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Muffakham Jah College of Engineering and Technology
(Sultan-ul-uloom Education Society)

Affiliated to Osmania University, Approved by AICTE

Accredited by NAAC and NBA (Civil, CSE, ECE and Mech)

Mount Pleasant, 8-2-249 to 267, Road No. 3, Banjara Hills, Hyderabad - 500 034, Telangana, India



Scheme of Instruction, Examination & Syllabi for
M.E. I to IV Semester of Two-Year Degree program in
Structural Engineering
(With effect from the AY 2026-27)



AUGC Autonomous Institution from the year 2025-26

Master of Engineering (M.E.) R 26

S.V.N. Reddy
HEAD
DEPT. OF CIVIL ENGINEERING
MUFFAKHAM JAH COLLEGE OF
Road No: 3, Banjara Hills, Hyderabad-34.
FOR PEKETI VENTURES PVT. LTD.

Director

M. M. Santay
(Mr. M. SANTAY)

Courses offered:

M.E. / M.Tech. (SE, CAD/CAM, ES & VLSI Design, CSE)

Dean
(Academics)
MJCE

Dr. Binnya Patnay
ASSOCIATE PROF.
NICMAR
HYDERABAD

Haseeb Siddiqui
HASEEB SIDDIQUI

SCHEME OF INSTRUCTIONS

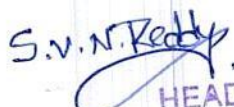
of

M.E. STRUCTURAL ENGINEERING

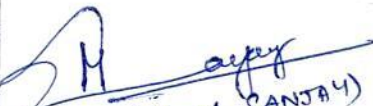
(I to IV Semesters)

With Effect from the Batch 2026-2028

SCHEME OF INSTRUCTION


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DEPT. OF CIVIL ENGINEERING
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Road No: 3, Banjara Hills, Hyderabad-34.


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(Academics)
MJCET


(Mr. M. SANJAY)


Haseel


PROFESSOR
Department of Civil Engineering
University College of Engineering
(Autonomous)
Osmania University, Hyderabad-500 007.

Vision

To produce technically competent and socially responsible civil engineers to propel infrastructural development.

Mission

To impart quality education and inculcate professional skills to function as proficient planners, designers and constructors capable of ensuring sustainability and safety.


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Programme Educational Objectives (PEO):

PEO1: Impart basic knowledge in the field of Civil Engineering.

PEO2: Develop skills to analyze and provide viable solutions to various Civil Engineering problems.

PEO3: Enhance communication skills and encourage team work.

PEO4: Prepare Civil Engineering professionals with zeal for research, life-long learning, and work for sustainable development of society with ethics.

PROGRAM OUTCOMES (POs)

POs	Engineering Graduates will be able to:
PO1	Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering Solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

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Board of Studies for M. E. Structural Engineering – R26 Regulations

The following are the members of the Board of Studies for the Department of Civil Engineering, as approved by the Academic Council.

S.No.	BoS Members Description	Name of the Member and Designation
1	I/C Head of the Department (Chair Person)	Dr. S. V. Narsi Reddy, Assistant Professor. <i>S.V.N. Reddy</i>
2	Faculty members from the department	1. Dr. Mohd. Hamraj, Professor & Dean (Academics)
		2. Mr. Shakeel Ayjaz, Associate Professor <i>Shakeel Ayjaz</i>
		3. Mr. V. D. Raju, Assistant Professor
		4. Mr. M. Sanjay, Assistant Professor <i>Sanjay</i>
3	Subject experts from outside the parent University	1. Dr. Binaya Patnaik, Associate Professor and Controller of Examinations, NICMAR University of Construction Studies, Hyderabad
		2. Dr. S. Ashok Kumar, Associate Professor, Department of Civil Engineering, Malla Reddy University, Hyderabad.
4	Expert member nominated by Vice Chancellor and recommended by college Principal	Prof. D. Annapurna, Civil Engineering Department, UCE, Osmania University.
5	Representative from Industry	Sri. P. Koundinya, Director, Pekteti Ventures Pvt. Ltd. Hyderabad. <i>Pekteti Ventures Pvt. Ltd.</i>
6	MJCET College Alumni nominated by the college Principal	Mr. Mohammed Haseebullah Siddiqui (Bridge Engineer), JACOBS India Pvt. Ltd. <i>Haseeb</i>

S.V.N. Reddy
BOS CHAIRMAN
HEAD
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A. J.
PROFESSOR
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University College of Engineering
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Osmania University, Hyderabad-500 007.

S. L. ...
PRINCIPAL
PRINCIPAL
Muffakham Jah College Of
Engineering & Technology,
Banjara Hills, Road No.3,
HYDERABAD - 500 034 .

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(Academics)
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MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY
(Autonomous)
DEPARTMENT OF CIVIL ENGINEERING

CED/BOS/July/2026/2

Date:30.07.2026

Minutes of the Board of Studies Meeting held for the finalization of the M.E. Structural Engineering Scheme of Instruction under R26 Regulations

Time: 3:00 PM – 3:40 PM

Venue: Department of Civil Engineering, MJCET

Members Present

S.No.	BoS Members Description	Name of the Member and Designation
1	I/C Head of the Department (Chair Person)	Dr. S. V. Narsi Reddy, Assistant Professor. <i>S.V.N.Reddy</i>
2	Faculty members from the department	1. Dr. Mohd. Hamraj, Professor & Dean (Academics) 2. Mr. Shakeel Ayjaz, Associate Professor <i>Shakeel</i> 3. Mr. V. D. Raju, Assistant Professor 4. Mr. M. Sanjay, Assistant Professor <i>Sanjay</i>
3	Subject experts from outside the parent University	1. Dr. Binaya Patnaik, Associate Professor and Controller of Examinations, NICMAR University of Construction Studies, Hyderabad 2. Dr. S. Ashok Kumar, Associate Professor, Department of Civil Engineering, Malla Reddy University, Hyderabad. <i>AS</i>
4	Expert member nominated by Vice Chancellor and recommended by college Principal	Prof. D. Annapurna, Civil Engineering Department, UCE, Osmania University.
5	Representative from Industry	Sri. P. Kounthiya, Director, Peketi Ventures Pvt. Ltd. Hyderabad. <i>P. Kounthiya</i>
6	MJCET College Alumni nominated by the college Principal	Mr. Mohammed Haseebullah Siddiqui (Bridge Engineer), JACOBS India Pvt. Ltd. <i>Haseeb</i>

Proceedings

The meeting commenced at 3:00 PM with the Chairperson, Dr. S. V. Narsi Reddy, I/C Head, Department of Civil Engineering, welcoming all the members of the Board of Studies and expressing his gratitude to the distinguished expert members for their gracious presence and valuable guidance.

The Chairperson presented the proposed Scheme of Instruction for the M.E. Structural Engineering Programme under R26 Regulations and explained the rationale behind the

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B **Dean (Academics)**
MJCET

curriculum structure, credit distribution, introduction of new courses, professional electives, laboratory components, and alignment with the AICTE Model Curriculum, National Education Policy (NEP) 2020, UGC guidelines for Autonomous Institutions, Outcome-Based Education (OBE), Academic Bank of Credits (ABC), NBA and NAAC requirements, industry expectations, multidisciplinary learning, research orientation, and the emerging needs of higher education.

The members examined the proposed Scheme of Instruction in detail and offered the following observations and recommendations.

Item No. 1: Professional Elective – Ground Improvement Techniques

Dr. Binaya Patnaik observed that the Professional Elective Course Ground Improvement Techniques may not be directly relevant to the Structural Engineering specialization. He suggested replacing the course with another elective that is more closely aligned with the specialization.

Resolution:

The department agreed to review the Professional Elective basket and consider replacing the course with a more relevant subject.

Item No. 2: Inclusion of Building Information Modelling (BIM)

Dr. Binaya Patnaik suggested that Building Information Modelling (BIM) be incorporated into the curriculum considering its increasing importance in structural engineering practice and the construction industry.

Resolution:

The Board recommended examining the feasibility of including BIM in the curriculum while finalizing the Scheme of Instruction.

Item No. 3: Open Elective – Embedded Systems

Dr. Binaya Patnaik sought clarification regarding the inclusion of Embedded Systems as an Open Elective for M.E. Structural Engineering students.

The Chairperson informed the Board that the course had been offered by the Department of Electronics and Communication Engineering as an Open Elective for students of other programmes.

The expert member observed that, instead of Embedded Systems, it would be more beneficial to offer a basic Computer Science related programming course as an Open Elective. The members opined that such a course would equip students with interdisciplinary programming skills and enhance their employability.

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Road No: 3, Banjara Hills, Hyderabad-500 007
Professor
Department of Civil Engineering
Osmania University College of Engineering
(Autonomous)
Osmania University, Hyderabad-500 007.

Resolution:

The board recommended examining the feasibility of offering a basic computer science related programming course as an Open elective, in consultation with the concerned department, keeping in view its relevance and availability.

Item No. 4: MOOCs Course

Prof. D. Annapurna sought clarification regarding the MOOCs course proposed in the III Semester and enquired whether the students would independently choose the course or whether the department would recommend suitable courses.

The Chairperson informed the Board that the department would recommend appropriate MOOC courses based on their relevance to the programme and their availability during the respective semester.

Resolution:

The Board noted the clarification and recommended continuing the practice of guiding students in selecting appropriate MOOC courses.

Item No. 5: Virtual Smart Structures and Dynamics Laboratory

Prof. D. Annapurna sought clarification regarding the conduct of the Virtual Smart Structures and Dynamics Laboratory.

The Chairperson explained the proposed methodology for conducting the laboratory through virtual platforms and simulation-based learning.

Following the discussion, the expert member observed that practical exposure through laboratory experimentation would provide a more effective learning experience and suggested establishing the necessary laboratory facilities instead of conducting the course entirely in virtual mode.

Resolution:

The department agreed to examine the feasibility of establishing the required laboratory facilities while considering the available infrastructure and resources.

Item No. 6: Detailed Project Report (DPR) Preparation

One of the expert members observed that the Professional Elective Detailed Project Report (DPR) Preparation may have overlapping content with the course Research Methodology and Intellectual Property Rights (IPR), as certain topics related to DPR preparation are already covered in the syllabus. The expert member suggested reviewing the necessity of offering DPR Preparation as a separate Professional Elective.

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S.V. N. Teddy
HEAD

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Resolution:

The department agreed to review the course content and examine the possibility of avoiding duplication in the curriculum.

Item No. 7: Inclusion of Soil Dynamics

Dr. S. Ashok Kumar suggested introducing Soil Dynamics as a Professional Elective in place of Ground Improvement Techniques, considering its greater relevance to the Structural Engineering specialization.

Resolution:

The Board recommended examining the proposal while finalizing the Professional Elective basket.

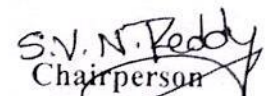
General Resolution

The Board appreciated the efforts of the Department in preparing the proposed Scheme of Instruction for the M.E. Structural Engineering Programme under R26 Regulations and offered several valuable suggestions for further strengthening the curriculum.

After detailed deliberations, the Board resolved that the recommendations made by the expert members be duly examined and incorporated, wherever found appropriate and in conformity with AICTE guidelines, institutional policy, and statutory requirements, before placing the revised Scheme of Instruction before the Academic Council for its consideration and approval. The Chairperson expressed his sincere gratitude to the expert members for their valuable suggestions, insightful observations, and constructive recommendations, which would significantly contribute to strengthening the curriculum. He thanked all the members for their active participation and cooperation throughout the deliberations.

There being no other item on the agenda, the meeting concluded at 3:40 PM with a formal vote of thanks by the Chairperson.

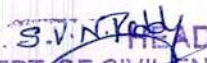

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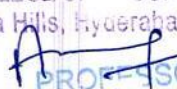

S.V.N. Reddy
Chairperson
Board of Studies
Department of Civil Engineering
MJCET

31/7/26

FOR PEKETI VENTURES.


Director


S.V.N. Reddy
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M.E. Four Semester Program Scheme of Instruction and Evaluation - R26 Regulation

S.No	Course Code	Course Name	Contact hours per week				Scheme of Examination		Credits	
			L	T	P	Hrs.	CIE	SEE		
SEMESTER-I										
1	26PC1101SE	Theory of Elasticity	3			3	40	60	3	
2	26PC1102SE	Advanced Structural Analysis	3			3	40	60	3	
3	26PE111XSE	Professional Elective-I	3			3	40	60	3	
4	26PE111XSE	Professional Elective-II	3			3	40	60	3	
5	26OE910XYZ	Open elective	3			3	40	60	3	
6	26AD900XYZ	Audit Course	2			2	50	-	0	
Experiential Learning Course										
7	26PC1151SE	Laboratory - I			3	3	40	60	1.5	
8	26PC1152SE	Laboratory - II			3	3	40	60	1.5	
Participative Learning Course										
7	26PW1151SE	Seminar			3	3	50	-	1.5	
TOTAL			17		9	26	380	420	19.5	
SEMESTER-II										
1	26PC1103SE	Structural Dynamics	3			3	40	60	3	
2	26PC1104SE	Advanced Reinforced Concrete Design	3			3	40	60	3	
3	26PE112XSE	Professional Elective-III	3			3	40	60	3	
4	26PE112XSE	Professional Elective-IV	3			3	40	60	3	
5	26SD5125ME	Research Methodology & IPR	3			3	40	60	3	
6	26AD901XYZ	Audit Course-II	2			2	50	-	0	
Experiential Learning Course										
7	26PC1153SE	Laboratory - III			3	3	40	60	1.5	
8	26PW1152SE	Mini-Project			6	6	40	60	3	
TOTAL			17		9	26	330	420	19.5	
SEMESTER-III										
Self-Directed Learning										
1	CORE	NPTEL/MOOC'S	As designated in the MOOC's Platform						3	
Research Oriented Learning										
2	26PW1153SE	Dissertation – I			20	20	40	60	10	
TOTAL					20	20	40	60	13	
SEMESTER-IV										
Research Oriented Learning										
1	26PW1154SE	Dissertation-II			32	32	50	150	16	
GRAND TOTAL					32	32	50	150	68	

CIE: Continuous Internal Evaluation SEE: Semester End Examination

Osmania University, Hyderabad-500 007.

(Mr. N. SANJAY)

List of subjects of Professional Core

S. No.	Course Code	Course Title
1	26PC1101SE	Theory of Elasticity
2	26PC1102SE	Advanced Structural Analysis
3	26PC1103SE	Structural Dynamics
4	26PC1104SE	Advanced Reinforced Concrete Design

List of subjects of Professional Electives I

S. No.	Course Code	Course Title
1	26PE1111SE	Advanced Concrete Technology
2	26PE1112SE	Advanced Steel Design
3	26PE1113SE	Retrofitting and Rehabilitation of Structures

List of subjects of Professional Electives II

1	26PE1114SE	Earthquake Resistant Design of Buildings
2	26PE1115SE	Finite Element Methods in Structural Engineering
3	26PE1116SE	Theory of Structural Stability

List of subjects of Professional Electives III

1	26PE1121SE	Bridge Engineering
2	26PE1122SE	Design of Pre stressed Concrete Structures
3	26PE1123SE	Infrastructural Engineering and Management

List of subjects of Professional Electives IV

1	26PE1124SE	Design of Industrial Structures
2	26PE1125SE	Design of High Rise Structures
3	26PE1126SE	Structural Health Monitoring

List of Open Electives

S. No.	Course Code	Course Title
1	26OE9101CE**	Cost Management of Engineering Projects
2	26OE9102CS	Business Analytics
3	26OE9103EC	Embedded System Design
4	26OE9102EE	Waste to Energy
5	26OE9105ME	Industrial Safety

Note: ** Open Elective Subject is not offered to the students of Civil Engineering Department.

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Huseen
Director

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(Mr. N. Sanjay)

List of subjects of Audit Course-I

S. No.	Course Code	Course Title
1	26AD9001HS	English for Research Paper Writing
2	26AD9002CE	Disaster Management
3	26AD9003HS	Sanskrit for Technical Knowledge
4	26AD9004HS	Value Education

List of subjects of Audit Course-II

S. No.	Course Code	Course Title
1	26AD9011HS	Constitution of India and Fundamental Rights
2	26AD9012HS	Pedagogy Studies
3	26AD9013HS	Stress Management by Yoga
4	26AD9014HS	Personality Development through life Enlightenment Skills

List of Laboratory Courses

S. No.	Course Code	Course Title
1	26PC1151SE	Advanced Concrete Lab
2	26PC1152SE	Structural Design Lab
3	26PC1153SE	Virtual Smart Structures and Dynamics Lab

List of Seminars Courses

S. No.	Course Code	Course Title
1	26 PW1151SE	Seminar
2	26 PW1152SE	Mini project

List of project works

S. No.	Course Code	Course Title
1	26 PW1153SE	Dissertation – I
2	26 PW1154SE	Dissertation – II

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Course Code	THEORY OF ELASTICITY	L	T	P	C
26PC1101SE		3	-	-	3

Course Objectives:

1. **Understand** the fundamental concepts of elasticity, stress-strain relationships, and the governing equations of three-dimensional elastic bodies.
2. **Develop** the ability to analyze two-dimensional elasticity problems in Cartesian and polar coordinate systems using appropriate analytical methods.
3. **Introduce** Airy's stress function as a mathematical tool for solving two-dimensional elasticity problems under different boundary conditions.
4. **Acquire** the theoretical knowledge and analytical skills required to evaluate the torsional behavior of prismatic bars with various cross-sectional geometries.
5. **Apply** the principles of elasticity and torsion to analyze and solve practical structural engineering problems involving stress distribution and deformation.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Apply the fundamental principles of elasticity to analyze three-dimensional stress and strain problems.
CO2:	Analyze principal stresses, principal strains, and strain energy in elastic bodies.
CO3:	Solve two-dimensional elasticity problems in Cartesian coordinates using Airy's stress function.
CO4:	Analyze stress distributions in polar coordinates for axisymmetric and stress concentration problems.
CO5:	Apply torsion theories and analytical methods to solve problems involving prismatic bars.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	1	2	2	-	-	-	-	-	2	2	3
CO 2	3	3	2	2	2	-	-	-	-	-	2	2	3
CO 3	3	3	3	3	2	-	-	-	-	-	2	3	3
CO 4	3	3	3	3	2	1	-	-	-	-	2	3	3
CO 5	3	3	3	3	3	1	-	-	-	-	3	3	3

UNIT 1

Introduction: Definition and notation for forces and stresses, components of stress and strain, Generalized Hooke's law, Stress-strain relations in three directions, Plane stress and plane strain, Equations of equilibrium and compatibility in two and three dimensions, Stress components on an oblique plane, Transformation of stress components under change of co-ordinate system.

UNIT 2

Principal stresses and principal planes: Stress invariants, Mean and Deviator stress, Strain energy per unit volume, Distortion strain energy per unit volume, Octahedral shear stress, Strain of a line element. Principal strains, Strain invariants, Volume strain, Principle of superposition, reciprocal theorem.

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UNIT 3
Two dimensional problems in Cartesian co-ordinates: Solution by polynomials, St. Venant's Principle, Uniqueness of solution, Stress components in terms of Airy's stress function. Applications to Cantilever, simply supported and fixed beams with simple loading.
UNIT 4
Two dimensional problems in Polar co-ordinates: Stress-strain components, Equilibrium equations, Compatibility equations, Applications using Airy's strain functions in polar co-ordinates for stress distributions symmetric about an axis, Effect of hole on stress distribution in a plate in tension, Stress due to load at a point on a semi-infinite straight boundary, Stresses in a circular disc under diametrical loading.
UNIT 5
Torsion: Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars, Torsion of rectangular bars, Solution of Torsional problems by energy method, use of soap films in solving torsion problems, Prandtl's membrane analogy. Solution of torsion of rectangular bars by (i) Raleigh Ritz method and (ii) Finite difference method.
Text Books:
1. <i>Theory of Elasticity</i>, S. Timoshenko & N. Goodier, Mc Graw Hill, 2017. 2. <i>Theory of Elasticity</i>, Valiappan, McGraw Hill. 3. <i>Theory of Elasticity</i>, Sadhu Singh, Khanna publishers, Twelvth Edition, 2018.
Reference Books:
1. <i>Theory of Elasticity</i>, Valentin Molotnikov, Antonina Molotnikovau, Springer, 2021. 2. <i>Theory of Elasticity</i>, P N Chandramouli, Yes Dee Publishing Pvt Ltd, 2017. 3. <i>Theory of Elasticity</i>, A N Shankar, Atlantic Publishers and Distributors (P) Ltd, 2023. 4. <i>Elasticity</i>. Sadd, Martin H, Academic Press, 2014. 5. <i>An Introduction to the Theory of Elasticity</i>, R J Atkin, N Fox, Dover Publications, 2013.
Online Learning Resources:
1. NPTEL – Theory of Elasticity (IIT Kharagpur) https://archive.nptel.ac.in/courses/105/105/105105177/ 2. NPTEL – Advanced Solid Mechanics (IIT Madras) https://nptel.ac.in/courses/112106293 3. MIT OpenCourseWare – Mechanics of Materials https://ocw.mit.edu/courses/2-001-mechanics-materials-i-fall-2006/ 4. MIT OpenCourseWare – Solid Mechanics https://ocw.mit.edu/search/?q=solid+mechanics 5. Coursera – Mechanics of Materials (University of Illinois Urbana-Champaign) https://www.coursera.org/learn/mechanics-1

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B

Course Code	ADVANCED STRUCTURAL ANALYSIS	L	T	P	C
26PC1102SE		3	-	-	3

Course Objectives:

1. Understand the concepts of matrix methods of analysis and equip them with the knowledge to independently handle the problems of structural analysis.
2. Enhance the competency level in analysis of continuous beam, portal frames, pin jointed structures by flexibility and stiffness matrix methods.
3. Understand the formation of global stiffness matrix from local stiffness matrix and equation solving techniques using direct stiffness method.
4. Gain an insight into the nonlinear analysis of structures.
5. Learn the concepts of beams on elastic foundation.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Analyze the continuous beams, rigid jointed frames and pin jointed structures by stiffness method.
CO2:	Analyze the continuous beams, rigid jointed frames and pin jointed structures by flexibility method.
CO3:	Formulate the element and global stiffness matrices by direct stiffness method and learn equation solution techniques.
CO4:	Understand and differentiate between the linear and nonlinear analyses.
CO5:	Solve the problems pertaining to beams on elastic foundation.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	3	2	-	-	-	-	-	2	3	3
CO 2	3	3	3	3	2	-	-	-	-	-	2	3	3
CO 3	3	3	3	3	3	-	-	-	-	-	3	3	3
CO 4	3	3	2	3	2	1	-	-	-	-	3	3	3
CO 5	3	3	2	3	2	1	-	-	-	-	2	3	3

UNIT 1**Introduction to Matrix Methods of Analysis:**

Static indeterminacy and kinematic indeterminacy, Coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, equivalent joint loads and fixed end forces.

Stiffness Method:

Stiffness of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

UNIT 2

Flexibility Method: Flexibility of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements,

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internal hinges and guided fixed end supports.
UNIT 3
Direct Stiffness Method: Assemblage of global stiffness matrix, Analysis of plane truss, continuous beams, plane frame and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.
UNIT 4
Introduction to Nonlinear Analysis: Geometric and material nonlinearity, P- Δ effect, Effects of axial force on flexural stiffness – buckling of ideal columns, buckling behavior of real columns, flexural behavior of beam columns, flexural stiffness measures for braced prismatic beam columns, effect of axial tension, flexural stiffness measures for unbraced prismatic beam columns.
UNIT 5
Beams on Elastic Foundations: Introduction-Modulus of foundation & Basic equation. Beams of infinite length under concentrated & uniformly distributed loads, Analysis of semi-infinite beams making use of functions for infinite beams.
Text Books:
1. <i>Advanced Structural Analysis</i> by Ashok.K. Jain, New Channel Brothers. 2. Devdas Menon, " <i>Advanced Structural Analysis</i> ", Narosa Publishing House, 2009. 3. Asslam Kassimali, " <i>Matrix Analysis of Structures</i> ", Brooks/Cole Publishing Co., USA, 1999.
Reference Books:
1. William Weaver, Jr & James M. Gere, <i>Matrix Analysis of Framed Structures</i> , CBS Publishers & Distributors, 1970. 2. Wang C.K., <i>Matrix methods of Structural Analysis</i> , McGraw Hill book, 1973. 3. <i>Advanced Mechanics of solids & structures</i> , N. Krishna Raju, Mc Graw Hill, 2018 4. Amin Ghali, Adam M Neville and Tom G Brown, " <i>Structural Analysis: A Unified Classical and Matrix Approach</i> ", Sixth Edition, 2007, Chapman & Hall. 5. Igor A Karnovsky, Olga Lebed, <i>Advanced Methods of Structural Analysis</i> , Second edition, 2021
Online Learning Resources:
1. NPTEL – Advanced Structural Analysis (IIT Madras) https://archive.nptel.ac.in/courses/105/106/105106050/ 2. NPTEL – Structural Analysis II (IIT Kharagpur) https://nptel.ac.in/courses/105105166 3. MIT OpenCourseWare – Structural Mechanics https://ocw.mit.edu/search/?q=structural+mechanics 4. MIT OpenCourseWare – Finite Element Procedures for Solids and Structures https://ocw.mit.edu/search/?q=finite+element 5. CSI Knowledge Base (SAP2000, ETABS, SAFE) https://wiki.csiamerica.com

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Course Code	ADVANCED CONCRETE TECHNOLOGY	L	T	P	C
26PE1111SE		3	-	-	3

Course Objectives:

1. **Analyse** the concept of cement and its properties, mechanical and thermal properties of aggregates.
2. **Determine** the properties and testing of concrete in fresh and hardened state.
3. **Evaluate** the shrinkage and creep mechanisms, curing and durability of concrete.
4. **Design** concrete mix by various methods as per different codes.
5. **Determine** the different types of admixtures, mix design, properties and applications of special concretes.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1: Analyse hydration of cement and tests on properties of cement and aggregates.

CO2: Determine the properties and testing of concrete in fresh and hardened state.

CO3: Evaluate the shrinkage and creep mechanisms, curing and durability of concrete.

CO4: Design concrete mixes by various methods.

CO5: Determine the types of admixtures and applications of special concretes.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	1	2	2	-	-	-	-	-	2	2	2
CO 2	3	3	2	3	2	1	-	-	-	-	2	3	2
CO 3	3	3	2	3	2	2	-	-	-	-	2	3	2
CO 4	3	3	3	3	2	1	-	-	-	-	2	3	3
CO 5	3	3	3	2	2	2	-	-	-	-	3	3	3

UNIT 1

Cement: Types of cement and their composition, manufacture of Portland cement, hydration of cement and hydration product, structure of hydrated cement, heat of hydration, gel theories, review of tests on properties of cement.

Aggregate: Classification of aggregates, particle shape and texture, bond and strength of aggregate and its influence on strength of concrete, porosity, absorption and moisture content and their influence, soundness of aggregate, alkali aggregate reaction, sieve analysis and grading of aggregate, review of tests on properties of aggregate.

UNIT 2

Properties of Concrete: Mixing and batching, workability, factors affecting workability, measurements of workability, various tests and procedures, segregation and bleeding, vibration of concrete, types of vibrators and their influence on composition, analysis of fresh concrete, strength of concrete, water-cement ratio, gel space ratio, effective water in the mix, mechanical properties of concrete, tests and procedure, influence of various parameters on strength of concrete, relationship between various mechanical strengths of concrete.

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Shrinkage and Creep of Concrete: Types of shrinkage, mechanism of shrinkage, factors affecting shrinkage, creep mechanism, factors influencing creep, rheological model, effects of creep.

Curing of Concrete: Methods of curing, maturity concept, effect of temperature on strength of concrete. **Durability of Concrete:** Permeability of concrete, chemical attack of concrete, tests on sulphate resistance, effect of frost, concreting in cold weather, hot weather concreting, and air entrained concrete.

UNIT 4

Mix Design of Concrete: Basic considerations, process of mix design, factors in the choice of mix proportions and their influence, quality control, various methods of mix design, I.S. Code method, British and ACI methods.

UNIT 5

Admixtures: Classification of admixtures, chemical and mineral admixtures, influence of various admixtures on properties of concrete, their applications. **Fly Ash Concrete:** Mix design, properties and its applications. **High Strength Concrete:** Mix design, properties and its applications. **Fiber Reinforced Concrete:** Mix design, properties and its applications. **Ferro cement, lightweight concrete, high-density concrete, recycled aggregate concrete and their applications.**

Text Books:

1. *Properties of Concrete*, Neville. A.M, (1988), English Language Book Society/Longman Publications.
2. *Concrete – Microstructure – Properties and Material*, Mehta. P.K and Paulo. J.M.M, (1997), McGraw-Hill.
3. *Design of Concrete Mix*, Krishna Raju. N., (1985), CBS Publications

Reference Books:

1. *Advanced Concrete Technology*, Zongjin Li, Wiley, 2011.
2. *Advanced Concrete Technology*, John Newman, Elsevier Science, 2003.
3. *Advanced Concrete Technology*, Zongjin Li, Xiangming Zhou, Hongyan Ma, Dongshuai Hou, Wiley, 2022.
4. *Concrete Technology*, A. R. Santhakumar, Oxford University Press, 2018.
5. *Advanced Concrete Technology*, S. Kandasamy, Notion Press, 2020.

Online Learning Resources:

1. NPTEL – Advanced Concrete Technology (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106176/>
2. NPTEL – Concrete Technology (IIT Kharagpur)
<https://nptel.ac.in/courses/105105185>
3. MIT OpenCourseWare – Building Technology and Materials
<https://ocw.mit.edu/search/?q=concrete>
4. American Concrete Institute (ACI) – Technical Resources
<https://www.concrete.org>
5. Portland Cement Association (PCA) – Concrete Technology Resources
<https://www.cement.org>

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B

Course Code	ADVANCED STEEL DESIGN	L	T	P	C
26PE1112SE		3	-	-	3

Course Objectives:

1. **List** the fundamentals of design of steel tanks and grillage foundations and solve the practical problems pertaining to steel tanks and grillage foundations.
2. **Make use of** the concepts of analysis and design of various members of tubular structures.
3. **Explain** the knowledge of design of bunkers and silos using appropriate method and solve the practical problems pertaining to it.
4. **Utilise** the fundamentals of design of transmission line towers and solve the practical problems pertaining to it.
5. **Assess** the concepts of analysis and design of various members of light-gauge steel structures.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Design and detail of the rectangular plated, pressed steel tanks, grillage foundations for structures
CO2:	Design and detail of the hollow rectangular, square and circular tubular members in a truss including its joints.
CO3:	Formulate the rectangular and square bunkers and silos using appropriate method.
CO4:	Choose the geometry, analysis and design the transmission towers subjected to various loads.
CO5:	Design the light gauge steel compression and flexural members.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	2	2	1	-	-	-	-	2	3	3
CO 2	3	3	3	3	2	1	-	-	-	-	2	3	3
CO 3	3	3	3	3	2	1	-	-	-	-	2	3	3
CO 4	3	3	3	3	3	2	-	-	-	-	3	3	3
CO 5	3	3	3	3	3	1	-	-	-	-	3	3	3

UNIT 1

Steel Tanks: Introduction, Types, Loads, Permissible stresses, Detailed design of elevated rectangular and pressed steel tanks including columns.

UNIT 2

Grillage Foundations: Introduction, Necessity of grillage foundation, Various types, Grillage foundations for single and double columns.

Tubular Structures: Introduction, Permissible stresses, Design considerations, Design of tension members, compression members and flexural members, Design of tubular trusses including joints.

UNIT 3

Bunkers and Silos: Introduction, General design principles, Design theories for bunkers and silos, Detailed design of bunkers and silos.

UNIT 4

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Transmission Line Towers: Classification, Economical spacing, Design loads, IS Codal provisions, Calculation of wind loads, Permissible stresses, Overall arrangement and design procedure, detailed design including foundations.

UNIT 5

Design of Light Gauge Steel Structures: Introduction, Forms of light-gauge sections, Behaviour of compression elements, Effective width for load and deflection calculation, behaviour of unstiffened and stiffened elements, Design of compression members, Design of laterally supported beams and laterally unsupported beams, Connections.

Text Books:

1. *Design of Steel Structures*, S.K. Duggal, Tata McGraw Hill, 2009.
2. *Design of Steel Structures*, B.C Punmia, Laxmi Publications, 2001.
3. *Design of Steel Structures*, Ram Chandra, Vol. I & II, Standard Book House, 1989.

Reference Books:

1. *Design of Steel Structures*, P. Dayaratnam, Orient Longman Publications, 1987.
2. *Design of Steel Structures*, I.C. Syal and S. Singh, Standard Book House, 2000
3. *Advanced Steel Design of Structures*, Srinivasan Chandrasekaran, CRC Press, 2020
4. *Advanced Analysis and Design of Steel Frame*, Guo Qiang Li, Jin Jun Li, Wiley, 2007.
5. *Design of Steel Structures*, Ram K S Sai, Dorling Kindersley, 2010.

Online Learning Resources:

1. NPTEL – Advanced Steel Design (IIT Madras)
https://onlinecourses.nptel.ac.in/noc22_oe02
2. NPTEL – Design of Steel Structures (IIT Kharagpur)
<https://nptel.ac.in/courses/105105183>
3. NPTEL – Steel Structures (IIT Madras)
<https://nptel.ac.in/courses/105106112>
4. American Institute of Steel Construction (AISC) – Design Resources
<https://www.aisc.org>
5. Steel Construction Institute (SCI) – Technical Publications
<https://www.steel-sci.com>

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Course Code	RETROFITTING AND REHABILITATION OF STRUCTURES	L	T	P	C
26PE1113SE		3	-	-	3

Course Objectives:

1. **Explain** the fundamentals of maintenance and repair strategies.
2. **Deduce** the quality assurance, serviceability and durability of concrete.
3. **Select** the various materials and techniques used for repair of structures.
4. **Recommend** the different repair, strengthening, rehabilitation and retrofitting techniques.
5. **Perceive** the various health monitoring and demolition techniques.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** Explain the fundamentals of maintenance and repair strategies.
- CO2:** Deduce for serviceability and durability aspects of concrete.
- CO3:** Select the materials and techniques used for repair of structures.
- CO4:** Recommend the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.
- CO5:** Perceive an appropriate health monitoring and demolition techniques.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	2	1	2	-	-	-	-	2	2	2
CO 2	3	3	2	3	2	2	-	-	-	-	2	3	2
CO 3	3	3	3	3	2	2	-	-	-	-	2	3	3
CO 4	3	3	3	3	2	3	-	-	-	-	3	3	3
CO 5	3	3	2	3	3	2	-	-	-	-	3	3	3

UNIT 1

Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure.

UNIT 2

Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

UNIT 3

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete, Bacterial concrete, Rust

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eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Guniting and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection.

UNIT 4

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Crete – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

UNIT 5

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

Text Books:

1. *Concrete Technology* by A.R. Santakumar, Oxford University press
2. *Defects and Deterioration in Buildings*, E F & N Spon, London
3. *Non-Destructive Evaluation of Concrete Structures* by Bungey - Surrey University

Reference Books:

1. *Building Failures: Diagnosis and Avoidance*, EF & N Spon, London, B
2. *Concrete- Microstructure, Properties and Materials*, Mehta, P.K and Montevic. P.J., ICI, 1997.
3. *Civil Engineering Materials*, Jackson, N., ELBS, 1983.
4. *Maintenance and Repair of Civil Structures*, B.L. Gupta and Amit Gupta, Standard Publications.
5. *Maintenance, Repair, Rehabilitation, and Retrofitting of Structures*, G. Nandini Devi, Dreamtech Press, 2021.

Online Learning Resources:

1. NPTEL – Retrofitting and Rehabilitation of Civil Infrastructure
<https://archive.nptel.ac.in/courses/105/105/105105213/>
2. NPTEL – Repair and Rehabilitation of Concrete Structures (IIT Madras)
<https://nptel.ac.in/>
3. SWAYAM – Civil Engineering Courses (Repair, Rehabilitation & Durability)
<https://swayam.gov.in/>
4. National Programme on Technology Enhanced Learning (NPTEL – Civil Engineering)
<https://nptel.ac.in/courses/105>
5. Indian Concrete Institute (ICI) – Technical Resources
<https://www.indianconcreteinstitute.org/>

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Course Code	EARTHQUAKE RESISTANT DESIGN OF BUILDINGS	L	T	P	C
26PE1114SE		3	-	-	3

Course Objectives

Upon successful completion of the course, the student will be able to:

1. Understand the fundamentals of engineering seismology, earthquake ground motion, and structural dynamic s.
2. Analyze the seismic behavior and performance of reinforced concrete buildings.
3. Apply codal procedures for seismic analysis and modelling of buildings using static and dynamic methods.
4. Design earthquake-resistant reinforced concrete buildings using ductile detailing and capacity design principles.
5. Evaluate the seismic performance and design of masonry buildings as per Indian Standards.

Course Outcomes (CO's):

CO1:	Explain the principles of engineering seismology, earthquake ground motion, and structural dynamics.
CO2:	Analyze the seismic behavior of reinforced concrete buildings considering structural irregularities.
CO3:	Apply seismic analysis and modelling methods for reinforced concrete buildings as per IS 1893.
CO4:	Design earthquake-resistant reinforced concrete buildings using ductile detailing as per IS 13920.
CO5:	Evaluate and design earthquake-resistant masonry buildings using relevant IS codal provisions.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	2	2	-	1	-	-	-	2	3	2
CO 2	3	3	2	2	2	-	1	-	-	-	2	3	3
CO 3	3	3	3	3	3	-	1	-	-	1	2	3	3
CO 4	3	3	3	2	2	-	1	-	-	1	2	3	3
CO 5	3	3	3	2	2	1	2	-	-	-	2	3	3

UNIT 1**Introduction:**

Earthquake Ground Motion: Engineering seismology, Seismic zoning map of India, Strong motion studies in India, Strong motion characteristics, Evaluation of seismic design parameters.

Structural Dynamics: Initiation into structural dynamics, Dynamics of SDOF systems, Theory of seismic pickup, Numerical evaluation of dynamic response, Response spectra, Dynamics of MDOF systems.

UNIT 2

Concepts of Earthquake Resistant Design of RCC Buildings: Basic elements of

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earthquake resistant design, Identification of seismic damages in RCC buildings, Effect of structural irregularities on performance of RCC buildings during earthquakes, earthquake resistant building architecture.

UNIT 3

Seismic Analysis and Modelling of RCC Buildings: Code based procedure or determination of design lateral loads, Infill walls, Seismic analysis procedure as per IS 1893 code, Equivalent static force method, Response spectrum method, Time history analysis, Mathematical modelling of multi-storey RCC buildings.

UNIT 4

Earthquake Resistant Design of RCC Buildings: Ductility considerations, Earthquake resistant design of multi-storey RCC buildings and shear walls based on IS 13920 code, Capacity based design.

UNIT 5

Earthquake Resistant Design of Masonry Buildings: Identification of damages and non-damages in masonry buildings, Elastic properties of structural masonry, Lateral load analysis of masonry buildings, Seismic analysis and design of one-storey and two-storey masonry buildings.

Text Books:

1. S. K. Duggal, *Earthquake Resistant Design of Structures*, Oxford University Press, 3rd Edition (Latest).
2. Pankaj Agarwal and Manish Shrikhande, *Earthquake Resistant Design of Structures*, PHI Learning Pvt. Ltd., Latest Edition.
3. Vinod Hosur, *Earthquake Resistant Design of Building Structures*, Wiley India, Latest Edition.

Reference Books:

1. T. Paulay and M. J. N. Priestley, *Seismic Design of Reinforced Concrete and Masonry Buildings*, John Wiley & Sons.
2. Anil K. Chopra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, Pearson Education.
3. M. Y. H. Bangash, *Earthquake Resistant Buildings: Dynamic Analyses, Numerical Computations and Applications*, Springer.
4. Mohiuddin Ali Khan, *Earthquake-Resistant Structures: Design, Build and Retrofit*, Elsevier. Bruce A. Bolt, *Earthquakes*, W. H. Freeman & Company.

Online Learning Resources:

1. NPTEL – Introduction to Earthquake Engineering (IIT Kanpur)
<https://archive.nptel.ac.in/courses/105/101/105101004/>
2. NPTEL – Geotechnical Earthquake Engineering (IIT Madras)
<https://archive.nptel.ac.in/courses/105/108/105108074/>
3. NPTEL – Structural Dynamics (IIT Madras)
<https://nptel.ac.in/courses/105106049>
4. NPTEL – Advanced Structural Analysis (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106050/>
5. National Information Centre of Earthquake Engineering (NICEE), IIT Kanpur
<https://www.nicee.org>

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Course Code	FINITE ELEMENT METHODS IN STRUCTURAL ENGINEERING	L	T	P	C
26PE1115SE		3	-	-	3

Course Objectives

The objectives of this course is to impart knowledge of

1. Learn the rudiments of finite element analysis.
2. Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.
3. Explain the core concepts of variational and weighted residual methods in FEM.
4. Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.
5. Formulate the simple structural problems in to finite elements.

Course Outcomes (CO's):

CO1: Build and analyse the FEA models for various engineering problems.

CO2: Identify the information requirements and sources for analysis, design and evaluation.

CO3: Use the standard finite element software to solve the structural engineering problems.

CO4: Interpret the results obtained from FEA software.

CO5: Interpretation and conclusions with awareness of limitations.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	3	2	-	-	-	-	2	2	3	3
CO 2	3	3	3	3	3	-	-	-	-	2	2	3	3
CO 3	3	3	3	3	3	-	-	-	-	2	2	3	3
CO 4	3	3	3	3	3	-	-	-	-	2	2	3	3
CO 5	3	3	3	3	3	-	-	-	-	2	2	3	3

UNIT 1

Introduction to FEM: Types of Problems – Types of Materials – Elastic / Inelastic situations – Types of forces: Body forces / Surface Traction / Point loads – Deformable bodies – Types of Deformations – Homogeneous / Non homogeneous Problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D / 3-D – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strain problems.

Virtual Work Formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

Finite Difference Method with Central Differences: Solving ODE's and PDE's with central differences. Application to beam and plate bending problems of simple geometry.

UNIT 2

Variational Formulation: Finite Element Formulation - Stationarity of Functional – Given the Functional or Differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix / stiffness matrix / Minimum Potential

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Energy Approach

/ Rayleigh-Ritz Method / introduction to natural coordinates / stiffness matrix of second order bar element / Axial bar subjected to point loads, body forces and surface traction forces / Problems with kinematic indeterminacy not exceeding two.

2-D Triangular Elements: Displacement models / criterion for convergence / geometric invariance / conforming and non-conforming elements - 3-node triangular elements (CST) / determination of strain- displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceeding three.

2nd Order triangular elements: Shape functions – degradation technique / strain-displacement matrix / Expression for stiffness matrix / Load matrices due to body forces and surface traction.

UNIT 3**Iso-parametric elements:**

Quadrilateral elements: Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/ Expressions for stiffness matrix, load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2nd Order Quadrilateral elements: - Determination of shape functions for 2nd order quadrilateral elements and for elements of with serendipity / Strain-displacement matrices / Load matrices for body force and surface traction.

UNIT 4**Method of Weighted Residuals:**

Galerkin's Method of Weighted Residuals – Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

Galerkin's Finite Element Method – Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

Axi-symmetric Problems: Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elements only.

UNIT 5

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, stiffness matrix, load matrices due to body force and surface traction/ introduction to Hexahedron (brick) elements.

Non-linear Finite element analysis: Introduction – problems with material non-linearity – problems with geometric non-linearity – problems with both material and geometric non-linearity.

Introduction to MSC Nastran: Illustration on different modules of Nastran / Structural engineering applications of the package/Creation of a simple 1-D model, 2-D model and a 3-D model/ analysis and post processing of the results.

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Text Books:

1. T. R. Chandrupatla and A. D. Belegundu, *Introduction to Finite Elements in Engineering*, 4th Edition, Pearson Education, 2012.
2. J. N. Reddy, *An Introduction to the Finite Element Method*, 3rd Edition, McGraw-Hill Education, 2006.
3. O. C. Zienkiewicz, R. L. Taylor and J. Z. Zhu, *The Finite Element Method: Its Basis and Fundamentals*, 7th Edition, Butterworth-Heinemann, 2013.

Reference Books:

1. K. J. Bathe, *Finite Element Procedures*, Prentice Hall, 1996.
2. D. L. Logan, *A First Course in the Finite Element Method*, 6th Edition, Cengage Learning, 2016.
3. C. S. Krishnamoorthy, *Finite Element Analysis: Theory and Programming*, Tata McGraw-Hill, 1994.
4. M. G. Prasad, *Finite Element Analysis*, New Age International Publishers, 2011.
5. S. S. Rao, *The Finite Element Method in Engineering*, 6th Edition, Butterworth-Heinemann, 2018.

Online Learning Resources:

1. NPTEL – *Finite Element Analysis*, IIT Madras.
<https://nptel.ac.in/courses/105106051>
2. NPTEL – *Introduction to Finite Element Method*, IIT Madras.
<https://www.nptel.ac.in/courses/112106135>
3. NPTEL – *Basics of Finite Element Analysis-I*, IIT Kanpur.
<https://www.nptel.ac.in/courses/112104193>
4. NPTEL – *FEM Applied to Ocean Engineering*.
<https://nptel.ac.in/courses/114106742>

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Department of Civil Engineering
University College of Engineering
(Autonomous)
Osmania University, Hyderabad-500 007.

B

Course Code		THEORY OF STRUCTURAL STABILITY										L	T	P	C
26PE1116SE												3	-	-	3
Course Objectives:															
1. Learn the buckling of columns, analysis using equilibrium, energy and approximate methods.															
2. Know the stability analysis of beam-columns and frames with different loads.															
3. Analyse for torsional, flexural and lateral buckling of beams.															
4. Perform the buckling analysis of thin plates using different approaches.															
5. Study the inelastic buckling analysis of plates.															
Course Outcomes (CO's):															
After completing this course, the student will be able to:															
CO1:	Understand the analysis of buckling of columns using appropriate method.														
CO2:	Analyse the practical problems of beam-columns and frames.														
CO3:	Analyse the beams for torsional, flexural and lateral buckling.														
CO4:	Perform buckling analysis of thin plates..														
CO5:	Analyse the plates for inelastic buckling and understand the post-buckling behaviour of plates														
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	3	3	2	2	2	-	-	-	-	2	2	3	2		
CO 2	3	3	3	3	2	-	-	-	-	2	2	3	3		
CO 3	3	3	3	3	3	-	-	-	-	2	2	3	3		
CO 4	3	3	3	3	3	-	-	-	-	2	2	3	3		
CO 5	3	3	3	3	3	-	-	-	-	3	2	3	3		
UNIT 1															
Buckling of columns: States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkin's approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.															
UNIT 2															
Buckling of beam-columns and frames: Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.															
UNIT 3															
Torsional and lateral buckling: Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever beam.															
UNIT 4															
Buckling of plates: Governing differential equation - Buckling of thin plates, various edge															

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conditions Analysis by equilibrium and energy approach - Approximate and Numerical techniques.

UNIT 5

Inelastic buckling: Double modulus theory - Tangent modulus theory – Shanley's model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behavior of plates

Text Books:

1. S. P. Timoshenko and J. M. Gere, *Theory of Elastic Stability*, 2nd Edition, McGraw-Hill Education.
2. A. Chajes, *Principles of Structural Stability Theory*, Prentice Hall.
3. Ashwini Kumar, *Stability Theory of Structures*, Tata McGraw-Hill.

Reference Books:

1. M. L. Gambhir, *Stability Analysis and Design of Structures*, Springer.
2. Chai H. Yoo & Sung C. Lee, *Stability of Structures: Principles and Applications*, Elsevier.
3. W. F. Chen & E. M. Lui, *Structural Stability: Theory and Implementation*, Elsevier.
4. N. G. R. Iyengar, *Structural Stability of Columns and Plates*, Affiliated East-West Press.
5. Sukhvarsh Jerath, *Structural Stability Theory and Practice*, Wiley India.

Online Learning Resources:

1. NPTEL – *Elastic Stability of Structures*
https://onlinecourses.nptel.ac.in/noc22_ce91
2. IIT Kharagpur – NPTEL Structural Stability Course Archive
<https://nptel.ac.in/courses/105105166>
3. MIT OpenCourseWare – Structural Mechanics
<https://ocw.mit.edu>
4. IIT Madras – Structural Engineering Courses
<https://nptel.ac.in>

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Course Code	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
26OE9101CE		3	-	-	3

Course Objectives

1. Develop an understanding of cost concepts and strategic cost management principles for engineering projects.
2. Explain project planning, execution, cost control, and project management techniques used in engineering projects.
3. Apply cost accounting and profit planning techniques for effective managerial decision-making.
4. Analyze modern cost management practices, budgeting methods, and performance evaluation techniques.
5. Apply quantitative techniques for planning, scheduling, and optimizing engineering project costs.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Apply cost concepts and strategic cost management principles in engineering decision-making.
CO2:	Analyze project planning, execution, contracts, scheduling, and cost control techniques for engineering projects.
CO3:	Evaluate cost behaviour, profit planning, pricing strategies, and managerial decision-making using cost accounting techniques.
CO4:	Analyze activity-based costing, budgeting methods, benchmarking, and performance measurement systems for project cost management.
CO5:	Apply quantitative optimization and project scheduling techniques for effective cost management of engineering projects.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	2	3	2	1	2	-	-	-	-	2	2	1	1
CO 2	2	3	2	2	2	-	-	-	-	3	2	1	1
CO 3	2	3	3	2	2	-	-	-	-	3	2	1	1
CO 4	2	3	3	2	2	-	-	-	-	3	2	1	1
CO 5	2	3	3	3	3	-	-	-	-	3	3	1	1

UNIT 1

Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision- making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision- Making.

UNIT 2

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with

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significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT 3

Cost Behavior and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in- time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT 4

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT 5

Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. *Cost Accounting: A Managerial Emphasis* – Charles T. Horngren, Srikant M. Datar & Madhav V. Rajan, Pearson Education, 16th Edition (or latest edition).
2. *Project Management: A Systems Approach to Planning, Scheduling and Controlling* – Harold Kerzner, John Wiley & Sons, 13th Edition (or latest edition).
3. *Engineering Economy* – Leland Blank & Anthony Tarquin, McGraw-Hill Education, 8th Edition.

Reference Books:

1. *Cost Accounting – A Managerial Emphasis*, Prentice Hall of India, New Delhi.
2. Charles T. Horngren and George Foster, *Advanced Management Accounting*.
3. Robert S Kaplan Anthony A. Alkinson, *Management & Cost Accounting*.

Online Learning Resources:

1. NPTEL – Cost Accounting
<https://nptel.ac.in/courses/110107144>
2. NPTEL – Project Management
<https://nptel.ac.in/courses/110107128>
3. NPTEL – Operations Research
<https://nptel.ac.in/courses/110106062>
4. NPTEL – Engineering Economy
<https://nptel.ac.in/courses/110105154>
5. SWAYAM – Project Management and Cost Management Courses
<https://swayam.gov.in/>

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Course Code	BUSINESS ANALYTICS	L	T	P	C
26OE9102CS		3	-	-	3

Course Objectives

1. **Understand** the concepts, processes, and organizational applications of business analytics and statistical methods.
2. **Analyze** business data using regression, predictive analytics, and data mining techniques for informed decision-making.
3. **Apply** business analytics tools and management strategies to solve organizational and operational problems.
4. **Evaluate** forecasting models, simulation techniques, and risk analysis methods for business planning.
5. **Apply** decision analysis techniques and emerging business intelligence tools to support strategic business decisions.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** **Explain** the principles, processes, and statistical foundations of business analytics.
- CO2:** **Analyze** business data using regression analysis, predictive analytics, and data mining techniques.
- CO3:** **Apply** business analytics tools and management practices to improve organizational decision-making.
- CO4:** **Evaluate** forecasting models, simulation techniques, and risk analysis for business applications.
- CO5:** **Apply** decision analysis methods and business intelligence tools to solve real-world business problems.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	2	2	1	1	2	-	-	-	-	2	2	1	1
CO 2	2	3	2	2	3	-	-	-	-	2	2	1	1
CO 3	2	3	3	2	3	-	-	-	-	3	2	1	1
CO 4	2	3	3	3	3	-	-	-	-	2	3	1	1
CO 5	2	3	3	3	3	-	-	-	-	3	3	1	1

UNIT 1

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT 2

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

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UNIT 3

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT 4

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New- Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT 5

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without 8 Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in Embedded and collaborative business intelligence, Visual data 4 recovery, Data Storytelling and Data journalism.

Text Books:

1. James R. Evans, *Business Analytics*, Pearson Education, 3rd Edition.
2. Marc J. Schniederjans, Dara G. Schniederjans & Christopher M. Starkey, *Business Analytics: Principles, Concepts, and Applications*, Pearson FT Press, 2014.
3. U. Dinesh Kumar, *Business Analytics: The Science of Data-Driven Decision Making*, Wiley India, Latest Edition.

Reference Books:

1. Marc J. Schniederjans, Dara G. Schniederjans & Christopher M. Starkey, *Business Analytics: Principles, Concepts, and Applications*, Pearson FT Press.
2. Foster Provost & Tom Fawcett, *Data Science for Business*, O'Reilly Media.
3. Wayne L. Winston, *Microsoft Excel Data Analysis and Business Modeling*, Microsoft Press.
4. Nitin Kale, *Business Intelligence and Analytics Systems for Decision Support*, Pearson Education.
5. Galit Shmueli et al., *Data Mining for Business Analytics*, Wiley.

Online Learning Resources:

1. https://www.nptel.ac.in/courses/106106361?utm_source=chatgpt.com
2. https://onlinecourses-archive.nptel.ac.in/noc18_mg09/preview?utm_source=chatgpt.com
3. https://www.nptel.ac.in/courses/110107092?utm_source=chatgpt.com
4. https://nptel.ac.in/courses/110104513?utm_source=chatgpt.com
5. https://onlinecourses.nptel.ac.in/?utm_source=chatgpt.com

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Course Code	EMBEDDED SYSTEM DESIGN	L	T	P	C
26OE9103EC		3	-	-	3

Course Objectives:

1. Detailed overview of important concepts of Embedded system.
2. Analyse PIC microcontroller, its features and programming.
3. Describe ARM Microcontroller architectural details and instruction set.
4. Understand ARM Memory management.
5. Learn the techniques to develop an embedded system and case studies.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** Understand the fundamentals of the embedded system design
- CO2:** Enumerate the instruction set of ARM Processor by studying the architecture of ARM core
- CO3:** Acquire knowledge on the serial, parallel and network communication protocols.
- CO4:** Learn the embedded system design life cycle and co-design issues.
- CO5:** List the various embedded software development tools used in the design of embedded system for various applications.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	2	-	-	-	-	1	2	1	1
CO 2	3	3	2	2	3	-	-	-	-	1	2	1	1
CO 3	3	3	2	2	3	-	-	-	-	1	2	1	1
CO 4	3	3	3	2	3	-	-	-	-	2	2	1	1
CO 5	2	2	3	2	3	-	-	-	-	2	3	1	1

UNIT 1

Introduction to Embedded Systems: Overview of Embedded System Architecture, Challenges & Trends of Embedded Systems, Hardware Architecture, Software Architecture. Application areas of Embedded Systems and Categories of Embedded Systems. Embedded System Design and Co-Design issues and Design Cycle Process

UNIT 2

PIC 18: Family Overview, Architecture, Instruction Set, Addressing modes. Timers, interrupts of PIC 18, Capture/Compare and PWM modules of PIC 18

UNIT 3

ARM Architecture: ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families. Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.

UNIT 4

ARM Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing

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Instruction Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Exception and interrupt handling.

ARM Memory Management: Cache Architecture, Policies, Flushing and Caches, MMU, Page Tables, Translation Access Permissions, Context Switch.

UNIT 5

Embedded Software Development Tools, Host and Target Machines, Linkers/Locators for Embedded Software, Getting Embedded Software into the Target System. Debugging Techniques.

Case Studies: Design of Embedded Systems using Microcontrollers—for applications in the Area of communications and automotives. (GSM/GPRS, CAN, Zigbee)

Text Books:

1. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, 3rd Edition, McGraw Hill Education, 2017.
2. Andrew N. Sloss, Dominic Symes and Chris Wright. *ARM System Developer's Guide: Designing and Optimizing System Software*, Morgan Kaufmann (Elsevier), 2008.
3. Muhammad Ali Mazidi, Rolin D. McKinlay and Danny Causey, *PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18*, Pearson Education, 2008.

Reference Books:

1. David E. Simon, *An Embedded Software Primer*, Pearson Education.
2. Jonathan W. Valvano, *Embedded Microcomputer Systems: Real-Time Interfacing*, Cengage Learning, Latest Edition.
3. Frank Vahid and Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley India.
4. Steve Heath, *Embedded Systems Design*, Newnes (Elsevier), 2nd Edition.
5. Shibu K. V., *Introduction to Embedded Systems*, McGraw Hill Education.

Online Learning Resources:

1. NPTEL – Embedded System Design (IIT Kharagpur):
<https://nptel.ac.in/courses/108105057>
2. NPTEL – Embedded Systems (IIT Madras) <https://nptel.ac.in/courses/106106188>
3. NPTEL – Microprocessors and Microcontrollers (IIT Kharagpur):
<https://nptel.ac.in/courses/108105102>
4. ARM Developer Documentation: <https://developer.arm.com/documentation>
5. Microchip Developer Resources: <https://www.microchip.com/en-us/training>

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Course Code	WASTE TO ENERGY	L	T	P	C
26OE9102EE		3	-	-	3

Course Objectives:

1. Understand the principles of waste-to-energy technologies and the classification of biomass and waste as renewable energy resources.
2. Explain the design, operation, and performance of biomass gasification systems for thermal and power generation.
3. Analyze biomass combustion technologies and their applications in efficient energy conversion.
4. Apply the principles of biogas production and biomass conversion processes for sustainable energy generation.
5. Evaluate biochemical conversion technologies and the utilization of waste resources for renewable energy production.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Explain the classification of waste resources and waste-to-energy conversion technologies.
CO2:	Analyze the design, operation, and performance of biomass gasification systems.
CO3:	Analyze the working principles and applications of biomass combustion systems and improved biomass stoves.
CO4:	Apply the concepts of biogas technology and thermochemical biomass conversion processes.
CO5:	Evaluate biochemical conversion processes and waste-to-energy technologies for sustainable energy applications.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	2	2	3	-	-	1	2	1	1
CO 2	3	3	2	2	3	2	2	-	-	1	2	1	1
CO 3	3	3	2	2	3	2	2	-	-	1	2	1	1
CO 4	3	3	3	2	3	3	3	-	-	2	2	1	1
CO 5	2	3	3	3	3	3	3	-	-	2	3	1	1

UNIT 1

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT 2

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

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UNIT 3

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT 4

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction

UNIT 5

Biochemical conversion: Anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Text Books:

1. D. S. Chauhan, *Non-Conventional Energy Resources*, New Age International Publishers, Latest Edition.
2. Khandelwal, K. C. and Mahdi, S. S., *Biogas Technology – A Practical Handbook*, Vol. I & II, Tata McGraw-Hill Publishing Co.
3. C. Y. WereKo-Brobby and E. B. Hagan, *Biomass Conversion and Technology*, John Wiley & Sons.

Reference Books:

1. S. P. Sukhatme and J. K. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, McGraw Hill Education.
2. Twidell, J. and Weir, T., *Renewable Energy Resources*, Routledge (Taylor & Francis), Latest Edition.
3. G. D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers.
4. D. Yogi Goswami, Frank Kreith and Jan F. Kreider, *Principles of Solar Engineering*, CRC Press.
5. S. A. Abbasi and N. Abbasi, *Renewable Energy Sources and Their Environmental Impact*, Prentice Hall of India.

Online Learning Resources:

1. NPTEL – Biomass Energy Conversion Technologies (IIT Roorkee)
<https://nptel.ac.in/courses/103107155>
2. NPTEL – Non-Conventional Energy Resources (IIT Kharagpur)
<https://nptel.ac.in/courses/108105058>
3. NPTEL – Renewable Energy Engineering (IIT Madras)
<https://nptel.ac.in/courses/121106014>
4. MNRE (Ministry of New and Renewable Energy), Government of India
<https://mnre.gov.in>
5. IRENA (International Renewable Energy Agency) – Learning Resources
<https://www.irena.org>

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Course Code	INDUSTRIAL SAFETY	L	T	P	C
260E9105ME		3	-	-	3

Course Objectives:

1. Causes for industrial accidents and preventive steps to be taken.
2. Fundamental concepts of Maintenance Engineering.
3. About wear and corrosion along with preventive steps to be taken.
4. The basic concepts and importance of fault tracing.
5. The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** Concepts of engineering systems safety, identify the causes for Industrial accidents and suggest preventive measures.
- CO2:** Identify the basic tools and requirements of different maintenance procedures.
- CO3:** Apply different techniques to reduce and prevent Wear and corrosion in Industry.
- CO4:** Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
- CO5:** Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine toolset.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	2	2	3	2	-	-	1	2	1	1
CO 2	3	2	2	2	3	2	1	-	-	1	2	1	1
CO 3	3	3	2	2	3	2	2	-	-	1	2	1	1
CO 4	3	3	3	3	2	2	1	-	-	1	2	1	1
CO 5	3	2	3	2	3	2	2	-	-	2	3	1	1

UNIT 1

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety colour codes. Fire prevention and fire fighting, equipment and methods.

UNIT 2

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT 3

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT 4

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT 5

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Text Books:

1. H. P. Garg, *Maintenance Engineering*, S. Chand & Company Ltd., New Delhi, Latest Edition.
2. Lindley R. Higgins and R. Keith Mobley (Eds.), *Maintenance Engineering Handbook*, McGraw-Hill Education, Latest Edition.
3. Charles D. Reese, *Occupational Health and Safety Management: A Practical Approach*, CRC Press, Latest Edition.

Reference Books:

1. B. S. Dhillon, *Engineering Maintenance: A Modern Approach*, CRC Press, Latest Edition.
2. R. C. Mishra and K. Pathak, *Maintenance Engineering and Management*, PHI Learning Pvt. Ltd., Latest Edition.
3. John V. Grimaldi and Rollin H. Simonds, *Safety Management*, AITBS Publishers (or latest available edition).
- A. K. Gupta, *Industrial Safety and Environment*, Laxmi Publications, Latest Edition.
4. Frank R. Spellman, *Handbook of Occupational Safety and Health*, Government Institutes (Bernan Press), Latest Edition.

Online Learning Resources:

1. NPTEL – Industrial Safety Engineering
<https://onlinecourses.nptel.ac.in/>
2. NPTEL – Maintenance Engineering and Management
<https://onlinecourses.nptel.ac.in/>

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3. NPTEL – Reliability Engineering
<https://onlinecourses.nptel.ac.in/>
4. Directorate General Factory Advice Service & Labour Institutes (DGFASLI), Ministry of Labour & Employment, Government of India
<https://dgfasli.gov.in/>
5. National Safety Council (India)
<https://nsc.org.in/>

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B

Course Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
26AD9001HS		2	-	-	0

Course Objectives

Upon successful completion of the course, the student will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Understand the nuances of language and vocabulary in writing a Research Paper.
3. Develop the content, structure and format of writing a research paper.
4. Produce original research papers without plagiarism.

Course Outcomes (CO's):

CO1: Interpret the nuances of research paper writing.

CO2: Differentiate the research paper format and citation of sources.

CO3: To review the research papers and articles in a scientific manner.

CO4: Avoid plagiarism and be able to develop their writing skills in presenting the research work.

CO5: Create a research paper and acquire the knowledge of how and where to publish their original research papers.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	2	2	-	-	1	-	-	3	-	3	2	1	1
CO 2	2	3	-	1	2	-	-	3	-	3	2	1	1
CO 3	2	3	1	2	2	-	-	3	-	3	3	2	1
CO 4	2	3	1	2	2	-	-	3	-	3	3	2	1
CO 5	2	3	2	2	2	-	-	3	-	3	3	2	2

UNIT 1**Introduction:**

Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope –

Benefits, Limitations – outcomes.

UNIT 2

Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT 3

Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

UNIT 4

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.

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UNIT 5

Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits **Presentation Skills:** Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

Text Books:

- 1.C. R Kothari, Gaurav, Garg, —Research Methodology Methods and TechniquesI, 4/e, New Age International Publishers.
- 2.Day R, —How to Write and Publish a Scientific Paper”, Cambridge University Press, 2006.
- 3.MLA Hand book for writers of Research PapersI, 7/e, East West Press Pvt. Ltd, New Delhi.
- 4.Lauri Rozakis, Schaum’s, Quick Guide to Writing Great Research PapersI, Tata McGraw Hills Pvt. Ltd, New Delhi.

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B

Course Code	DISASTER MANAGEMENT	L	T	P	C
26AD9002CE		2	-	-	0

Course Objectives

Upon successful completion of the course, the student will be able to:

1. Understand the concepts, types, causes, and impacts of natural and man-made disasters.
2. Analyze disaster-prone regions and disaster vulnerabilities with special reference to India.
3. Explain disaster preparedness, monitoring, early warning systems, and community participation.
4. Evaluate disaster risk assessment and mitigation strategies using modern technologies.
5. Understand national and global frameworks for disaster risk reduction and sustainable disaster management.

Course Outcomes (CO's):

- CO1:** Explain the concepts, types, causes, and impacts of natural and man-made disasters.
- CO2:** Analyze disaster-prone regions, hazards, and post-disaster consequences in India.
- CO3:** Apply disaster preparedness, monitoring, and early warning techniques for effective disaster management.
- CO4:** Evaluate disaster risk assessment methods and community-based disaster management practices.
- CO5:** Recommend appropriate disaster mitigation and disaster risk reduction strategies based on national and global frameworks.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	2	2	-	-	1	2	3	-	-	1	2	1	-
CO 2	2	3	1	2	2	2	3	-	-	1	2	1	-
CO 3	2	3	2	2	3	2	3	-	1	2	2	1	1
CO 4	2	3	2	3	3	2	3	-	1	2	3	1	1
CO 5	2	3	2	3	3	3	3	-	1	2	3	2	1

UNIT 1

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT 2

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT 3

Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with

Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

UNIT 4

Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT 5

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Text Books:

1. Rajib Shaw, *Disaster Risk Reduction and Management*, Universities Press, Hyderabad, 2003.
2. Anil K. Gupta & Sreeja S. Nair, *Environmental Knowledge for Disaster Risk Management*, NIDM, New Delhi, Latest Edition.
3. Ministry of Home Affairs, Government of India, *National Disaster Management Guidelines*, National Disaster Management Authority (NDMA), Latest Edition.

Reference Books:

1. C. Emdad Haque & David Etkin (Eds.), *Disaster Risk and Vulnerability: Mitigation through Mobilizing Communities and Partnerships*, McGraw-Hill Education, Latest Edition.
2. D. K. Sinha, *Disaster Management: Preparedness, Response and Recovery*, SBS Publishers & Distributors, New Delhi.
3. Jagbir Singh, *Disaster Management: Future Challenges and Opportunities*, I.K. International Publishing House.
4. National Disaster Management Authority (NDMA), *National Disaster Management Plan*, Government of India, Latest Edition.
5. United Nations Office for Disaster Risk Reduction (UNDRR), *Sendai Framework for Disaster Risk Reduction 2015–2030*, United Nations.

Online Learning Resources:

1. NPTEL – Disaster Management
<https://nptel.ac.in/>
2. National Disaster Management Authority (NDMA)
<https://ndma.gov.in/>
3. National Institute of Disaster Management (NIDM)
<https://nidm.gov.in/>
4. United Nations Office for Disaster Risk Reduction (UNDRR)
<https://www.undrr.org/>
5. SWAYAM – Disaster Management Courses
<https://swayam.gov.in/>

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Course Code	SANSKRIT FOR TECHNICAL KNOWLEDGE	L	T	P	C
26AD9003HS		2	-	-	0

Course Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
2. To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects.
3. To explore the huge knowledge from ancient Indian literature.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** Develop passion towards Sanskrit language
- CO2:** Decipher the latent engineering principles from Sanskrit literature
- CO3:** Correlates the technological concepts with the ancient Sanskrit history.
- CO4:** Develop knowledge for the technological progress
- CO5:** Explore the avenue for research in engineering with aid of Sanskrit

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	2	1	-	-	-	-	-	2	-	3	2	1	-
CO 2	3	2	1	-	-	-	-	2	-	2	2	1	1
CO 3	3	3	2	1	-	-	-	2	-	2	2	2	2
CO 4	3	3	2	2	1	-	-	2	-	2	2	2	2
CO 5	3	2	2	1	-	-	1	2	-	2	2	2	2

UNIT 1

Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa- parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)

UNIT 2

Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).

The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

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Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

UNIT 4**Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology):**

Computer languages and the Sanskrit languages-computer command words and the vedic command words- analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

UNIT 5

Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram

Text Books:

1. M Krishnamachariar, History of Classical Sanskrit Literature, TTD Press, 1937.
2. M.R. Kale, A Higher Sanskrit Grammar: For the Use of School and College Students, Motilal Banarsidass Publishers, 2015.
3. Kapail Kapoor, Language, Linguistics and Literature: The Indian Perspective, ISBN- 10: 8171880649, 1994.
4. Pride of India, Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5. Shri Rama Verma, Vedas the source of ultimate science, Nag publishers, 2005.

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Course Code		VALUE EDUCATION										L	T	P	C
26AD9004HS												2	-	-	0
Course Objectives															
1.Understand the need and importance of Values for self-development and for National development.															
2.Imbibe good human values and Morals.															
3.Cultivate individual and National character.															
Course Outcomes (CO's):															
CO1:	Gain necessary Knowledge for self-development														
CO2:	Learn the importance of Human values and their application in day to day professional life.														
CO3:	Appreciate the need and importance of interpersonal skills for successful career and social life.														
CO4:	Emphasize the role of personal and social responsibility of an individual for all-round growth														
CO5:	Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.														
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	1	-	-	-	-	2	-	3	1	1	2	-	-		
CO 2	1	-	-	-	-	2	-	3	2	1	2	-	-		
CO 3	1	-	-	-	-	3	-	3	2	2	2	-	-		
CO 4	1	-	-	-	-	2	-	3	2	2	2	-	-		
CO 5	1	-	-	-	-	3	-	3	2	2	3	-	-		
UNIT 1															
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.															
UNIT 2															
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.															
UNIT 3															
Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.															

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UNIT 4

Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

UNIT 5

Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

Text Books:

1. Chakroborty, S.K., Values & Ethics for organizations Theory and practice, Oxford University Press, New Delhi, 1998.
2. Jaya Dayal Goyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning, Gita Press, Gorakhpur, 2017.

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Course Code	ADVANCED CONCRETE TECHNOLOGY	L	T	P	C
26PC1151SE	LABORATORY	-	-	3	1.5

Course Objectives:

Upon successful completion of this course, the student will be able to:

1. Develop advanced concrete mixes including high-strength, fly ash-based, geo polymer, and fiber reinforced concrete using standard mix design procedures.
2. Evaluate the fresh, mechanical, and durability-related properties of advanced concrete through laboratory testing.
3. Perform destructive and non-destructive testing (NDT) techniques for assessing the structural performance and quality of concrete.
4. Investigate the structural behaviour of reinforced concrete members under flexural and shear loading through experimental studies.
5. Interpret experimental results and establish correlations between destructive and non-destructive test methods for engineering applications.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Design and prepare high-strength, fly ash-based, geo polymer, and fiber reinforced concrete mixes using standard procedures.
CO2:	Evaluate the fresh and hardened properties of advanced concrete through laboratory experiments.
CO3:	Conduct destructive tests to determine the mechanical properties and structural behaviour of concrete specimens and reinforced concrete members.
CO4:	Perform non-destructive testing of concrete using Rebound Hammer and Ultrasonic Pulse Velocity (UPV) methods.
CO5:	Analyze experimental data and establish correlations between destructive and non-destructive test results for structural assessment.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	2	3	-	-	-	-	-	2	3	3
CO 2	3	3	2	3	3	-	-	-	-	-	2	3	3
CO 3	3	3	3	3	3	-	-	-	-	-	2	3	3
CO 4	3	3	2	3	3	-	-	-	-	-	2	3	3
CO 5	3	3	3	3	3	-	-	-	-	-	3	3	3

LIST OF EXPERIMENTS

1. To design the mix for High Strength Concrete.
2. To determine fresh properties of High Strength Concrete.
3. Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
4. Behaviour of beams under flexure and shear.
5. Mix proportion on fly-ash based concrete for compressive strength.
6. Mix proportion on Geo-polymer concrete for compressive strength.
7. Mix proportion on FRC for compressive strength.

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8. Cube compressive strength of fly-ash and geo polymer concrete.
9. Split tensile strength and modulus of rupture for fly-ash concrete/geo-polymer concrete.
10. Development of correlation between Non-Destructive and Destructive Tests using Rebound Hammer and UPV instruments.

Text Books:

1. Neville, A. M., *Properties of Concrete*, 5th Edition, Pearson Education Limited, 2011.
2. Mehta, P. Kumar & Monteiro, Paulo J. M., *Concrete: Microstructure, Properties and Materials*, 4th Edition, McGraw-Hill Education, 2014.
3. Shetty, M. S., *Concrete Technology: Theory and Practice*, S. Chand Publishing, Revised Edition, 2019.

Reference Books:

1. Li, Zongjin, *Advanced Concrete Technology*, 2nd Edition, John Wiley & Sons, 2022.
2. Newman, John & Choo, Ban Seng (Eds.), *Advanced Concrete Technology*, Elsevier, 2003.
3. Malhotra, V. M. & Carino, N. J., *Handbook on Non-Destructive Testing of Concrete*, 2nd Edition, CRC Press, 2004.
4. Naik, Tarun R. & Moriconi, Giacomo, *Environmental-Friendly Durable Concrete Made with Recycled Materials*, CRC Press, 2008.
5. IS 10262:2019, *Concrete Mix Proportioning – Guidelines*, Bureau of Indian Standards, New Delhi.

Online Learning Resources:

1. NPTEL – Advanced Concrete Technology
<https://archive.nptel.ac.in/courses/105/106/105106176/>
2. NPTEL – Concrete Technology
<https://nptel.ac.in/courses/105105208>
3. National Council for Cement and Building Materials (NCCBM)
<https://www.nccbm.res.in/>
4. American Concrete Institute (ACI)
<https://www.concrete.org/>
5. The Concrete Centre (UK)
<https://www.concretecentre.com/>
6. YouTube – NPTEL Advanced Concrete Technology Laboratory Lectures
https://www.youtube.com/results?search_query=Advanced+Concrete+Technology+NPTEL

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Course Code	STRUCTURAL DESIGN LAB	L	T	P	C
26PC1152SE		-	-	3	1.5

Course Objectives:

Upon successful completion of this course, the student will be able to:

1. Perform manual seismic and wind load calculations for reinforced concrete buildings in accordance with relevant Indian Standards.
2. Design and detail reinforced concrete structural members subjected to seismic and wind loads following ductile detailing provisions.
3. Analyze and design multi-storey reinforced concrete buildings using structural analysis and design software.
4. Compare manual design calculations with software-generated results and evaluate their accuracy.
5. Develop professional skills in structural design, detailing, documentation, and interpretation of analysis results.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- | | |
|-------------|---|
| CO1: | Compute seismic and wind loads on reinforced concrete buildings using relevant Indian Standard codes. |
| CO2: | Design and detail beams, columns, and beam-column joints for earthquake-resistant reinforced concrete structures. |
| CO3: | Perform manual analysis and design of multi-storey reinforced concrete buildings subjected to seismic and wind loads. |
| CO4: | Analyze and design reinforced concrete buildings using structural analysis and design software and validate the results with manual calculations. |
| CO5: | Interpret structural analysis results and prepare professional structural design and detailing documents in accordance with codal provisions. |

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	2	3	-	-	-	-	-	2	3	3
CO 2	3	3	3	2	3	-	-	-	-	-	2	3	3
CO 3	3	3	3	3	3	-	-	-	-	-	2	3	3
CO 4	3	3	3	3	3	-	-	-	-	-	3	3	3
CO 5	3	3	3	3	3	-	-	-	-	2	3	3	3

LIST OF EXPERIMENTS

Seismic & Wind Analysis and Design:

1. Calculation of design seismic force by static and dynamic methods of IS 1893.
2. Calculation of lateral force distribution as per Torsion provisions of IS 1893.
3. Beam design of an RC frame building as per IS 13920.
4. Column design of an RC frame building as per IS 13920.
5. Beam-column joint design of an RC frame building as per IS 13920.
6. Complete manual seismic analysis, design and detailing of a simple G+3 storied building and its comparison with any structural analysis and design software.

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7. Calculation of wind pressures and design forces on walls and roof of a rectangular building.
8. Calculation of design wind forces on a RC building using force coefficient method.
9. Calculation of design wind forces on a RC building using Gust Factor Approach.
10. Complete manual wind analysis and design of a simple G+3 storied structure using any structural analysis and design software and its comparison with any structural analysis and design software.

Text Books:

1. P. C. Varghese, *Advanced Reinforced Concrete Design*, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2009.
2. N. Subramanian, *Design of Reinforced Concrete Structures*, Oxford University Press, New Delhi, 2019.
3. Bureau of Indian Standards, *IS 456:2000 – Plain and Reinforced Concrete – Code of Practice; IS 875 (Parts 1–3): 2015; IS 1893 (Part 1): 2016; IS 13920:2016 (including latest amendments)*, BIS, New Delhi.

Reference Books:

1. Bungalow S. Taranath, *Reinforced Concrete Design of Tall Buildings*, CRC Press, 2010.
2. N. Krishna Raju, *Advanced Reinforced Concrete Design*, CBS Publishers & Distributors, New Delhi.
3. Edward L. Wilson, *Three-Dimensional Static and Dynamic Analysis of Structures*, Computers and Structures Inc., Berkeley, California.
4. S. Unnikrishna Pillai & Devdas Menon, *Reinforced Concrete Design*, Tata McGraw-Hill Education.
5. Ashok K. Jain, *Limit State Design of Reinforced Concrete*, Nem Chand & Bros., Roorkee.

Online Learning Resources:

1. NPTEL – Design of Reinforced Concrete Structures
<https://nptel.ac.in/courses/105105105>
2. NPTEL – Earthquake Resistant Design of Structures
<https://archive.nptel.ac.in/courses/105/102/105102160/>
3. NPTEL – Design of Steel Structures
<https://archive.nptel.ac.in/courses/105/105/105105162/>
4. Bureau of Indian Standards (BIS)
<https://www.services.bis.gov.in/>
5. Computers and Structures Inc. (CSI – ETABS/SAP2000)
<https://www.csiamerica.com/>
6. Bentley Systems – STAAD.Pro Learning Resources
<https://www.bentley.com/software/staad/>

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Course Code	SEMINAR	L	T	P	C
26PW1151SE		-	-	3	1.5

Course Objectives:

Upon successful completion of this course, the student will be able to:

1. Develop the ability to identify, review, and critically analyze recent research literature in Structural Engineering.
2. Enhance technical writing, presentation, and scientific communication skills.
3. Identify research gaps and propose future research directions in a chosen area of specialization.
4. Strengthen analytical thinking, independent learning, and ethical research practices.
5. Prepare and present a technical seminar following professional and academic standards.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Identify and review recent research literature in a selected area of Structural Engineering.
CO2:	Critically analyze research methodologies, findings, and technical contributions reported in scholarly publications.
CO3:	Identify research gaps and suggest potential future research directions.
CO4:	Deliver effective technical presentations using appropriate scientific communication techniques.
CO5:	Prepare a seminar report in a professional format adhering to technical writing and referencing standards.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	1	3	2	-	-	2	-	3	-	3	2
CO 2	3	3	2	3	2	-	-	2	-	3	-	3	3
CO 3	3	3	3	3	2	-	-	2	-	3	1	3	3
CO 4	2	2	2	2	2	-	-	2	3	3	-	2	2
CO 5	2	2	2	2	2	-	-	3	2	3	1	2	2

GUIDELINES:

1. Each student shall select a recent and technically relevant research topic in the area of Structural Engineering, preferably related to the student's area of specialization and intended future research/dissertation work.
2. The selected topic shall preferably be based on recent research publications, normally published within the last five years, with emphasis on peer-reviewed international/national journals, reputed conference proceedings, relevant codes and standards, and authoritative technical reports.
3. Each student shall carry out a comprehensive and systematic literature survey under the guidance of an allotted faculty supervisor.
4. The seminar shall demonstrate the student's ability to understand, analyse, compare, and critically evaluate existing research rather than merely reproduce or summarize published literature.

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5. The literature survey shall cover relevant theoretical developments, research methodologies, important findings, limitations, applications, and emerging trends associated with the selected topic.
6. The student shall identify and clearly explain the research gaps, unresolved issues, limitations, or challenges identified from the reviewed literature.
7. Based on the literature review and critical analysis, the student shall propose appropriate future research directions and indicate the possible scope for further investigation.
8. The seminar report shall normally contain the following sections:
 - Title
 - Abstract
 - Introduction
 - Problem Statement
 - Objectives
 - Literature Review
 - Critical/Comparative Analysis of Reviewed Studies
 - Research Gap Identification
 - Research Methodologies Adopted in the Reviewed Studies
 - Key Findings and Technical Discussion
 - Future Scope / Proposed Research Directions
 - Conclusions
 - References
9. References shall be cited consistently using an accepted academic referencing style such as IEEE, APA, or ASCE, as prescribed by the Department.
10. Students shall prepare professional presentation slides containing appropriate technical content, figures, tables, graphs, flowcharts, and other scientific illustrations wherever required.
11. Each student shall deliver the seminar before a Departmental Evaluation Committee constituted by the Head of the Department.
12. The seminar presentation shall normally be of 20–25 minutes' duration, followed by approximately 10–15 minutes of discussion and questions.
13. Students shall demonstrate adequate understanding of the selected topic and shall be able to explain the reviewed research methodologies, findings, limitations, research gaps, and future directions.
14. The seminar shall emphasize independent learning, critical thinking, scientific communication, technical writing, ethical use of literature, and proper acknowledgement of sources. Plagiarism and inappropriate use of copyrighted material shall be avoided.
15. The seminar topic should, wherever possible, contribute to the student's future dissertation/research work and help establish a strong technical foundation for subsequent research.
16. The Seminar course shall be evaluated entirely through Continuous Internal Evaluation (CIE) for 50 marks. There shall be no Semester-End Examination (SEE) for this course.

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CONTINUOUS INTERNAL EVALUATION (CIE) – 50 MARKS

The CIE shall assess the student's continuous literature survey, critical analysis, seminar preparation, technical presentation, report quality, and response to questions.

Evaluation by	Evaluation Component	Max. Marks
Faculty Supervisor	Topic Selection & Relevance	05
	Literature Survey & Progress	05
	Critical Analysis & Research Gap Identification	05
	Seminar Report / Continuous Work	05
Departmental Evaluation Committee	Technical Understanding & Content	05
	Literature Review & Comparative Analysis	05
	Research Gap & Future Research Directions	05
	Presentation & PPT Quality	05
	Seminar Report Quality	05
	Question & Answer / Viva-Voce	05
	Total CIE	50

Text Books:

1. C. R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition, New Age International Publishers, 2019.
2. Kate L. Turabian, A Manual for Writers of Research Papers, Theses, and Dissertations, 9th Edition, University of Chicago Press, 2018.
3. Day, R. A. & Gastel, B., How to Write and Publish a Scientific Paper, 8th Edition, Cambridge University Press, 2016.

Reference Books:

1. Michael Alley, The Craft of Scientific Presentations, Springer, 2013.
2. Robert A. Day & Barbara Gastel, Scientific English: A Guide for Scientists and Other Professionals, Greenwood, 2012.
3. Wayne C. Booth, Gregory G. Colomb & Joseph M. Williams, The Craft of Research, 4th Edition, University of Chicago Press, 2016.

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4. American Society of Civil Engineers (ASCE), Author's Guide to Journals, Latest Edition.
5. Springer Nature, Writing and Publishing Scientific Papers, Springer, Latest Edition.

Online Learning Resources:

1. **NPTEL – Technical English for Engineers**
<https://nptel.ac.in/courses/109106094>
2. **NPTEL – Research Methodology**
<https://nptel.ac.in/courses/109105115>
3. **Springer Nature Researcher Academy**
<https://researcheracademy.springernature.com>
4. **Elsevier Researcher Academy**
<https://researcheracademy.elsevier.com>
5. **Google Scholar** (for literature survey)
<https://scholar.google.com>
6. **ASCE Library** (Structural Engineering journals)
<https://ascelibrary.org>


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B

Course Code		STRUCTURAL DYNAMICS										L	T	P	C
26PC1103SE												3	-	-	3
Course Objectives:															
1. Understand the fundamentals of structural vibration, dynamic loading, and formulation of equations of motion for structural systems.															
2. Analyze the dynamic response of single-degree-of-freedom systems subjected to free and forced vibrations.															
3. Apply dynamic analysis techniques to evaluate the response of multi-degree-of-freedom structural systems.															
4. Evaluate the dynamic characteristics of structural systems using approximate and iterative vibration analysis methods.															
5. Apply the principles of structural dynamics in earthquake-resistant analysis and design of civil engineering structures.															
Course Outcomes (CO's):															
After completing this course, the student will be able to:															
CO1:	Formulate the equations of motion for structural systems subjected to dynamic loading.														
CO2:	Analyze the free and forced vibration response of single-degree-of-freedom structural systems.														
CO3:	Apply dynamic analysis methods to determine the response of multi-degree-of-freedom structural systems.														
CO4:	Evaluate the dynamic characteristics of structures using approximate methods and continuous system modelling.														
CO5:	Apply structural dynamics principles for earthquake response analysis and seismic design as per relevant IS Codes.														
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	3	2	–	2	1	–	–	–	–	–	2	3	2		
CO 2	3	3	1	2	2	–	–	–	–	–	2	3	3		
CO 3	3	3	2	3	3	–	–	–	–	1	2	3	3		
CO 4	3	3	2	3	2	–	–	–	–	1	2	3	3		
CO 5	3	3	3	2	2	1	1	–	–	1	2	3	3		
UNIT 1															
Principles of Vibration Analysis:															
Introduction - Elements of vibratory system - Degrees of Freedom -Continuous System - Lumped mass idealization - Oscillatory motion - Simple Harmonic motion -Vectorial representation of S.H.M. – Fundamental objectives of dynamic analysis -Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods – Direct equilibration using Newton’s law of motion / D’Alembert’s principle, Principle of virtual work and Hamilton principle.															
UNIT 2															

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B

Single Degree of Freedom Systems:

Free vibrations of single degree of freedom system -undamped and damped vibrations - critical damping - Logarithmic decrement - Forced vibration of SDOF systems – Half Power (Band-Width) Method-Harmonic excitation - Vibration Isolation –Response to support Motion-Force transmitted to the Foundation-Transmissibility-Dynamic magnification factor – Phase angle.

Response to General Dynamic Loading – Duhamel's Integral-Constant Force, Rectangular load, Triangular load, Response to Periodic loading- Fourier series expression of periodic loading Response to Fourier series loading.

UNIT 3**Dynamic Response of Multi-Degree of Freedom Systems:**

Mathematical models of Multi-degree of freedom systems, orthogonality of normal modes, free and forced vibrations of multi degree of freedom systems Mode superposition technique, Applications-Duhamel integral. Orthogonality of normal modes - Approximate methods.

UNIT 4

Practical Vibration Analysis: Introduction - Stodola method - Fundamental mode analysis - Analysis of second and higher modes - Holzer method - Basic procedure.

UNIT 5

Distributed Parameter Systems: Partial Differential Equation of Motion – Beam Flexure (Elementary case) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates. Earthquake Resistant Design: Brief exposure to relevant IS Codes of Practice, Response Spectra method.

Text Books:

1. Anil K. Chopra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 5th Edition, Pearson Education, 2020.
2. Mario Paz and William Leigh, *Structural Dynamics: Theory and Computation*, 6th Edition, Springer, 2019.
3. S. R. Damodarasamy and S. Kavitha, *Basics of Structural Dynamics and Aseismic Design*, PHI Learning Pvt. Ltd., New Delhi, Latest Edition.

Reference Books:

1. Ray W. Clough and Joseph Penzien, *Dynamics of Structures*, 3rd Edition, Computers & Structures Inc., 2003.
2. James M. Biggs, *Introduction to Structural Dynamics*, McGraw-Hill International Edition, 1964.
3. James C. Anderson and Farzad Naeim, *Basic Structural Dynamics*, Wiley India, 2012.
4. Eduardo Kausel, *Advanced Structural Dynamics*, Cambridge University Press, 2017.
5. Roy R. Craig Jr. and Andrew J. Kurdila, *Fundamentals of Structural Dynamics*, 2nd Edition, Wiley, 2011.

Online Learning Resources:

1. NPTEL – Structural Dynamics (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106151/>

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2. NPTEL – Earthquake Engineering (IIT Kanpur)
<https://archive.nptel.ac.in/courses/105/101/105101004/>
3. NPTEL – Advanced Structural Analysis (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106050/>
4. National Information Centre of Earthquake Engineering (NICEE), IIT Kanpur
<https://www.nicee.org/>
5. SWAYAM – Civil Engineering Courses
<https://onlinecourses.swayam2.ac.in/>

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B

held on 30.07.2020

Course Code	ADVANCED REINFORCED CONCRETE										L	T	P	C
26PC1102SE	DESIGN										3	-	-	3

Course Objectives:
Upon successful completion of this course, the student will be able to:

1. Analyze and design reinforced concrete beams curved in plan using codal provisions.
2. Evaluate and design deep beams considering flexural, shear, and serviceability requirements.
3. Design reinforced concrete domes and water tanks for various loading and storage conditions.
4. Apply codal provisions for the analysis and design of reinforced concrete bunkers and silos.
5. Design raft foundations, pile foundations, pile caps, and machine foundations for practical engineering applications.

Course Outcomes (CO's):
After completing this course, the student will be able to:

CO1:	Design reinforced concrete beams curved in plan in accordance with relevant IS code provisions.
CO2:	Analyze and design reinforced concrete deep beams considering flexural and shear behaviour.
CO3:	Design reinforced concrete domes and water tanks for safe and economical structural performance.
CO4:	Design reinforced concrete bunkers and silos using appropriate analytical methods and codal provisions.
CO5:	Design reinforced concrete raft foundations, pile foundations, pile caps, and machine foundations for structural applications.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	2	2	-	-	-	-	-	2	3	3
CO 2	3	3	3	3	2	-	-	-	-	-	2	3	3
CO 3	3	3	3	2	2	-	-	-	-	-	2	3	3
CO 4	3	3	3	3	2	-	-	-	-	-	2	3	3
CO 5	3	3	3	2	3	1	1	-	-	1	2	3	3

UNIT 1

Beams Curved in Plan: Introduction - design principles – Terminologies, structural design of beams curved in plan of circular and rectangular type.

UNIT 2

Deep Beams: Introduction to deep beams, Flexural and Shear stresses in deep beams, IS Code provisions - design of deep beams.

UNIT 3

Domes: Introduction - Stresses and forces in domes - design of spherical and conical domes.
Water Tanks: Types, Codal specifications, Design of circular and rectangular type water tanks.

UNIT 4

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Bunkers and Silos: Introduction - Design principles and theories Code provisions - design of square and circular bunkers - design of cylindrical silos. IS specifications.

UNIT 5

Raft and Pile Foundations: Introduction, need for the design, Design principles - Structural design of raft and pile foundations including the design of pile caps.

Machine Foundations: Introduction, Types, Design Principles, Case studies, detailed designs.

Text Books:

1. P. C. Varghese, *Advanced Reinforced Concrete Design*, 2nd Edition, PHI Learning Pvt. Ltd.
2. N. Krishna Raju, *Advanced Reinforced Concrete Design*, CBS Publishers & Distributors.
3. N. Subramanian, *Design of Reinforced Concrete Structures*, Oxford University Press.

Reference Books:

1. S. S. Bhavikatti, *Advanced Reinforced Concrete Design*, New Age International Publishers.
2. M. N. Bajad, *Advanced Design of Concrete Structures*, Nirali Prakashan.
3. H. J. Shah, *Reinforced Concrete (Vol. II)*, Charotar Publishing House.
4. B. C. Punmia, Ashok Kumar Jain & Arun Kumar Jain, *R.C.C. Designs*, Laxmi Publications.
5. Georgios Gaganelis, Patrick Forman & Peter Mark, *Advanced Reinforced Concrete Design*, Wiley, 2022.

Online Learning Resources:

1. NPTEL – Advanced Reinforced Concrete Design (IIT Kharagpur)
https://onlinecourses.nptel.ac.in/noc23_ce109/preview
2. NPTEL – Design of Reinforced Concrete Structures (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106116/>
3. NPTEL – Advanced Concrete Technology (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106176/>
4. National Programme on Technology Enhanced Learning (NPTEL) – Civil Engineering
<https://nptel.ac.in/courses/105>
5. IS 456 and BIS Standards Portal
<https://www.services.bis.gov.in/>

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B

Course Code		BRIDGE ENGINEERING										L	T	P	C
26PE1121SE												3	-	-	3
Course Objectives:															
Upon successful completion of this course, the student will be able to:															
1. Understand the planning, loading standards, hydraulic, geological, and geotechnical considerations in bridge engineering.															
2. Analyze and design reinforced concrete bridge deck systems and box girder bridges using codal provisions.															
3. Analyze and design steel and composite bridges for highway and railway applications.															
4. Design bridge substructures, foundations, bearings, and bridge appurtenances.															
5. Apply modern design principles and construction techniques for long-span bridges, including seismic-resistant design.															
Course Outcomes (CO's):															
After completing this course, the student will be able to:															
CO1:	Apply bridge planning principles, loading standards, and site investigations for bridge design.														
CO2:	Analyze and design reinforced concrete bridge deck systems and box girder bridges using relevant IRC provisions.														
CO3:	Design steel truss and composite steel-concrete bridges for structural safety and serviceability.														
CO4:	Design bridge substructures, foundations, bearings, and bridge appurtenances using codal requirements.														
CO5:	Evaluate and design long-span bridges considering construction techniques, seismic resistance, inspection, and maintenance requirements.														
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	3	2	1	2	2	–	1	–	–	–	2	3	2		
CO 2	3	3	3	3	2	–	–	–	–	–	2	3	3		
CO 3	3	3	3	3	2	–	–	–	–	–	2	3	3		
CO 4	3	3	3	2	2	1	1	–	–	–	2	3	3		
CO 5	3	3	3	3	3	1	2	–	–	1	2	3	3		
UNIT 1															
Introduction: Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments, box girder bridges, historical bridges (in India and overseas). Planning and layout of bridges, hydraulic design, geological and geo-technical considerations; Design aids, computer software, expert systems.															
UNIT 2															
Concrete Bridges: Bridge deck and approach slabs, Slab design methods, design of bridge deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.															

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Bridge deck and approach slabs, Slab design methods, design of bridge deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.

UNIT 3

Steel and Composite Bridges: Introduction to composite bridges, Advantages and disadvantages, Orthotropic decks, box girders, composite steel-concrete bridges, analysis and design, truss bridges.

UNIT 4

Sub-Structure: Piers, columns and towers, analysis and design, shallow and deep foundations, caissons, abutments and retaining walls. **Bridge appurtenances:** Expansion joints, design of joints, types and functions of bearings, design of elastomeric bearings, railings, drainage system, lighting.

UNIT 5

Long span bridges: Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices. Construction techniques (cast in-situ, prefabricated, incremental launching, free cantilever construction), inspection, maintenance and rehabilitation, current design and construction practices.

Text Books:

1. S. Ponnuswamy, *Bridge Engineering*, 3rd Edition, McGraw-Hill Education (India).
2. D. Victor Johnson, *Essentials of Bridge Engineering*, 7th Edition, CBS Publishers & Distributors.
3. Weiwei Lin and Teruhiko Yoda, *Bridge Engineering: Classifications, Design Loading, and Analysis Methods*, Elsevier, 2017.

Reference Books:

1. Wai-Fah Chen and Lian Duan, *Bridge Engineering Handbook*, CRC Press.
2. Gongkang Fu, *Bridge Design and Evaluation*, John Wiley & Sons.
3. Barker, R. M. and Puckett, J. A., *Design of Highway Bridges*, John Wiley & Sons.
4. P. P. Xanthakos, *Theory and Design of Bridges*, John Wiley & Sons.
5. Hamid Yaghoubi, *Bridge Engineering*, IntechOpen.

Online Learning Resources:

1. NPTEL – Bridge Engineering (IIT Kharagpur)
<https://archive.nptel.ac.in/courses/105/105/105105216/>
2. NPTEL – Prestressed Concrete Structures (IIT Madras)
<https://archive.nptel.ac.in/courses/105/106/105106118/>
3. Indian Roads Congress (IRC)
<https://www.irc.nic.in/>
4. Indian Academy of Highway Engineers (IAHE)
<https://www.iahe.org.in/>
5. MoRTH (Ministry of Road Transport & Highways)
<https://morth.nic.in/>

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B

Course Code		DESIGN OF PRESTRESSED CONCRETE STRUCTURES										L	T	P	C
26PE1122SE												3	-	-	3
Course Objectives: Upon successful completion of this course, the student will be able to: 1. Understand the principles, systems, materials, and methods of prestressing and evaluate the effects of various losses of prestress. 2. Analyze prestressed concrete members for stress distribution, pressure line, load balancing, and deflection under service conditions. 3. Analyze and design prestressed concrete members for flexure, shear, and torsion based on relevant codal provisions. 4. Analyze and design prestressed concrete pipes subjected to prestressing forces and service loads. 5. Analyze and design prestressed concrete one-way and two-way floor slabs for strength and serviceability requirements.															
Course Outcomes (CO's): After completing this course, the student will be able to:															
CO1:		Explain prestressing systems and evaluate the stresses and losses in prestressed concrete members.													
CO2:		Analyze prestressed concrete members for deflection and determine their ultimate flexural strength.													
CO3:		Analyze and design prestressed concrete members for shear and torsion using relevant codal provisions.													
CO4:		Analyze and design circular prestressed concrete pipes for specified loading and service conditions.													
CO5:		Analyze and design prestressed concrete one-way and two-way slabs for strength and serviceability requirements.													
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1		
CO 2	CO1	3	3	2	2	2	-	-	-	-	-	2	3		
CO 3	CO2	3	3	3	3	3	-	-	-	-	2	2	3		
CO 4	CO3	3	3	3	3	3	-	-	-	-	2	2	3		
CO 5	CO4	3	3	3	3	3	-	-	-	-	2	2	3		
UNIT 1															
Introduction: Prestressing Systems – Pre-tensioning Systems – Post-tensioning Systems – High Strength Steel and Concrete - Analysis of Prestress - Resultant Stresses at a Section – Pressure Line or Thrust Line – Concept of Load Balancing. Losses of Prestress – Loss Due to Elastic Deformation of Concrete – Shrinkage of Concrete –Creep – Relaxation of Stress in Steel – Friction – Anchorage Slip.															
UNIT 2															
Deflections of Prestressed Concrete Members: Importance of Control of Deflections – Factors Influencing Deflection – Short-term Deflections of Uncracked Members – Prediction of Long-time															

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Deflections – Deflections of Cracked Members – Requirements of IS 1343-2012.

Ultimate Flexural Strength of Beams: Introduction, Flexural theory using first principles – Simplified Methods – Ultimate Moment of Resistance of untensioned Steel.

UNIT 3

Shear: Shear in principal stresses – cracked and un-cracked sections - codal provisions – Design of shear reinforcement.

Torsion: Torsion for cracked and un-cracked sections, codal provisions and design.

UNIT 4

Prestressed Concrete Pipes: Circular Prestressing, Types of Prestressed Concrete Pipes, Design Of Prestressed Concrete Pipes.

UNIT 5

Slabs: Types of Prestressed Concrete Floor Slabs- Design of Prestressed Concrete One Way and Two Way Slabs.

Text Books:

1. N. Krishna Raju, *Prestressed Concrete*, 6th Edition, Tata McGraw-Hill Education, New Delhi.
2. T. Y. Lin and Ned H. Burns, *Design of Prestressed Concrete Structures*, 3rd Edition, John Wiley & Sons.
3. □ P. Dayaratnam, *Prestressed Concrete Structures*, Oxford & IBH Publishing Co., New Delhi.

4. Reference Books:

1. N. Rajagopalan, *Prestressed Concrete*, Narosa Publishing House, New Delhi.
2. Antoine E. Naaman, *Prestressed Concrete Analysis and Design: Fundamentals*, 3rd Edition, Techno Press.
3. T. Y. Lin, Ned H. Burns and H. Nilson, *Design of Prestressed Concrete Structures*, John Wiley & Sons.
4. Edward G. Nawy, *Prestressed Concrete: A Fundamental Approach*, Pearson Education.
5. Christian Menn, *Prestressed Concrete Bridges*, Birkhäuser.

Online Learning Resources:

1. **NPTEL – Prestressed Concrete Structures**
NPTEL Courses Useful for fundamentals of prestressing, analysis, losses, flexure and design concepts.
2. **NPTEL – Prestressed Concrete Structures / Structural Design Courses**
NPTEL Civil Engineering Courses Useful for supplementary lectures on prestressed concrete and structural design.
3. **Bureau of Indian Standards (BIS)** – for verification and use of IS 1343:2012 and related structural codes. Bureau of Indian Standards
4. **NPTEL – Design of Reinforced Concrete Structures**
NPTEL – Civil Engineering Courses Useful as supplementary material for flexure, shear, torsion and slab design principles.

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B

Course Code		INFRASTRUCTURAL ENGINEERING & MANAGEMENT										L	T	P	C
26PE1123SE												3	-	-	3
Course Objectives Upon successful completion of this course, the student will be able to: 1. Understand the fundamentals, significance, and current status of infrastructure systems in economic development. 2. Analyze infrastructure planning techniques for forecasting demand, supply, and level of service. 3. Evaluate risk management strategies and sustainable approaches for infrastructure project planning and execution. 4. Analyze technical, economic, environmental, and contractual challenges associated with infrastructure projects. 5. Apply contract laws, legal frameworks, and dispute resolution mechanisms in infrastructure project management.															
Course Outcomes (CO's): After completing this course, the student will be able to:															
CO1:	Explain the fundamentals, classifications, and role of infrastructure in economic development.														
CO2:	Analyze infrastructure planning methods for estimating demand, supply, and service levels.														
CO3:	Evaluate risk management strategies and sustainable planning approaches for infrastructure projects.														
CO4:	Analyze the technical, economic, environmental, and contractual challenges encountered in infrastructure development.														
CO5:	Apply contract laws and dispute resolution mechanisms in the planning and management of infrastructure projects.														
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	2	2	–	1	1	2	1	–	–	2	2	2	1		
CO 2	2	3	2	2	2	2	1	–	–	2	2	2	2		
CO 3	2	3	2	3	2	3	3	–	–	2	2	2	2		
CO 4	2	3	2	3	2	3	3	1	–	2	2	2	2		
CO 5	2	2	2	2	1	3	2	2	1	3	2	2	1		
UNIT 1															
Introduction to Infrastructure Definition of basic terminologies, role of infrastructure in economic development, types of infrastructure, measurement of infrastructure capacity, Indian scenario in respect of adequacy and quality.															
UNIT 2															
Infrastructure Planning Goals and objectives of infrastructure planning, identification and quantification of the casual factors are influencing the demand for infrastructure, review and application of techniques to															

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estimate supply and demand for infrastructure, models to forecast the demand and level of service of infrastructure.

UNIT 3

Strategies for Infrastructure Projects

Risk management framework for infrastructure projects, shaping the planning phase of infrastructure projects to mitigate risks, designing sustainable contracts, sustainable development of infrastructure, innovative design and maintenance of infrastructure facilities.

UNIT 4

Challenges in Infrastructure Planning

Mapping and facing the landscape of risks in infrastructure projects, economic and demand risks, socio environmental risks, cultural risks in international, infrastructure projects, legal and contractual issues in infrastructure, challenges in construction and maintenance of infrastructure

UNIT 5

Contract Laws & Legal Framework of Construction

Introduction contracts; Indian contract act-1872, provision of the act, classification of contracts, contract documents, types of contract, alternative dispute resolution methods-negotiations, mediations, conciliation, dispute resolution boards, arbitration, litigation.

Text Books:

1. Alvin S. Goodman and Makarand Hastak, *Infrastructure Planning Handbook*, McGraw-Hill Professional.
2. C. S. ReVelle, E. E. Whitlatch and J. R. Wright, *Civil and Environmental Systems Engineering*, Prentice Hall.
3. Neil S. Grigg, *Infrastructure Engineering and Management*, Wiley.

Reference Books:

1. W. Ronald Hudson, Ralph Haas and Waheed Uddin, *Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation and Renovation*, McGraw-Hill.
2. Bent Flyvbjerg, *The Oxford Handbook of Megaproject Management*, Oxford University Press.
3. R. L. K. Tiong (Ed.), *Risk Management in Construction Projects*, Springer.
4. Kumar Neeraj Jha, *Construction Project Management: Theory and Practice*, Pearson Education.
5. FIDIC, *Conditions of Contract for Construction (Red Book)*, International Federation of Consulting Engineers.

Online Learning Resources:

1. NPTEL – Infrastructure Planning and Management (IIT Kharagpur)
<https://archive.nptel.ac.in/courses/105/106/105106188/>
2. NPTEL – Construction Project Management (IIT Delhi)
<https://onlinecourses.nptel.ac.in/>
3. SWAYAM – Project Management and Infrastructure-related Courses
<https://swayam.gov.in/>
4. Indian Roads Congress (IRC)
<https://www.irc.nic.in/>
5. Ministry of Housing and Urban Affairs (MoHUA)
<https://mohua.gov.in/>

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B

Course Code	DESIGN OF INDUSTRIAL STRUCTURES										L	T	P	C
26PE1124SE											3	-	-	3
Course Objectives:														
Upon successful completion of this course, the student will be able to:														
1. Analyze industrial steel building systems subjected to gravity and wind loads.														
2. Design industrial building components including trusses, gantry girders, columns, purlins, girts, bracings, and their connections.														
3. Evaluate transmission line towers for wind loading and structural performance.														
4. Apply the principles of cold-formed light gauge steel design considering local buckling and effective width concepts.														
5. Design pre-engineered buildings and cold-formed steel structural members as per relevant IS codes.														
Course Outcomes (CO's):														
After completing this course, the student will be able to:														
CO1:	Analyze industrial steel buildings under gravity and wind loads.													
CO2:	Design industrial structural components and their connections as per relevant IS codes.													
CO3:	Analyze and design transmission line towers subjected to wind loading.													
CO4:	Apply the principles of cold-formed light gauge steel design considering effective width and local buckling.													
CO5:	Design pre-engineered buildings and cold-formed steel members for industrial applications.													
CO-PO Articulation Matrix:														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	
CO 1	3	3	2	2	2	–	–	–	–	2	2	3	2	
CO 2	3	3	3	2	2	–	–	–	–	2	2	3	3	
CO 3	3	3	3	2	2	–	–	–	–	2	2	3	3	
CO 4	3	3	2	3	2	–	–	–	–	2	2	3	2	
CO 5														
UNIT 1														
Introduction:														
Analysis of industrial building for Gravity and Wind load. Analysis and design of framing components namely, girders, trusses, gable frames.														
UNIT 2														
Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections														
UNIT 3														
Analysis of transmission line towers for wind load and design of towers including all connections														
UNIT 4														

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B

Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.

UNIT 5

Concept of Pre-engineered buildings, Design of compression and tension members of cold formed light gauge sections, Design of flexural members (Laterally restrained / laterally unrestrained)

Text Books:

1. N. Subramanian, *Design of Steel Structures*, Oxford University Press, 2nd Edition, 2018.
2. S.K. Duggal, *Limit State Design of Steel Structures*, McGraw Hill Education India, 3rd Edition, 2019.
3. **Bureau of Indian Standards (BIS),**
 - **IS 800:2007** – *General Construction in Steel – Code of Practice.*
 - **IS 875 (Parts 1, 2 & 3)** – *Design Loads (Dead, Imposed and Wind Loads).*
 - **IS 801:1975 (Latest Revision, if applicable)** – *Code of Practice for Use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction.*

Reference Books:

1. Ram Chandra & Virendra Gehlot, *Design of Steel Structures*, Volumes I & II, Scientific Publishers.
2. B.C. Punmia, Ashok Kumar Jain & Arun Kumar Jain, *Design of Steel Structures*, Laxmi Publications.
3. Edwin H. Gaylord Jr., Charles N. Gaylord & James E. Stallmeyer, *Design of Steel Structures*, McGraw-Hill International.
4. Srinivasan Chandrasekaran, *Advanced Steel Design of Structures*, CRC Press, 2020.
5. Wei-Wen Yu & Roger A. LaBoube, *Cold-Formed Steel Design*, John Wiley & Sons.

Online Learning Resources:

1. **NPTEL – Design of Steel Structures (IIT Kharagpur)**
<https://nptel.ac.in/courses/105106112>
2. **NPTEL – Advanced Steel Design**
https://onlinecourses.nptel.ac.in/noc22_oe02/preview
3. **NPTEL Archive – Steel Structures (IIT Kharagpur)**
<https://archive.nptel.ac.in/courses/105/105/105105105/>
4. **Bureau of Indian Standards (BIS) – Indian Standards and Codes**
<https://www.services.bis.gov.in>
5. **Institute for Steel Development & Growth (INSDAG) – Design manuals, steel construction resources, and educational material**
<https://www.steel-insdag.org>

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Course Code		DESIGN OF HIGH RISE STRUCTURES										L	T	P	C
26PE1125SE												3	-	-	3
Course Objectives:															
1. To study the functioning and behaviour of high rise buildings.															
2. To understand the characteristics and effect of wind loads on buildings.															
3. To understand the effect of earthquake on buildings and to learn the techniques for earthquake resistance.															
4. To analyse tall buildings subjected to lateral loads.															
5. To understand the interaction between the various structural components of high rise structures.															
Course Outcomes (CO's):															
After completing this course, the student will be able to:															
CO1:	Understand the concepts of high rise building structures.														
CO2:	Analyse and design high rise structures subjected to wind loads.														
CO3:	Familiarize with the different structural systems used in high rise buildings.														
CO4:	Analyse and design high rise structures subjected to earthquake loads.														
CO5:	Understand the behaviour and response of slab column frames.														
CO-PO Articulation Matrix:															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2		
CO 1	3	2	2	1	1	–	–	–	–	1	2	3	2		
CO 2	3	3	3	3	3	–	1	–	–	2	3	3	3		
CO 3	3	3	3	2	2	–	1	–	1	2	2	3	3		
CO 4	3	3	3	3	3	1	1	–	1	2	3	3	3		
CO 5	3	3	3	3	3	1	1	–	1	2	3	3	3		
UNIT 1															
Introduction: Design Principles for Lateral Load resistance, ductility considerations in earthquake resistant design of concrete buildings, construction methods, choice of materials, cladding systems and their design principles, types of foundations for tall buildings..															
UNIT 2															
Wind: Introduction to wind, characteristics of wind, impact on structures, wind pressure, internal and external wind, dynamic action of wind, aerodynamic forces, natural frequencies, wind tunnels, types of wind tunnel tests, Introduction to computational fluid dynamics, behaviour of tall buildings subjected to wind, National standards, maximum design loads for buildings and other structures. Calculation of wind loads, special winds, gust, wind speed data and importance. Wind resistant design.															
UNIT 3															
Earthquake: Introduction to earthquake, characteristic, impact of earthquake on ground, foundations and structural elements, response of elements attached to buildings, ground motion, quasi-static approach, dynamic analysis, performance criteria, Vibration Control –															

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active control and passive control, liquefaction effects of earthquakes, Introduction to time history analysis and pushover analysis.

UNIT 4

Structural Systems: Necessity of special structural systems for tall buildings, Structural Systems for Steel Buildings - Braced frames, Staggered Truss System, Eccentric Bracing System, Outrigger & Belt truss system, Tube Systems; Structural Systems for Concrete Buildings - shear walls, frame tube structures, bundled tube structures; Design of shear wall as per IS code.

UNIT 5

Special Topics: Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor levelling problems, Panel zone effects, P-Delta analysis.

Text Books:

1. *Tall Building Structures: Analysis and Design*, Smith, B. S. and Coull, A., John Wiley & Sons, 1991.
2. *Reinforced Concrete Design of Tall Buildings*, Taranath, B. S., CRC Press, 2010.
3. *Tall Building Design: Steel, Concrete and Composite Systems*, Taranath, B. S., CRC Press, 2017.

Reference Books:

1. *Wind Effect on Structures: Modern Structural Design for Wind*, Simiu, E. and Yeo, D., Wiley Blackwell, 2019.
2. *Design of Earthquake Resistant Structures*, Emilio Rosenblueth, Pentech Press Ltd., 1990.
3. *Handbook of Concrete Engineering*, M. Fintel, Von Nostrand Reinhold Company, 1985.
4. *Reinforced Concrete Design of Tall Buildings*, Bungale S. Taranath, Taylor & Francis, 2010.
5. *Designing Tall Buildings: Structure as Architecture*, Mark Sarkisian, Routledge, 2016.

Online Learning Resources:

1. NPTEL – Structural Dynamics
<https://archive.nptel.ac.in/courses/105/106/105106151/>
2. NPTEL – Introduction to Earthquake Engineering
<https://archive.nptel.ac.in/courses/105/101/105101004/>
3. Council on Tall Buildings and Urban Habitat (CTBUH)
<https://www.ctbuh.org>

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Course Code	STRUCTURAL HEALTH MONITORING	L	T	P	C
26PE1126SE		3	-	-	3

Course Objectives

Upon successful completion of this course, the student will be able to:

1. Understand the principles, significance, and methodologies of Structural Health Monitoring (SHM) for civil infrastructure.
2. Analyze vibration-based damage detection techniques and model-based approaches for structural condition assessment.
3. Apply fiber-optic sensing technologies for monitoring strain, temperature, and damage in structures.
4. Evaluate piezoelectric sensor-based acoustic emission and guided wave techniques for damage detection.
5. Assess electrical resistance-based SHM techniques for monitoring damage in advanced composite materials.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- | | |
|-------------|--|
| CO1: | Explain the principles, methodologies, and applications of Structural Health Monitoring for civil infrastructure. |
| CO2: | Analyze structural damage using vibration-based monitoring and model-based diagnostic techniques. |
| CO3: | Apply fiber-optic sensor technologies for structural condition monitoring and damage assessment. |
| CO4: | Evaluate piezoelectric sensor-based acoustic emission and guided wave techniques for structural health monitoring. |
| CO5: | Assess structural integrity using electrical resistance-based sensing techniques for composite materials. |

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	2	2	-	-	-	-	2	2	3	2
CO 2	3	3	2	3	3	-	-	-	-	2	2	3	3
CO 3	3	3	2	3	3	-	-	-	-	2	2	3	3
CO 4	3	3	2	3	3	-	-	-	-	2	2	3	3
CO 5	3	3	2	3	3	-	-	-	-	2	2	3	3

UNIT 1**Introduction to Structural Health Monitoring (SHM):**

Definition of Structural Health Monitoring (SHM), objectives, need and motivation for SHM, steps involved in SHM, SHM as a smart structural system, SHM and biomimetics, process and pre-usage monitoring, SHM as a part of system management, evolution and development of SHM, components of SHM systems, overview of SHM sensors, sensor selection and placement, data acquisition systems, signal conditioning, sampling techniques, feature extraction, data interpretation, and applications of SHM in bridges, buildings, dams, tunnels, and other civil engineering structures.

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UNIT 2

Vibration-Based Techniques for SHM: Basic vibration concepts for SHM -Local and global methods - Damage diagnosis as an inverse problem -Model-based damage assessment - General dynamic behavior - State- space description of mechanical systems - Neural network approach to SHM - The basic idea of neural networks - Detection of delamination in a CFRP plate with stiffeners.

UNIT 3

Fiber-Optic Sensors: Classification of fiber-optic sensors - Intensity-based sensors - Phase-modulated optical fiber sensors - or interferometers -Wavelength based sensors - or Fiber Bragg Gratings (FBG) - The fiber Bragg grating as a strain and temperature sensor - Orientation of the optical fiber optic with respect to the reinforcement fibers - Fiber Bragg gratings as damage sensors for composites -Measurement of strain and stress variations

UNIT 4

SHM with Piezoelectric Sensors: The use of embedded sensors as Acoustic Emission (AE) detectors - Available industrial AE systems- New concepts in acoustic emission - State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research –The full implementation of SHM of localized damage with guided waves in composite materials - Available industrial acousto ultrasonic systems with piezoelectric sensors.

UNIT 5

SHM Using Electrical Resistance: Composite damage - Electrical resistance of unloaded composite - Percolation concept - Anisotropic conduction properties in continuous fiber reinforced polymer - Influence of temperature - Composite strain and damage monitoring by electrical resistance -Randomly distributed fiber reinforced polymers - Damage localization.

Text Books:

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

Reference Books:

1. Victor Giurgiutiu, *Structural Health Monitoring with Piezoelectric Wafer Active Sensors*, 2nd Edition, Academic Press, 2014.
2. Fu-Kuo Chang (Ed.), *Structural Health Monitoring: Current Status and Perspectives*, CRC Press/Technomic, 1997.
3. Alfredo Güemes, Daniel Balageas & Claus-Peter Fritzen, *Structural Health Monitoring*, Wiley, 2010.
4. Vistasp M. Karbhari & Farhad Ansari (Eds.), *Structural Health Monitoring of Civil Infrastructure Systems*, Woodhead Publishing/Elsevier, 2009.
5. M. V. Gandhi & B. S. Thompson, *Smart Materials and Structures*, Springer, 1992.

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1. NPTEL – Structural Health Monitoring
<https://archive.nptel.ac.in/courses/105/105/105105213/>
2. NPTEL – Sensors and Actuators
<https://archive.nptel.ac.in/courses/108/105/108105064/>
3. MIT OpenCourseWare – Civil and Environmental Engineering
<https://ocw.mit.edu/courses/civil-and-environmental-engineering/>
4. International Society for Structural Health Monitoring of Intelligent Infrastructure (ISHMII)
<https://www.ishmii.org/>
5. ASCE Library – Structural Engineering Resources
<https://ascelibrary.org/>
6. ScienceDirect – Structural Health Monitoring Resources
<https://www.sciencedirect.com/topics/engineering/structural-health-monitoring>

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Course Code	RESEARCH METHODOLOGY AND IPR	L	T	P	C
26SD5125ME		3	-	-	3

Course Objectives

The objectives of this course are to:

1. Understand the fundamental concepts, objectives, types, approaches, and processes of research methodology.
2. Develop skills in conducting literature surveys, assessing research sources, and preparing research reports and proposals.
3. Understand research design, experimental design, sampling methods, and planning of research studies.
4. Apply appropriate methods for data collection, organization, statistical analysis, and interpretation of research results.
5. Understand the fundamentals of Intellectual Property Rights, patents, licensing, and technology transfer.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Explain the fundamental concepts, approaches, processes, and criteria of good research.
CO2:	Conduct literature surveys and prepare research reports, proposals, and research grant proposals.
CO3:	Formulate appropriate research designs, experimental plans, and sampling strategies for research studies.
CO4:	Apply suitable data collection, statistical analysis, and interpretation techniques to research problems.
CO5:	Explain Intellectual Property Rights and apply basic principles of patenting, licensing, and technology transfer.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	2	1	-	-	-	-	2	2	2	1
CO 2	3	3	2	3	2	-	-	-	1	3	2	3	2
CO 3	3	3	3	3	2	-	-	-	-	2	2	3	3
CO 4	3	3	2	3	3	-	-	-	-	2	2	3	3
CO 5	2	2	2	2	2	1	-	2	-	2	3	2	2

UNIT 1

Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem.

UNIT 2

Literature Survey and Report writing: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review,

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Guidelines for Review, Record of Research Review.

Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanism of writing a report. **Research Proposal Preparation:** Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

UNIT 3

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, developing a Research Plan, Steps in sample design, types of sample designs.

UNIT 4

Data Collection and Analysis: Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, non- parametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test.

UNIT 5

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, the main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, granting of patent, Rights of a patent, Licensing, Transfer of technology.

Text Books:

1. C. R. Kothari and Gaurav Garg, *Research Methodology: Methods and Techniques*, 4th Edition, New Age International Publishers, New Delhi, 2019.
2. R. Panneerselvam, *Research Methodology*, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2014.
3. □ Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 5th Edition, SAGE Publications, 2019.

Reference Books:

1. John W. Creswell and J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 6th Edition, SAGE Publications, 2023.
2. P. Saravanavel, *Research Methodology*, Kitab Mahal, 2007.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar and M. Mathirajan, *Management Research Methodology: Integration of Principles, Methods and Techniques*, Pearson Education.
4. R. Ganesan, *Research Methodology for Engineers*, MJP Publishers.
5. P. Narayanan, *Intellectual Property Rights*, Eastern Law House.

Online Learning Resources:

1. **NPTEL – Research Methodology**
[NPTEL – Research Methodology Courses](#)
2. **NPTEL – Research Methodology: An Introduction**
[NPTEL Course Portal](#)
3. **Shodhganga – Indian theses and dissertations** — particularly useful for Literature Survey, research-gap identification and understanding research-report structure.
[Shodhganga – INFLIBNET](#)
4. **ShodhShuddhi – Plagiarism Detection Initiative** — useful for research ethics and plagiarism-related aspects of academic research.
[ShodhShuddhi – INFLIBNET](#)

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5. **Indian Patent Advanced Search System (InPASS)** — useful for patent search, patent documents and prior-art study under Unit V.
IP India – Patent Search
6. **Intellectual Property India** — official resource for patents, patent filing, procedures, forms and IPR information.
Intellectual Property India
7. **WIPO – World Intellectual Property Organization** — useful for patents, licensing, technology transfer and international IPR concepts.
WIPO – Intellectual Property

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A-I

B

Course Code	CONSTITUTION OF INDIA AND FUNDAMENTAL RIGHTS	L	T	P	C
25AD9011HS		2	-	-	0

Course Objectives:

Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3: Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO4: Discuss the passage of the Hindu Code Bill of 1956

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	-	-	-	-	-	3	2	3	1	2	-	-	-
CO 2	-	-	-	-	-	3	2	3	1	2	-	-	-
CO 3	-	-	-	-	-	3	2	3	2	3	1	-	-
CO 4	-	-	-	-	-	3	2	3	2	3	1	-	-
CO 5	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT 1

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT 2

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT 3

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT 4

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level:

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Role of Elected and Appointed officials, Importance of grass root democracy.
UNIT 5
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.
Text Books:
1. The Constitution of India, 1950 (Bare Act), Government Publication. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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Course Code	PEDAGOGY STUDIES	L	T	P	C
25AD9012HS		2	-	-	0

Course Objectives:

1. **To present** the basic concepts of design and policies of pedagogy studies.
2. **To provide** understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. **To familiarize** various theories of learning and their connection to teaching practice.
4. **To create** awareness about the practices followed by DFID, other agencies and other researchers.
5. **To provide** understanding of critical evidence gaps that guides the professional development.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
- CO2:** Examine the effectiveness of pedagogical practices.
- CO3:** Understand the concept, characteristics and types of educational research and perspectives of research.
- CO4:** Describe the role of classroom practices, curriculum and barriers to learning.
- CO5:** Understand Research gaps and learn the future directions.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	-	1	-	2	-	2	1	2	3	3	1	-	-
CO 2	-	2	2	3	-	2	1	2	3	3	1	-	-
CO 3	-	2	2	3	2	2	1	2	2	3	2	-	-
CO 4	-	1	1	2	-	3	2	3	3	3	2	-	-
CO 5	-	2	2	3	2	2	1	2	2	3	2	-	-

UNIT 1

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT 2

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT 3

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT 4

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT 5

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

Text Books:

1. Ackers J, Hardman F, Classroom Interaction in Kenyan Primary Schools, Compare||, 31 (2): 245 –261, 2001.
2. Agarwal M, Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3. Akyeampong K, Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER), Country Report 1. London: DFID, 2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282, 2013.
5. Alexander R J, Culture and Pedagogy: International Comparisons in Primary Education, Oxford and Boston: Blackwell, 2001.
6. Chavan M, Read India: A mass scale, rapid, learning to read campaign, 2003.

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B

Course Code	STRESS MANAGEMENT BY YOGA	L	T	P	C
25AD9013HS		2	-	-	0

Course Objectives:

1. Creating awareness about different types of stress and the role of yoga in the management of stress.
2. Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3. Prevention of stress related health problems by yoga practice.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1: Understand yoga and its benefits.

CO2: Enhance Physical strength and flexibility.

CO3: Learn to relax and focus.

CO4: Relieve physical and mental tension through asanas.

CO5: Improve work performance and efficiency.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	-	-	-	-	-	2	3	2	2	2	-	-	-
CO 2	-	-	-	-	-	3	3	2	2	2	-	-	-
CO 3	-	-	-	-	-	3	3	3	2	2	-	-	-
CO 4	-	-	-	-	-	3	3	3	2	2	-	-	-
CO 5	-	-	-	-	-	3	3	3	3	3	1	-	-

UNIT 1

Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT 2

Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT 3

Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT 4

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT 5

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation Techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

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Text Books:

1. "Yogic Asanas for Group Training - Part-I", Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R and Nagaratna R, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan, Bangalore.

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B

Course Code	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
26AD9014HS		2	-	-	0

Course Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1: Develop their personality and achieve their highest goal of life.

CO2: Lead the nation and mankind to peace and prosperity.

CO3: Practice emotional self-regulation.

CO4: Develop a positive approach to work and duties.

CO5: Develop a versatile personality.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	-	-	-	-	-	2	2	3	2	2	-	-	-
CO 2	-	-	-	-	-	3	2	3	3	3	1	-	-
CO 3	-	-	-	-	-	2	2	3	2	2	-	-	-
CO 4	-	-	-	-	-	3	2	3	3	2	1	-	-
CO 5	-	-	-	-	-	3	2	3	3	3	1	-	-

UNIT 1

Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT 2

Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT 3

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT 4

Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT 5

Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Text Books:

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1. Srimad Bhagavad Gita, Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Online Learning Resources:

Online Resources: NPTEL: <http://nptel.ac.in/downloads/109104115/>

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A-I
PROFESSOR
Department of Civil Engineering
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(Autonomous)
Osmania University, Hyderabad-500 007.

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Course Code	VIRTUAL SMART STRUCTURES AND DYNAMICS LAB	L	T	P	C
26PC1153SE		-	-	3	1.5

Course Objectives:

Upon successful completion of this course, the student will be able to:

1. Analyze the dynamic response of structural systems subjected to free, forced, impulse, wind, earthquake, and other dynamic loadings using virtual simulation tools.
2. Understand the vibration characteristics of single-degree-of-freedom (SDOF), multi-degree-of-freedom (MDOF), and continuous structural systems.
3. Apply smart sensing technologies, including piezoelectric sensors and Electro-Mechanical Impedance (EMI) techniques, for structural health monitoring and damage detection.
4. Investigate structural behaviour, vibration control, response spectrum analysis, corrosion detection, and energy harvesting through virtual laboratory experiments.
5. Interpret simulation results using modern virtual laboratory platforms for structural dynamics, smart structures, and displacement measurement applications.

Course Outcomes (CO's):

After completing this course, the student will be able to:

CO1:	Analyze the dynamic behaviour of structural systems subjected to various dynamic loading conditions using virtual simulation techniques.
CO2:	Evaluate the vibration characteristics of SDOF, MDOF, beam, plate, and continuous structural systems.
CO3:	Apply piezoelectric sensor-based Structural Health Monitoring (SHM) techniques for damage detection and structural condition assessment.
CO4:	Interpret response spectrum analysis, vibration control, corrosion detection, and energy harvesting through virtual laboratory simulations.
CO5:	Utilize modern virtual laboratory tools for structural dynamics, smart structures, photogrammetry, and engineering data interpretation.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	3	3	-	-	-	-	-	2	3	3
CO 2	3	3	2	3	3	-	-	-	-	-	2	3	3
CO 3	3	3	3	3	3	-	-	-	-	-	2	3	3
CO 4	3	3	3	3	3	-	-	-	-	-	3	3	3
CO 5	3	3	2	3	3	-	-	-	-	2	3	3	3

LIST OF EXPERIMENTS**Simulation based:**

1. Free Vibration of S.D.O.F System.
2. Forced Vibration of S.D.O.F System.
3. Impulse Response of S.D.O.F System.
4. Concept of Response Spectrum.
5. Vibration of M.D.O.F System.
6. Behaviour of Rigid Blocks.
7. Torsional Response of Building.

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8. Continuous Systems.
9. Vibration Control.
10. Modes of Vibration of Simply Supported Beam Under Flexure.
11. Modes of Vibration of Simply Supported Plate.
12. Damage Detection and Qualitative Quantification Using Electro-Mechanical Impedance (EMI) Technique.
13. Dynamics of Bandra Worli Sea Link Bridge.
14. Piezoelectric Energy Harvesting and Structural Health Monitoring Using Thin Surface Bonded PZT Patches.
15. Shear Lag Effect in Electro-Mechanical Impedance (EMI) Technique.
16. Rebar Corrosion Detection and Assessment Using Electro-Mechanical Impedance (EMI) Technique.
17. Vibration Characteristics of Aluminium Cantilever Beam Using Piezoelectric Sensors.
18. Identification of High Frequency Axial Modes of Beam in "Free-Free" Condition Using Electro- Mechanical Impedance (EMI) Technique.
19. Forced Excitation of Steel Beam Using Portable Shaker.
20. Photogrammetry for Displacement Measurement.

Text Books:

7. Mario Paz & William Leigh, *Structural Dynamics: Theory and Computation*, 6th Edition, Springer, 2019.
8. Anil K. Chopra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 5th Edition, Pearson Education, 2020.
9. Daniel Balageas, Claus-Peter Fritzen & Alfredo Güemes, *Structural Health Monitoring*, Wiley-ISTE, 2006.

Reference Books:

1. Victor Giurgiutiu, *Structural Health Monitoring with Piezoelectric Wafer Active Sensors*, 2nd Edition, Academic Press, 2014.
2. Douglas E. Adams, *Health Monitoring of Structural Materials and Components: Methods with Applications*, John Wiley & Sons, 2007.
3. J. P. Ou, H. Li & Z. D. Duan, *Structural Health Monitoring and Intelligent Infrastructure*, Vol. 1, Taylor & Francis, 2006.
4. Roy R. Craig Jr. & Andrew J. Kurdila, *Fundamentals of Structural Dynamics*, 3rd Edition, Wiley, 2011.
5. Fu-Kuo Chang (Ed.), *Structural Health Monitoring: Current Status and Perspectives*, CRC Press, 1997.

Online Learning Resources:

1. **Virtual Labs – IIT Hyderabad – Structural Dynamics Laboratory**
<http://sd-iiith.vlabs.ac.in/>
2. **Virtual Smart Structures and Dynamics Laboratory – IIT Delhi**
<http://vssd-iitd.vlabs.ac.in/>
3. **NPTEL – Structural Dynamics**
<https://archive.nptel.ac.in/courses/105/101/105101004/>
4. **NPTEL – Structural Health Monitoring**
<https://archive.nptel.ac.in/courses/105/105/105105213/>
5. **MIT OpenCourseWare – Structural Engineering**
<https://ocw.mit.edu/courses/civil-and-environmental-engineering/>
6. **ISHMII**
<https://www.ishmii.org/>

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Course Code	MINI PROJECT										L	T	P	C
26PW1152SE											-	-	6	3
Course Objectives:														
The course aims to:														
1. Develop the ability to identify and formulate a relevant structural engineering problem with research or practical significance.														
2. Develop skills in literature review and critical evaluation of scholarly and technical information related to the selected problem.														
3. Enable students to plan and conduct mathematical, experimental, or numerical investigations using appropriate research techniques and tools.														
4. Develop the ability to analyse, interpret, and correlate the results obtained and derive technically justified conclusions.														
5. Develop technical communication skills through preparation of a structured project report, seminar presentation, and defence of the work before an evaluation committee.														
Course Outcomes (CO's):														
After completing this course, the student will be able to:														
CO1:	Formulate a relevant structural engineering problem by defining its objectives, scope, and expected outcomes.													
CO2:	Review and critically analyse relevant literature to identify the technical background and research gap associated with the selected problem.													
CO3:	Develop and implement appropriate mathematical, experimental, or numerical models to investigate the selected structural engineering problem.													
CO4:	Analyse, interpret, and correlate the results obtained to draw technically justified conclusions and identify the scope for further work.													
CO5:	Prepare a standard technical report and effectively present and defend the project work before a technically qualified evaluation committee.													
CO-PO Articulation Matrix:														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	
CO 1	3	3	3	2	2	–	1	–	1	2	2	3	3	
CO 2	3	3	3	3	3	–	1	–	1	2	3	3	3	
CO 3	3	3	3	3	3	1	2	–	1	2	3	3	3	
CO 4	3	3	3	3	3	1	1	–	1	2	3	3	3	
CO 5	2	2	2	2	2	–	–	1	3	3	3	3	3	

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Guidelines:

1. As part of the curriculum in the II Semester of the programme, each student shall undertake a Mini Project under the guidance of an allotted faculty supervisor. The Mini Project shall normally comprise three to four weeks of prior reading and literature study, followed by approximately twelve weeks of active project/research work, culminating in a final presentation and evaluation.
2. Each student shall be allotted a faculty supervisor who shall mentor and monitor the progress of the Mini Project throughout the semester.
3. The Mini Project shall provide students with an opportunity to identify and investigate an accessible structural engineering problem having academic, research, industrial, societal, or practical significance.
4. The Mini Project shall preferably have interdisciplinary and/or industry relevance and shall encourage students to apply the knowledge and skills acquired through the programme to real-world engineering problems.
5. The Mini Project may involve one or more of the following approaches:
 - Mathematical modelling and analytical investigations;
 - Experimental investigations;
 - Numerical modelling and simulation;
 - Computational or software-based analysis;
 - Data-driven investigations, wherever appropriate;
 - A combination of the above approaches.
6. The selected problem shall be clearly defined, and the student shall establish the problem statement, objectives, scope, methodology, expected outcomes, and prospective deliverables in consultation with the supervisor.
7. Students shall undertake a systematic literature review using relevant textbooks, research papers, standards, codes, technical reports, and other scholarly sources. The literature review shall be used to establish the technical background and identify the research gap or specific engineering problem addressed by the Mini Project.
8. The methodology adopted for the project shall be appropriate to the identified problem. All mathematical formulations, experimental procedures, numerical models, assumptions, software tools, testing procedures, and analytical techniques shall be clearly documented and technically justified.
9. The project work shall involve continuous interaction between the student and the supervisor. The supervisor shall monitor the progress of the work and provide appropriate technical guidance throughout the semester.
10. Students shall maintain proper records of their project activities, including literature studied, methodology adopted, calculations, experimental observations, numerical models, results, discussions, and other relevant technical information.
11. The results obtained shall be systematically analysed and interpreted. Wherever applicable, the results shall be compared with theoretical predictions, experimental observations, published results, relevant standards/codes, or established engineering practices.
12. The Mini Project report shall contain, as appropriate:
 - Title and certificate;
 - Abstract;
 - Introduction and problem statement;
 - Objectives and scope;
 - Literature review;

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- Identification of research gap;
- Methodology;
- Mathematical/experimental/numerical details;
- Results and discussion;
- Conclusions;
- Scope for further work;
- References;
- Appendices, wherever required.

13. The student shall present the progress of the Mini Project before the Departmental Committee at prescribed stages during the semester. The Departmental Committee shall consist of the Project Supervisor and a minimum of two faculty members nominated by the Head of the Department.

14. The final Mini Project shall be evaluated through Continuous Internal Evaluation (CIE) for 40 marks and Semester-End Examination/External Evaluation (SEE) for 60 marks.

Departmental committee: Supervisor and a minimum of two faculty members:

Evaluation by	Component	Max. Marks
Supervisor	Problem Selection & Relevance	05
	Literature Review & Research Gap	05
	Progress of Project Work	10
	Technical Work / Methodology	05
Departmental Committee	Interim Presentation & PPT	05
	Report Preparation / Documentation	05
	Viva-Voce / Question & Answer	05
Total CIE		40

Evaluation Parameter	Max. Marks
Relevance, Novelty and Problem Definition	10
Literature Review and Identification of Research Gap	10
Methodology / Technical Approach	10
Analysis, Results and Discussion	15
Conclusions and Scope for Further Work	05
Technical Report Quality	05
Final Presentation & Viva-Voce	05
Total SEE	60

ONLINE LEARNING RESOURCES:

1. NPTEL – Research Methodology, IIT Madras.
<https://www.nptel.ac.in/courses/121106007>
2. NPTEL – Introduction to Research.
https://onlinecourses-archive.nptel.ac.in/noc17_ge01/preview
3. NPTEL – Introduction to Research Writing.
<https://www.nptel.ac.in/courses/109105115>
4. NPTEL – Effective Writing and Research Proposal Writing.
<https://www.nptel.ac.in/courses/109107172>

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5. • MIT OpenCourseWare – Graduate Technical Writing Workshop.
<https://ocw.mit.edu/courses/21w-794-graduate-technical-writing-workshop-january-iap-2019/>

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b

Course Code	DISSERTATION – I	L	T	P	C
26PW1153SE		-	-	20	10

Course Objectives:

The course aims to:

1. Develop the ability to identify and formulate a relevant structural engineering research problem with research potential.
2. Develop skills in systematic literature review using books, journals, databases, and other scholarly sources.
3. Enable students to select appropriate research methodology, techniques, and approaches for the proposed investigation.
4. Develop the ability to plan research work, collect/analyse preliminary data, and assess the feasibility of the proposed study.
5. Develop technical report writing, presentation, and research communication skills for effectively defending the proposed research work.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- | | |
|-------------|---|
| CO1: | Formulate a relevant research problem and define its objectives, scope, and expected outcomes. |
| CO2: | Critically review and synthesize relevant literature from scholarly sources to identify research gaps. |
| CO3: | Develop an appropriate research methodology and work plan for investigating the identified problem. |
| CO4: | Analyse and interpret preliminary results, wherever applicable, and draw technically justified inferences. |
| CO5: | Prepare and present a technical dissertation report and defend the proposed research work before a technically qualified committee. |

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	2	1	-	-	-	1	2	2	3	2
CO 2	3	3	2	3	2	-	-	-	1	2	2	3	3
CO 3	3	3	3	3	3	-	-	-	1	2	3	3	3
CO 4	3	3	3	3	3	1	-	-	2	2	3	3	3
CO 5	2	2	2	2	2	1	-	1	3	3	3	3	3

GUIDELINES

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS,

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- Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation):Max.Marks:40

Evaluation by	Evaluation Criteria/Parameter	Max.Marks
Supervisor	Project Status/Review(s)	10
	Report	5
Departmental Committee (Supervisor & Project coordinator from the respective department of the institution)	Relevance of the Topic	5
	PPT Preparation	5
	Presentation	5
	Question and Answers	5
	Report Preparation	5
	Total	40

Note: The Supervisor has to assess the progress of the student regularly.

Guidelines for Conducting Semester End Examination(SEE):

The student shall:

- Present the dissertation progress for 20 minutes using PowerPoint, highlighting the research problem, objectives, literature review, methodology, progress achieved, preliminary results (if any), and future work.
- Participate in a 10-minute viva-voce conducted by the examination committee.
- Submit a spiral-bound dissertation progress report in the prescribed department format at least One week before the commencement of the Semester End Examination.
- Demonstrate a clear understanding of the selected research problem, research methodology, literature review, implementation plan, and expected research contributions.
- Present the progress made during the semester along with the proposed work plan for Dissertation-II.

Distribution of SEE Marks(60)

S. No.	Evaluation Component	Marks
1	Problem formulation, research objectives, and literature survey	15
2	Research methodology, work completed, and preliminary results	10
3	Technical presentation, organization of PPT, and communication skills	10
4	Viva-Voce (technical understanding, methodology, and research plan)	10
5	Dissertation progress report (technical quality, documentation, formatting, references, and plagiarism compliance)	10
6	Novelty, feasibility, research planning, and future work	5
	Total	60

The Semester End Examination shall be conducted by a **Departmental Examination Committee**
Consisting of:

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- Head of the Department (or Nominee)
- Project Supervisor
- Project Coordinator
- External Examiner (wherever applicable)

A student who fails to appear for the Semester End Examination shall be treated as **absent** and shall re-appear as per the regulations.

Online Learning Resources:

1. NPTEL – Research Methodology, IISER Kolkata
https://onlinecourses.nptel.ac.in/noc22_ge08/preview
2. NPTEL – Research Methodology in Humanities and Social Sciences, IIT Roorkee
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_hs247
3. UGC – Academic and Research Integrity Resources
<https://www.ugc.gov.in/e-book/Academic-and-Research/>
4. UGC – Promotion of Academic Integrity and Prevention of Plagiarism
https://www.ugc.gov.in/regulations/UGC_Regulations_university
5. INFLIBNET – Shodhganga: A Reservoir of Indian Theses
<https://shodhganga.inflibnet.ac.in/>
6. NPTEL – Intellectual Property, IIT Madras
<https://www.nptel.ac.in/courses/109106137>

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Course Code	DISSERTATION – II	L	T	P	C
26 PW1154SE		-	-	32	16

Course Objectives:

This course aims

1. To carry out independent research by designing and implementing a solution to the identified research problem using appropriate experimental, computational, or analytical techniques.
2. To validate and evaluate the proposed solution through rigorous experimentation, simulation, or performance analysis against predefined objectives and benchmarks.
3. To analyze and interpret the research findings, draw meaningful conclusions, and identify the scope for future research and improvements.
4. To prepare a high-quality dissertation that systematically documents the research methodology, implementation, results, and conclusions while demonstrating originality, innovation, and professional ethics.
5. To effectively communicate and defend the research work through technical reports, presentations, publications (where applicable), and viva-voce before an expert examination committee.

Course Outcomes (CO's):

After completing this course, the student will be able to:

- CO1:** Use different experimental techniques and will be able to use different software/computational /analytical tools.
- CO2:** Design and develop an experimental setup/equipment/test rig.
- CO3:** Conduct tests on existing setups/ equipment's and draw logical conclusions from the results after analyzing them.
- CO4:** Either work in a research environment or in an industrial environment.
- CO5:** Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

CO-PO Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	3	2	-	-	-	1	2	3	3	3
CO 2	3	3	3	3	3	-	-	-	1	2	3	3	3
CO 3	3	3	3	3	3	1	-	-	2	2	3	3	3
CO 4	3	3	3	3	3	1	1	-	2	3	3	3	3
CO 5	2	2	3	3	3	1	1	1	3	3	3	3	3

GUIDELINES

- It is a continuation of Dissertation-I started in semester-III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the

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problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.

- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson-BoS, Head, Supervisor & Project coordinator from the Institute.
- The candidate has to be in regular contact with his/her Supervisor/Co-Supervisor

Guidelines for awarding marks in CIE (Continuous Internal

Evaluation by	Evaluation Criteria / Parameter	Max.Marks
Supervisor	Regularity, Progress and Periodic Reviews	10
	Quality of Research Work and	10
	Analytical/Programming/ Experimental	5
	Dissertation Documentation and Report	5
Departmental Evaluation Committee (Head of the Department/ Nominee, Project Coordinator and Supervisor)	Technical Progress and Achievement of Research Objectives	5
	Technical Presentation and Skills	5
	Technical Discussion and Viva-Voce	5
	Overall Assessment (Originality, Publications/Research Contribution and Readiness for Final Submission)	5
Total		50

Guidelines for Conducting Semester End Examination

The student shall:

- Present the completed dissertation work for 30 minutes using PowerPoint, highlighting the research problem, objectives, methodology, implementation, results, research contributions, publications (if any), conclusions, and future scope.
- Participate in a 15–20-minute viva-voce examination conducted by the examination committee.
- Submit the final dissertation report in the prescribed department format at least one week before the commencement of the Semester End Examination.
- Demonstrate the implementation, software, prototype, experimental setup, or research outcomes wherever applicable.
- Defend the originality, technical contribution, and significance of the research work before the examination committee.

Distribution of SEE Marks (150)

Evaluation by	Evaluation Criteria/ Parameter	Max.Marks
Supervisor	Regularity, Progress and Professional Conduct	10
	Quality of Research Work Completed	10
	Technical Contribution, Innovation and Research Quality	10
	Analytical/Programming/ Experimental Skills	10

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External Examination Committee (External Examiner, and Head of the Department/Nominee)	Dissertation Report Preparation and Documentation	10
	Technical Presentation and Communication Skills	20
	Quality of Dissertation, Research Methodology and Technical Evaluation	40
	Publications, Novelty, Industrial/Societal Relevance and Future Scope	10
	Demonstration/Implementation(where applicable)	10
	Viva-Voce and Technical Discussion	20
Total		150

Online Learning Resources:

1. **NPTEL – Research Methodology, IIT Madras**
<https://www.nptel.ac.in/courses/121106007>
2. **NPTEL – Qualitative Research Methods and Research Writing, IIT Kharagpur**
<https://www.nptel.ac.in/courses/109105115>
3. **NPTEL – Introduction to Research**
https://onlinecourses-archive.nptel.ac.in/noc18_ge12/preview
4. **Shodhganga – INFLIBNET: Indian Theses Repository**
<https://shodhganga.inflibnet.ac.in/>
5. **UGC – Academic and Research Integrity Resources**
<https://www.ugc.gov.in/e-book/Academic%20and%20Research/>
6. **NPTEL – Structural Dynamics: Theory and Computation, IIT Delhi**
<https://www.nptel.ac.in/courses/105102688>
7. **NPTEL – Finite Element Analysis**
<https://www.nptel.ac.in/courses/112104193>

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