5: Apply knowledge of special concretes and techniques in practical construction situations.

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

Assessment Methodology: Internal Examinations (70%), Activity (30%)

REFERENCES:	
1.	M. S. Shetty & Manish Mokal, "Concrete Technology Theory And Practice", Ninth Edition, 2025.
2.	Gambhir. M.L., "Concrete Technology: Theory and Practice" , Sixth Edition, McGraw Hill Education ,2025.
3.	A. M. Neville, "Properties of Concrete", Fifth Edition (Reprint), 2022.
4.	P.E. Steven Kosmatka, Gerald Neville, "Concrete Manual: Concrete Quality and Field Practices", IBC and ACI 318-19, 2021.
5.	Qiang Yuan, Caijun Shi, Dengwu Jiao, "Advanced Concrete Technology", Reprint, 2022.
6.	Mehta, P. K., & Monteiro, P. J. M., "Concrete: Microstructure, Properties, and Materials", Fourth Edition, 2014.
E resources/E materials:	
1.	NPTEL – Concrete Technology By Prof. B. Bhattacharjee, IIT Delhi https://onlinecourses.nptel.ac.in/noc26_ce17/preview
2.	NPTEL – Advanced Concrete Technology By Prof. Manu Santhanam, IIT Madras https://onlinecourses.nptel.ac.in/noc22_ce58/preview
3.	NPTEL (Archive) – Concrete Technology By Prof. B. Bhattacharjee, IIT Delhi https://onlinecourses-archive.nptel.ac.in/noc18_ce20/course
4.	IS: 456, IS: 10262, ASTM and EN standards Recent journal articles from Cement and Concrete Research, ACI Materials Journal, etc

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	2	2	2	-
CO2	2	-	2	2	-	-
CO3	2	-	2	3	2	-
CO4	2	2	2	3	2	2
CO5	2	-	3	3	3	2
CO	**2**	**2**	**2**	**3**	**2**	**2**

SE26112	PREFABRICATED STRUCTURES	L	T	P	TW/SL	Total	C	SDG
		45	0	0	45	90	3	4,9,11,12, 17

COURSE OBJECTIVES:

- To Study the design principles, analysis and design of prefabricated elements.

COURSE CONTENT:

Unit I	Fundamentals In Prefabricated Construction	9	0	0	9	18		4,9,12

General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and code provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls. Lifecycle assessment (LCA) of prefabricated components.
Activity: Prefabrication Plant Layout.

Unit II	Precast Reinforced Concrete Panels	9	0	0	9	18		9,12

Prefabricated structures - long wall and cross-wall large panel buildings, one way and two-way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column and column to column. Use of Ultra- High- Performance Concrete (UHPC) in joints.
Activity: Model Making of Precast Connections.

Unit III	Design And Performance Of Floor And Roof Systems	9	0	0	9	18		9,12

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab 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. Energy- efficient roofing systems (cool roofs, green roofs).
Activity: Comparative Study of Roofing Systems.

Unit IV	Walls and Structural Stability	9	0	0	9	18		9,11,12

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls. Thermal bridging and energy-efficient wall design.

Activity: Wall Panel Behavior Demonstration.								
Unit V	**Long-Span Prefabricated Structural Systems**	**9**	**0**	**0**	**9**	**18**		**4,9,11,17**
Components of single-storey industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hyper-prefabricated shells, Erection and jointing, joint design, hand book-based design. 3D printing in prefabricated industrial components. **Activity:** Industrial Shed Model.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1**: Apply design principles and IS codes to plan prefabrication systems and assess lifecycle performance. **CO2**: Apply concepts to design prefabricated RC elements and connections using advanced materials like UHPC. **CO3**: Apply analysis and design to develop floor, stair, and roof systems with energy-efficient solutions. **CO4**: Apply design methods to analyze and design wall systems considering stability and thermal efficiency. **CO5**: Apply principles to design industrial buildings and shell structures using modern techniques like 3D printing.								
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%								
Assessment Methodology: Internal Examinations (70%), Activity (30%)								
REFERENCES:								
1.	Elliott, K.S. and Magill, *M.*, "Precast Prestressed Concrete for Building Structures", CRC Press, 2024.							
2.	PCI Committee, "PCI Design Handbook: Precast and Prestressed Concrete", Precast/Prestressed Concrete Institute, 9th edition, 2025.							
3.	Steinle, A., Bachmann, H. and Tillmann, H., "Precast Concrete Structures", Ernst & Sohn, 2019.							
4.	Mark Lawson, Ray Ogden, "Design in Modular Construction", CRC Press, 2022.							
5.	William Hogan-O'Neill, "Prefabricated and Modular Architecture", The Crowood Press, 2021.							

E resources/E materials:	
1.	NPTEL -Building Materials and Composites, IIT Kharagpur, Prof. Sumana Gupta, https://nptel.ac.in/courses/124105013

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	-	-	1
CO2	1	-	-	2	2	1
CO3	2	2	1	1	2	2
CO4	2	2	2	3	2	2
CO5	2	2	2	3	2	3
CO	**1**	**1**	**1**	**2**	**2**	**2**

SE26113	**SAFETY IN CONSTRUCTION**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	3,8,9,11

COURSE OBJECTIVES:

- To understand the causes of construction accidents and the importance of safety regulations and training.
- To learn about various construction hazards and methods for their prevention.
- To understand safety requirements and protective measures for working at heights.
- To study the safe operation and inspection of construction machinery and equipment.
- To understand safety practices and procedures involved in demolition works and fire prevention.

COURSE CONTENT:

Unit 1	**Accidents in Construction**	**9**	**0**	**0**	**9**	**18**		**3,8**

Problems impeding safety in construction - Causes of fatal accidents, types - Human factors associated with these accidents – Construction regulations – Design aids for safe construction – Compensation - Recording of accidents and safety measures – Education and training.

Activity: Case study on construction accidents.

Unit 2	**Hazards in Construction And Prevention**	**9**	**0**	**0**	**9**	**18**		**3,8**

Excavations, basement and wide excavation, trenches – Scaffolding, types, causes of accidents,

scaffold inspection checklist – False work – Erection of structural frame work, Dismantling – Tunnelling – Pre-blast and post-blast inspection – Confined spaces – Work over water - Road works – Power plant construction – Construction of high rise buildings.
Activity: Think pair share on construction hazards and prevention.

Unit 3	**Working at Heights**	**9**	**0**	**0**	**9**	**18**		**3,8**

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights - Safe use of ladders, scaffoldings - Requirement for safe work platforms, stairways, gangways and ramps – Fall prevention and fall protection, safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems – Working on fragile roofs – Accident case studies.
Activity: Group discussion

Unit 4	**Construction Machinery**	**9**	**0**	**0**	**9**	**18**		**8,9**

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - Builder's hoist, winches, chain pulley blocks – Use of conveyors and mobile cranes - Safety in earth moving equipment, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, hoisting cranes – Manual handling.
Activity: Quiz on machinery used for construction.

Unit 5	**Safety in Demolition Work**	**9**	**0**	**0**	**9**	**18**		**3,11**

Safety in demolition work - Keys to safe demolition, pre survey inspection, site supervision, safe clearance zone, health hazards from demolition -Environmental hazards during demolition- Indian standard -Construction and demolition waste management rules- First aid – Fire hazards and prevention methods – Case study on experiences at construction site against fire accidents.
Activity: Mind mapping on safety in demolition.

COURSE OUTCOMES:

At the end of the course, the students will be able to:
CO1: Identify safety measures to minimize construction accidents and ensure safe working conditions.
CO2: Apply hazard identification techniques to prevent risks in various construction activities.
CO3: Make use of fall protection methods to ensure safety during work at heights.
CO4: Utilize construction machinery safely by following inspection and operational guidelines.
CO5: Execute safe demolition practices considering health, fire, and structural hazards.

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

Assessment Methodology: Internal Examinations (70%), Assignments (30%)

REFERENCES:

1.	Ahmed Hassanen, “Construction Industry: Occupational Safety and Health”, 2020.
2.	Kumar NeerajJha, Dilip A. Patel, Amarjit Singh, “Construction Safety Management” First edition, Pearson Education, 2022.
3.	M. Rashad Islam, “Construction Safety: Health, Practice, and OSHA”, McGraw-Hill, 2021.
4.	William Mincks, Hal Johnston, “Construction Jobsite Management”, Fifth edition Cengage Learning, 2024.
5.	Jonathan R. Clifford, “29 CFR 1926 OSHA Construction Industry Regulations & Standards 2026: The Complete Guide to Jobsite Safety, Inspections, Training, PPE and Hazard Control”, 2026.
E resources/E materials:	
1.	National Safety Council - Construction Safety Resources.
2.	OSHA Construction Safety e Tool – Interactive hazard guidance for employers and workers.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	3	-	-
CO2	-	-	2	3	-	-
CO3	-	-	3	3	-	1
CO4	3	-	3	3	3	-
CO5	3	-	3	3	-	-
CO	**3**	**-**	**2**	**3**	**3**	**1**

SE26114	**DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	9, 11

COURSE OBJECTIVES:

- To apply knowledge of composite construction principles for the analysis and design of steel–concrete structural systems, including members, connections, and bridges.

COURSE CONTENT:

Unit 1	**Introduction to Composite Behavior**	**9**	**0**	**0**	**9**	**18**		**9, 11**

Introduction to steel concrete composite construction - Behaviour of composite structural members under loading - Composite construction techniques, types of shear connectors, and interaction between steel and concrete - Design principles of composite beams - strength, stiffness, shear connection, and serviceability requirements.
Activity - Model preparation of steel concrete composite beam sections.

Unit 2	**Design of Composite Members**	**9**	**0**	**0**	**9**	**18**		**9**

Design principles of steel concrete composite beams, slabs, and columns under various loading conditions - Analysis and design of composite structural elements - strength, stiffness, and serviceability. Introduction to the design of composite trusses and their applications in modern construction.
Activity - Assignment on the design of composite beams, slabs, columns, and trusses.

Unit 3	**Design of Connections**	**9**	**0**	**0**	**9**	**18**		**9**

Study of shear connectors and types used in composite structures - Design of connections and shear connectors for effective load transfer - Behaviour and design of partial shear interaction in composite members.
Activity - Seminar on types and design of shear connectors in composite structures**.**

Unit 4	**Composite Box Girder Bridges**	**9**	**0**	**0**	**9**	**18**		**9**

Introduction to box girder bridges, design concepts, structural behaviour, and types - Analysis of load distribution and performance of box girder bridge - Design procedures and design concepts of box girder bridges under various loading conditions.
Activity -Model preparation of different types of box girder bridges.

Unit 5	**Field Studies on Composite Structures**	**9**	**0**	**0**	**9**	**18**		**9, 11**

Field studies on steel concrete composite construction in buildings – seismic behavior of composite structures.
Activity – Field study presentation on steel concrete composite buildings and their seismic behavior.

COURSE OUTCOMES:

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

CO1: Apply the principles of steel concrete composite construction to analyze the behavior of composite structural systems.

CO2: Compute the design requirements of composite beams, slabs, columns, and trusses using

standard design procedures. **CO3**: Design shears connectors and composite connections considering partial interaction effects. **CO4**: Develop design solutions for composite box girder bridges based on structural behavior and design concepts. **CO5**: Apply composite construction concepts to evaluate the performance of buildings and seismic behavior through case studies.	
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%	
Assessment Methodology: Internal Assessment Test (70%), Activities (30%)	
REFERENCES:	
1.	IS 11384:1985 – Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi. 2022.
2.	EN 1994-1-1:2004 (Eurocode 4) – Design of Composite Steel and Concrete Structures, European Committee for Standardization (CEN), Brussels, 2026.
3.	Wojciech Lorenc, Dariusz Czepizak, Piotr Koziol, Marian A. Gizejowski, Advances in Steel and Steel-Concrete Composite Structures: Bridging Science and Industry, Routledge, 2025.
4.	Gianluca Ranzi, Massimiliano Bocciarelli, and Alejandro Pérez Caldentey, Time-dependent Behaviour and Design of Composite Steel-concrete Structures, Kindle Edition, 2021.
5.	J.Y. Richard Liew, Ming-Xiang Xiong, Bing-Lin Lai, Design of Steel-Concrete Composite Structures Using High-Strength Materials, Woodhead Publishing, 2021.
E resources/E materials:	
1.	NPTEL https://nptel.ac.in/courses/105105162
2.	Class central https://www.classcentral.com/course/engineering-purdue-university-design-of-steel-con-22576

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	3	-	-
CO2	3	2	3	3	-	-
CO3	3	3	2	3	-	-
CO4	3	3	1	3	3	2

CO5	3	3	3	3	3	2
CO	**3**	**3**	**2**	**3**	**3**	**2**

OPEN ELECTIVE I

SE26901	**STRATEGIES FOR SUSTAINABLE DESIGN**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	6, 7, 9, 11, 12, 13

COURSE OBJECTIVES:

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

COURSE CONTENT:

Unit 1	**Sustainability, Climatology and Heat Transfer in Buildings**	**9**	**0**	**0**	**9**	**18**		3, 7, 11, 13

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

Unit 2	**Sustainable Materials for Reduction in Carbon Emission**	**9**	**0**	**0**	**9**	**18**		**6, 7, 9, 12, 13**

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

Unit 3	**Operation Energy Efficiency of Buildings**	**9**	**0**	**0**	**9**	**18**		**6, 7, 9, 11, 12, 13**

Operational energy reduction and net zero building - Optimization through use of Evolutionary

genetic algorithm - Energy management system – lighting and renewable energy and Energy Audit. Water Efficiency – Planning and design of water management system, Treatment and reuse. Waste management – Types of waste and its treatment methods, Construction and demolition waste management, Waste management in residential, commercial buildings, healthcare facilities.

Activity: Energy audit of a small building - assignment

Unit 4	**Energy Ratings of Buildings**	**9**	**0**	**0**	**9**	**18**		**7, 9, 11, 12, 13**

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

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

Unit 5	**Sustainable Buildings - Case Studies and Analysis**	**9**	**0**	**0**	**9**	**18**		**7, 9, 11, 12, 13**

Smart Buildings - Building Automation Systems - Case Studies in Smart Building Implementation - Overview of Building Energy Codes - Compliance Requirements for Energy-Efficient Buildings - Case Studies in Code Compliance - Real-World Examples of Energy-Efficient Buildings - Lessons Learned from Successful Projects - Economic and Environmental Benefits - Overcoming Implementation Challenges.

Activity: Group discussion on challenges and future of sustainable construction

COURSE OUTCOMES:

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

CO1: Apply sustainability, climatology, solar geometry and heat transfer principles in building design for thermal and visual comfort.

CO2: Employ sustainable material selection and carbon assessment techniques to reduce embodied energy and environmental impacts.

CO3: Implement energy, water and waste management strategies for improving building efficiency and resource conservation.

CO4: Use life cycle assessment and green building rating criteria to evaluate the sustainability performance of buildings.

CO5: Demonstrate the application of smart building technologies, energy codes and automation strategies for developing energy-efficient and sustainable buildings.

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

Assessment Methodology: Activity (30%) & Internal Examinations (70%)	
REFERENCES:	
1.	Majumdar, M., "Energy-efficient Buildings in India", The Energy and Resources Institute (TERI), 2002.
2.	Tyagi, A. K., "Handbook on Energy Audits and Management", Tata Energy Research Institute (TERI), 2000.
3.	Sodha, M. S., Bansal, N. K., Bansal, P. K., Kumar, A. and Malik, M. A. S., "Solar Passive Building: Science and Design", First Edition, Pergamon Press, 1986.
4.	DeKay, M. and Brown, G. Z., "Sun, Wind and Light: Architectural Design Strategies", Third Edition, John Wiley & Sons, 2013.
5.	Chiogioji, M. H. and Oura, E. N. (Eds.), "Energy Conservation in Commercial and Residential Buildings", Marcel Dekker, 1982.
6.	Dubin, F. S. and Long, C. G., "Energy Conservation Standards for Building Design, Construction and Operation", McGraw-Hill Book Company, 1990.
E resources/E materials:	
1.	NPTEL Energy Efficient Buildings, Mrs. Vandana Chandrakar & Mrs. Purvi Chandrar Chhattisgarh Swami Vivekanand Technical University (CSVTU), Bhilai. https://onlinecourses.swayam2.ac.in/nou24_ge85/
2.	NPTEL United Nations Sustainable Development Goals (UN SDGs) by Prof. Shiva Ji, IIT Madras
3.	NPTEL Sustainable Materials and Green Buildings, by Dr. B. Bhattacharjee, IIT Delhi

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	3	2	2
CO2	3	2	2	3	2	2
CO3	2	2	2	3	3	3
CO4	3	3	2	3	2	3
CO5	2	2	3	3	3	3

CO	2	2	2	3	2	3

SE26902	**STRUCTURAL INSPECTION AND HEALTH ASSESSMENT**	**L**	**T**	**P**	**TW/SL**	**Total**	**C**	**SDG**
		45	0	0	45	90	3	9,11

COURSE OBJECTIVES:

- To make the students familiar with various structural health monitoring tools and techniques

COURSE CONTENT:

Unit 1	**Introduction to Structural Health Monitoring**	**9**	**0**	**0**	**9**	**18**		**9,11**

Need for SHM, Structural Health Monitoring versus Non-Destructive Evaluation, Methods of SHM Local & Global Techniques for SHM, Short & Long-Term Monitoring, Active & Passive Monitoring, Remote Structural Health Monitoring- Advantages of SHM - Challenges in SHM
Activity: Identify and discuss the SHM methods used for a building or bridge.

Unit 2	**Sensors and Instrumentation For SHM**	**9**	**0**	**0**	**9**	**18**		**9,11**

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

Unit 3	**Static and Dynamic Measurement Techniques for SHM**	**9**	**0**	**0**	**9**	**18**		**9,11**

Static measurement - Load test, Concrete core trepanning, Flat jack techniques, Static response measurement, Dynamic measurement -Vibration based testing- Ambient Excitation methods, Measured forced Vibration-Impact excitation, step relaxation test, shaker excitation method.
Activity: Conduct a simple load/vibration test on a small structural model.

Unit 4	**Damage Detection**	**9**	**0**	**0**	**9**	**18**		**9,11**

Damage Diagnostic methods based on vibrational response- Method based on modal frequency/shape/damping, Curvature and flexibility method, Modal strain energy method, Sensitivity

method, Baseline-free method, Cross-correlation method, Damage Diagnostic methods based on wave propagation Methods-Bulk waves/Lamb waves, Reflection and transmission, Wave tuning/mode selectivity, Migration imaging, Phased array imaging, Focusing array/SAFT imaging **Activity:** Compare the vibration response of a damaged and undamaged model.								
Unit 5	**Data Processing and Case Studies**	**9**	**0**	**0**	**9**	**18**		**9,11**
Advanced signal processing methods – Wavelet Transform, Hilbert-Huang Transform, Principal Component Analysis, Outlier Analysis – Artificial Intelligence and Machine Learning for SHM – Neural Networks, Support Vector Machine – Internet of Things (IoT) based Structural Health Monitoring – Wireless Sensor Networks – Smart Sensors and Edge Computing – Cloud-based Data Acquisition and Monitoring – Real-time Structural Monitoring-Applications of SHM on bridges and buildings, case studies of SHM in Civil/ Structural engineering. **Activity**: Present a real-life case study of SHM in a bridge or building.								
COURSE OUTCOMES:								
At the end of the course, the students will be able to: **CO1**: State the different types of structural health inspection. **CO2**: Explain the need and importance of structural health monitoring. **CO3**: Identify the health of the Structure using the advance techniques. **CO4**: Correlate the process and methods of health monitoring techniques **CO5**: Evaluate the accuracy of various health monitoring techniques.								
Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%								
Assessment Methodology: Activity (30%) & Internal Examinations (70%)								
REFERENCES:								
1.	Daniel Balageas, Peter Fritzen, Alfredo Guemes, Structural Health Monitoring, John Wiley & Sons,2006.							
2.	Douglas E Adams, Health Monitoring of Structural Materials and Components Methods with Applications, Wiley Publishers, 2007							
3.	Hua-Peng Chen, Structural Health Monitoring of Large Civil Engineering Structures, Wiley Publishers, 2018							
4.	Ansari, F Karbhari, Structural health monitoring of civil infrastructure systems, V.M,Woodhead Publishing, 2009							

5.	J. P. Ou, H. Li and Z. D, "Duan Structural Health Monitoring and Intelligent Infrastructure", Vol1, Taylor and Francis Group, London, UK, 2006.
6.	Victor Giurglutiu, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc, 2007.
E resources/E materials:	
1.	Structural Health Monitoring of Composites, IIT Kanpur Prof. Bishakh Bhattacharya, Prof. Anand Kumar
2.	Structural Health Monitoring, IIT Madras Prof. Srinivas Chandrasekaran. https://www.youtube.com/watch?v=It4aogUfQis.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	3	2	2
CO2	3	2	2	3	2	2
CO3	2	2	2	3	3	3
CO4	3	3	2	3	2	3
CO5	2	2	3	3	3	3
CO	2	2	2	3	2	3