COEP Technological University Pune

(A Unitary Public University of Govt. of Maharashtra)

School of Civil Engineering and Planning

Curriculum Structure

F. Y. M. Tech.

(Regular)

Structural Engineering

(Effective from: A.Y. 2023-24)

Program Educational Objectives

I. Graduates of the program will have in-depth knowledge to identify and formulate challenging problems in Structural Engineering, apply appropriate research methodologies, use modern engineering tools and provide technically sound, economical and sustainable solutions.

II. Graduates will have ability for higher studies and undertake high value research on Structural Engineering and other related issues.

III. Graduate of program will actively engage in a professional career as a Structural Consultant and has sound analytical and lateral thinking ability to engage in lifelong learning for professional advancement to cope up with multidisciplinary and changing technologies in Structural Engineering.

IV. Graduates of the program will have sense of social responsibility, will demonstrate ability to communicate and work effectively as a team member in an ethical way, and will play leadership roles in their profession, public services and community.

Program Outcomes

After completion of the program, Graduates will be able to

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

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

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

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

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

List of Abbreviations

Abbreviation	Title
PSMC	Program Specific Mathematics Course
PSBC	Program Specific Bridge Course
PEC	Program Elective Course
MLC	Mandatory Learning Course
PCC	Program Core Course
LC	Laboratory Course
UOE	University Open Elective
LLC/CCA	Liberal Learning Course/ Co-curricular & Extracurricular Activities (CCA)
SLC	Self-Learning Course
SBC	Skill Based Course

M. Tech. Civil- Structural Engineering

NEP Curriculum Structure

Semester - I

Sr No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PSMC	CSE-23001	Numerical Methods in Structural Engineering	3	1	--	4
2	PSBC	CSE-23002	Advanced Analysis of Structures	4	0		4
3	PEC		**Elective – I**	3	--	--	3
		CSE(PE)-23001	Advanced Design of RC Structures				
		CSE(PE)-23002	Advanced Design of Steel Structures				
		CSE(PE)-23003	Any course approved by BOS				
4	PCC	CSE-23003	Solid Mechanics	4	--	--	4
5	PCC	CSE-23004	Structural Dynamics	3	--	-	3
6	LC	CSE-23005	Lab Practice -I: Computer Aided Design	-	--	4	2
7	LC	CSE-23006	Lab Practice - II: NDT and Structural Dynamics	-	-	2	1
8	LC	CSE-23007	Seminar	-	--	2	1
Total				**17**	**1**	**8**	**22**

Semester - II

Sr No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	PEC		**Elective – II**	3	--		3
		CSE(PE) – 23004	High Rise Structures				
		CSE(PE) – 23005	Bridge Engineering				
		CSE(PE) – 23006	Any course approved by BOS				
2	PEC		**Elective – III**	3	--	--	3
		CSE(PE) – 23007	Design of Prestressed Concrete Structures				
		CSE(PE) – 23008	Structural Health Monitoring				
		CSE(PE) – 23009	Nonlinear Analysis of Structures				
		CSE(PE) – 23010	Any course approved by BOS				
3	MLC	ML – 23001	Research Methodology and Intellectual Property Rights	2	-	-	-
4	PCC	CSE – 23008	Finite Element Method	3	-	-	3
5	PCC	CSE – 23009	Theory of Thin Plates and Shells	3	-	-	3
6	PCC	CSE – 23010	Earthquake Analysis and Design of Structures	3	-	-	3
7	LLC	LL	Liberal Learning Course	1	-	-	1
8	LC	CSE – 23011	Lab Practice - III: Experimental Concrete Technology	-	-	4	2
9	LC	CSE – 23013	Mini Project	-	--	2	1
10	UOE	OEC	Interdisciplinary Open Course- MATLAB for Engineers	3	-	-	3
Total				**21**	**-**	**6**	**22**

Semester - III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC		Dissertation Phase – I	--	--	18	9
2.	SLC		Massive Open Online Course (MOOC)–I	3	--	--	3
				Total Credits			**12**

Semester - IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC		Dissertation Phase – II	--	--	18	9
2.	SLC		Massive Open Online Course (MOOC) –II	3	--	--	3
					Total Credits		**12**

Civil Engineering Department,

Post Graduate Syllabus Structure 2023-24

M. Tech Structure FIRST YEAR

Semester-I

CSE-23001 Numerical Methods in Structural Engineering	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
Tutorial: 1 Hour/week	**End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Mathematically model a physical system.
CO 2: Identify appropriate numerical methods to find solutions of simulated physical system.
CO 3: Apply numerical methods to solve Structural Engineering problems.
CO 4: Use computer program to get solutions of problems in Structural Engineering

Unit 1	**Fundamentals of numerical methods**
	Fundamentals of numerical methods Error analysis, Engineering Systems, Physical and Mathematical Modelling, Error Analysis Approximations and round off and Truncation errors; Roots of nonlinear equations, multiple roots, Solution of Linear Simultaneous Solution of Nonlinear Simultaneous Equations.
Unit 2	**Eigen Values and Eigen Vectors**
	Power method, Relaxation Method, Diagonalization method.
Unit 3	**Numerical Differentiation and Integration**
	High Accuracy Differentiation Formulas, Derivatives of Unequal Spaced Data. Newton-Cotes formulae, Integration with unequal segments, multiple integration, Gauss Quadrature rule
Unit 4	**Ordinary Differential Equations**

	Method of Weighted Residuals, Initial Value and Boundary Value Problems, Eulers method, Improvement of Eulers method, Runge-Kutta Method, Multiple Steps Method
Unit 5	**Finite Difference method**
	Applications to beam bending, beam vibration, plate bending and plate vibration problems
Unit 6	**Partial Differential Equations**
	Elliptic and Parabolic Equations, Explicit and Implicit Methods

Reference Books:

1. Chapra S C and Canale R P, Numerical Methods for engineering. Mcgraw-HillInc, 7th Edition, 2016.
2. Scheid F, Theory and problems of Numerical analysis. New York. McGraw Hill Book Co.(Shaum Series), 1988
3. Sastry S S, Introductory Methods of Numerical Analysis. Prentice-Hall of India, 1998

CSE-23002 Advanced Analysis of Structures	
Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Analyze indeterminate structures using Flexibility method.
CO 2: Develop member stiffness matrices for Framed structures.
CO 3: Analyze indeterminate framed structures using Stiffness method.
CO 4: Analyze Framed structures using computer program.

Unit 1	**Basic Concepts of Structural Analysis**
	Types of Framed Structures, Deformations in Framed Structures, Actions and Displacements, Equilibrium, Compatibility, Static and Kinematic Indeterminacy, Principle of Virtual Work,Principle of Minimum Potential Energy, Castigliano's Theorem, Action and Displacement Equations
Unit 2	**Introduction to the Flexibility and Stiffness Matrix Methods**
	Flexibility Method, Stiffness Method, Temperature Changes, Pre-strains, and Support Displacements, Joint Displacements, Member End-Actions, and Support Reactions, Flexibilities of Prismatic Members
Unit 3	**Introduction to Stiffness Matrix Method**
	Stiffness Method Temperature Changes, Pre-strains and Support Displacements, Stiffness of Prismatic Members, Formalization of the Stiffness Method
Unit 4	**Direct Stiffness Method**

	Direct Stiffness Method , Complete Member Stiffness Matrices , Formation of Joint Stiffness Matrix , Formation of Load Vector , Analysis of Continuous Beams, Plane Truss Member Stiffnesses , Analysis of Plane Trusses, Rotation of Axes in Two Dimensions , Application to Plane Truss Members, Rotation of Axes in Three Dimensions, Plane Frame Member Stiffnesses, Analysis of Plane Frames , Grid Member Stiffnesses , Analysis of Grids, Space Truss Member Stiffnesses, Selection of Space Truss Member Axes, Analysis of Space Trusses, Space Frame Member Stiffnesses , Analysis of Space Frames
Unit 5	**Additional Topics of Stiffness Method**
	Loads between Joints, Temperature Changes and Pre-strains, Support Displacements, Oblique Supports, Elastic Supports, Non-prismatic Members, Releases in Members, Elastic Connections, Shearing Deformations, Axial-Flexural Interactions
Unit 6	**Introduction to Finite Element Method**
	Introduction, Stresses and Strains in Continua, Virtual-Work Basis of Finite Element Method, One-Dimensional Elements, Application to Framed Structures.

Reference Books:

1. Madhu Kanchi, "Matrix Methods of Structural Analysis", New Age Publications, 2016
2. William Weaver and James Gere, "Matrix Analysis of Framed Structures", Van Nostrand, 1990.

Reference Books:

1. William McGuire, Richard Gallagher and Ronald Ziemian, "Matrix Structural Analysis", Bucknell Publications, 2000.
2. Devdas Menon, "Advanced Structural Analysis", Alpha Science International, 2009.
3. Igor Karnovsky and Olga Lebed, "Advanced Methods of Structural Analysis", Springer Publications, 2010.
4. Mohamed Abdel-Rohman, "Analysis of Structures", BookSurge Publishing, 2011

CSE(PE)-23001 Advanced Design of RC Structures	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Analyze the special structures by understanding their behaviour
CO 2: Design and prepare detail structural drawings for execution
CO 3: Design the Water Storage Structures by understanding their behaviour
CO 4: Cite relevant IS Codes

Unit 1	
	Theory and Design of grid floors, flat slab.
Unit 2	
	Theory and Design of bunkers and Silos
Unit 3	
	Analysis and Design of ground resting reservoir, Analysis of elevated service reservoir
Unit 4	
	Design of RCC deep beams, Design of beams curved in plan
Unit 5	
	Design of domes, Intze tank
Unit 6	
	Basics of formwork

Reference Books:

1. N. Krishna Raju, Advanced Reinforced Concrete Design, 3rd edition, CBS Publishers
2. P.C. Varghese, Advanced Reinforced Concrete Design, 2nd edition, Prentice Hall of India
3. B.C. Punmia, Reinforced Concrete Structures, 7th edition, Laxmi Publications

CSE(PE)-23002 Advance Design of Steel Structures	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Analyze and design a framed multi-storey building and transfer girder
CO 2: Analyze and Design a Trussed girder, plate girder bridge
CO 3: Analysis of Bridge Substructures, bearings and wing walls.
CO 4: Analysis and Design of PEB frames

Unit 1	
	Types of systems to support multi-storey buildings, Earthquake resistant design. Push over analysis of steel building.
Unit 2	
	Design of rigid, semi-rigid and flexible connections, Design of splices, Haunched connections.
Unit 3	
	Torsion - Lateral torsional bucking of beams, Beam columns: Design for torsion, elastic torsional buckling, Design of footings - gusseted base, Buckling of columns and frames, P- δ effect and P - Δ effect
Unit 4	
	Transfer Girder design Plate girder bridge design, Design for earthquake, fatigue, fire and temperature variations.
Unit 5	
	Design of Tension members, Compression members, Bracing systems, Splicing and connection design
Unit 6	
	Trussed girder bridge design, Design for earthquake, fatigue, fire and temperature variations. Design of gable frame structure for pre-engineered building

Reference Books:

1. N. Subramanian, "Design of Steel Structures", Oxford University Press, 2008.
2. John Baker and Jacques Heyman, "Plastic design of frames: Fundamentals", Cambridge University press, Reprinted 2008.
3. Baker, Horne and Heyman, "The steel skeleton: Plastic behaviour and design", (Vol II)
4. Charles Salmon and John Johnson, "Steel Structures- Design and Behaviour", Harper Collins College Publishers, 1996.
5. Neal B.G, "Plastic Methods of Structural Analysis", Chapman and Hall London.
6. N.S. Trahair, M.A. Bradford, D.A. Nethercot, and L. Gardner, "The Behavior and Design of Steel Structures to EC3", 4th edition, Taylor and Francis
7. IS 800-2007 : General Construction in Steel - Code of Practice
8. SP – 6 (BIS) ISI Handbooks for Structural Engineers

CSE-23003 Solid Mechanics	
Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Comprehend principles of 3D Elasticity to be used for the analysis of structures.
CO 2: Solve simple elasticity problems.
CO 3: Apply principles of elasticity to solve complex problems of Mechanics
CO 4: Understand basic concepts of laminated composites

Unit 1	**Introduction**
	Review of Strength of Materials and Introduction to 3DTheory of Elasticity, History of Mechanics of materials.
Unit 2	**Stress**
	Cauchy Stress, Stress Transformation, Principal Stresses, Stress Invariant, Max Shear Stress. Stress tensor, Differential Equations of Equilibrium in cartesian and cylindrical co-ordinate systems.
Unit 3	**Strain**
	Normal Strain, Strain-Displacement Relationships, Strain Transformation, Plane Strain, Strain Tensor, Strain Compatibility conditions.
Unit 4	**Constitutive Relations**
	Generalized Hooke's Law for Homogeneous Isotropic material, Orthotropic Material and Anisotropic Material. Plastic deformations, Yield Criteria, Theories of Failure, Plastic stress- strain Relations.
Unit 5	**Applications**
	Airy's Stress function approach for plane stress and plane strain conditions, application to Beam Bending problems, Torsion of Cylindrical Bars and Non-circular Prismatic Bars.
Unit 6	**Composite Materials**
	Introduction to Laminated Composites, Plane Stress of Orthotropic Material, Classical Lamination Theory, Effective Laminate Properties, Effective Axial Modulus.

Reference Books:

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

CSE-23004 Structural Dynamics	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Apply fundamental theory of structural dynamics and equation of motion to field problems.
CO 2: Analyze and interpret dynamic response of single and multi-degree-of-freedom systems.
CO 3: Analyse base-isolated structure (up to 2 DOF) and design base isolators
CO 4: Perform dynamic analysis of single and multi-degree-of-freedom systems using MATLAB programs / Commercial software

Unit 1	**Introduction**
	Objectives of study, Importance of vibration analysis, difference between static and dynamic loading. Nature of exciting forces, Mathematical modeling of dynamic systems, Development of equation of motion for lumped mass system.
Unit 2	**Single Degree of Freedom (SDOF) System**
	Free and forced vibration with and without damping, Response to harmonic loading, Response to general dynamic loading using Duhamel's integral. Fourier analysis for periodic loading. Numerical solution to response of linear and non-linear systems using Newmark β method.
Unit 3	**Multi Degree of Freedom (MDOF) System (Lumped parameter)**
	Multi Degree of Freedom System (up to 3 DOF). Formulation of mass, stiffness and damping matrices. Determination of natural frequencies and mode shapes. Dynamic response by modal superposition method. Dynamic analysis of beams and plane frames. Time history response of MDOF systems using Newmark β method.
Unit 4	**Multi Degree of Freedom (MDOF) System (Distributed parameter)**

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

Unit 5	**Response Spectra Method**
	Theory and development of response spectra, Codal provisions, tripartite response spectra, Simple Problems
Unit 6	**Applications of Structural Dynamics**
	Introduction to techniques of vibration response control. Base isolation of SDOF and 2-DOF system, design of base isolators using provisions of IS 1893(2022) Part 6

Reference Books:

1. Anil K. Chopra, "Dynamics of Structures – Theory and Applications to Earthquake Engineering", Pearson, 3rd Edition, 2011
2. Gary Hart and Kevin Wong, "Structural Dynamics for Structural Engineers", John Wiley and Sons, 2000
3. J. W. Smith, "Vibration of Structures. Application in Civil Engineering Design", Chapman and Hall, 1988
4. Mario Paz and William Leigh, "Structural Dynamics - Theory and Computation, UpdatedWith SAP 2000", 5thEdition, Kluwer Academic Publishers
5. Clough and J. Penzien, "Dynamics of Structures", Computers & Structures, Inc., University Ave, Berkeley, USA, 1995
6. Leonard Meirovitch, "Fundamentals of Vibrations", Tata Mc Graw Hill, 2001
7. IS 1893(2016) Criteria for Earthquake Resistant design of buildings (Part I): General provisions and Building – Code of Practice (Sixth Revision), Bureau of Indian Standards, New Delhi
8. IS 1893(2022) Criteria for Earthquake Resistant Design of Structures - Part 6 Base Isolated Buildings

CSE-23005 Lab Practice -I: Computer Aided Design	
Teaching Scheme	**Examination Scheme**
Practical: 4 Hrs/ week	**Mid semester Exam -** 40 marks
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Apply appropriate tools to design and conduct experiments.
CO 2: Select and apply appropriate numerical techniques
CO 3: Function as team member for laboratory work

Laboratory Experiments using software:

Training of software

A) Analysis and Design of Steel Structures

- Analysis of plane frames for lateral loading
- Compare the response of the structure using different types of connections
- Analysis of plane frames using different types of bracing systems

B) Analysis and Design of RCC structures

- Analysis of RCC building
- Analysis of building for lateral loading
- Compare the response of the structure using different types of shear walls
- Finite Element Analysis of 3-D Solid Structures

Reference Books:

1. ASTM C512, "Standard Test method for creep of concrete in compression".
2. T. Chandrupatla and A. Belengundu, "Introduction to Finite Elements in Engineering", Prentice Hall, 2013
3. W. McGuire, R. H. Gallagher and R. D. Ziemian, " Matrix Structural Analysis", Wiley, 2013

CSE-23006 Lab Practice - II: NDT and Structural Dynamics	
Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/ week	**Mid semester Exam -** 40 marks
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Handle appropriate equipment and tools.
CO 2: Design simple experiments related to structural systems
CO 3: Function as team member for laboratory work

Laboratory Experiments:

- Estimation of compressive strength of concrete using Rebound Hammer,
- Estimation of compressive strength of concrete using UPV
- Corrosion prediction and analysis for RCmember
- Free vibration response of Steel Beam
- Free vibration response of Frames
- Determination of principal stresses using strain-gauges
- Response of Plane Frames under lateral loading.

Reference Books:

1. M. Paz and W. Leigh, "Integrated Matrix analysis of Structures", Kluwer Academic, 2001
2. M. Paz and W. Leigh, "Structural Dynamics Theory and Computation", Kluwer Academic, 2004
3. V. M. Malhotra and N. J. Cariano, "Handbook of Non-destructive Testing of Concrete", CRC Press, 2003
4. K. W. Day, J. Aldred and B. Hudson, "Concrete Mix Design, Quality Control and Specification", CRC Press, 2014

CSE-23007 Seminar	
Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/ week	**End semester Exam -** 100 marks

Course Outcomes: At the end of the course, the students will be able to
CO 1: Identify a topic for study and carry out literature survey
CO 2: Write a technical report related to selected topic
CO 3: Present outcome of the study with the help of presentation.

Seminar is to be held and reported by the end of the first semester

Semester-II

CSE(PE)-23004 High Rise Structures	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Analyze the design concept of special Structures
CO 2: Apply provisions from different design codes for High Rise Structures
CO 3: Analyze and Design Transmission tower
CO4: Analyze and Design Chimney Structure

Unit 1	**Design of Transmission/ TV Tower, Mast and Trestlers: Chimneys: Tall Buildings**
	Structural concepts, configurations, various systems, wind and seismic loads, Dynamic approach, Structural Design considerations, Codal Provisions, Firefighting Design provisions.
Unit 2	**Chimneys**
	Analysis and Design of RC and Steel Chimneys for gravity and lateral loads, Foundation design for varied soil strata
Unit 3	**Tall Buildings**
	Structural concept, configurations, various systems, wind and seismic loads, Dynamic approach, Structural Design considerations, Codal Provisions, Firefighting Design provisions

Reference Books:

1. Structural Analysis and Design of Tall Buildings, Bungale S. Taranath, CRC Press
2. Design of Steel Structures, P Dayaratnam, S. Chand Publishing, 2008
3. Plain and Reinforced Concrete – Vol II, Jai Krishna, O. P. Jain, Nem Chand Bors., Roorkee.
4. Tall Chimneys. Design And Construction, S. N. Manohar, Mcgraw-Hill Book Comp. · 1985

CSE(PE)-23005 Bridge Engineering	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Analyze the superstructure of bridges - slab, T-beam and Box type
CO 2: Design the superstructure of bridges - slab, T-beam and Box type
CO 3: Analysis of Bridge Substructures, bearings and wing walls.
CO 4: Analyze and design the type of bearings

Unit 1	**Introduction**
	Classification and Types. IRC Specifications for Road Bridges. Earthquake Resistant Design Considerations.
Unit 2	**Analysis of Bridges**
	Concentrated loads on slabs, Load Distribution Theories - Courbon's method, Hendry- and Guyon-Massonet method.
Unit 3	**Design of PSC Bridge**
	Slab Type, T-beam Type, Box Type.
Unit 4	**Classification and Design of Bearings**
	Metallic bearings, Elastomeric bearings, POT and PTFE bearings
Unit 5	**Analysis and Design of Abutment and Pier**
	Introduction to the Design of Open Well, Pile and Caisson Foundations.
Unit 6	**Analysis and Design of Wing Walls.**

Reference Books:

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

CSE(PE)-23007 Design of Prestressed Concrete Structures	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Apply the basic aspects of prestressed concrete fundamentals, including pre and post-tensioning processes.
CO 2: Analyze and design of prestressed concrete flexural members
CO 3: Analyze and design prestressed concrete deck slab and beam/ girders.
CO 4: Design end blocks for prestressed concrete members

Unit 1	**Introduction**
	Types of prestressing, systems and devices, materials, losses in prestress, Analysis of PSC flexural members: basic concepts, stresses at transfer and service loads, ultimate strength in flexure, code provisions
Unit 2	**Statically determinate PSC beams**
	Design for ultimate and serviceability limit states for flexure, analysis and design for shear and torsion, code provisions.
Unit 3	**Anchorage Zones**
	Transmission of prestresses in pretensioned members; Anchorage zone stresses for post-tensioned members.
Unit 4	**Statically indeterminate structures**
	Design of two span continuous beams, choice of cable profile, linear transformation and concordancy.
Unit 5	**Composite construction**
	Composite construction with precast PSC beams and cast in-situ RC slab, Partial prestressing - principles, analysis and design concepts, crack width calculations
Unit 6	**PT Slabs**
	Design of Post-Tensioned (PT) concrete slabs for buildings / bridges, IS code provisions. Use of commercial software for analysis and design of PT slabs / any other PSC element from the above theory covered.

Text Books:

1. Prestressed Concrete, Krishnaraju N., Tata McGraw Hill, New Delhi.
2. Prestressed concrete, Pandit and Gupta, CBS publishers

Reference Books:

1. Design of Prestressed Concrete Structures, Lin T.Y., Asia Publishing House.
2. Limit State Design of PrestressedConcrete, GuyanY., Applied Science Publishers
3. Prestressed Concrete, Dayaratnam
4. Fundamentals of Prestressed Concrete Sinha N.C. & Roy, S. Chand & Company
5. Prestressed Concrete, Rajagopalan N, Narosa Publishing house
6. IS: 1343- Code of Practice for Prestressed Concrete
7. IRC: 112

CSE(PE)-23008 Structural Health Monitoring	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Study the causes of distress in Structures
CO 2: Observe the status of structure from Visual observation and NDT Test
CO 3: Conduct structural audit.
CO 4: Suggest repairing methods and or retrofitting technique for strengthening of structural member and or structure.

Unit 1	
	Introduction, need of structural Health Monitoring (SHM): Factors affecting health of structures, causes of distress, load variation, material variations, Structural health monitoring. Various measures, regular maintenance, Advantages of SHM.
Unit 2	
	Visual Inspection of structure, techniques. Different types of NDT tests.
Unit 3	
	Structural audit, Role of Engineer, Purpose, survey of structural defects, Guidelines for structural audit, Case studies.
Unit 4	
	Cracks in structural members, types, measurements of cracks. Performance of structure for different loading, failure of structures, different techniques for repairs of cracks.
Unit 5	
	Carbonation of concrete, concept, deterioration of concrete, corrosion of reinforcement. Settlement of structures.
Unit 6	
	Structural repairs and retrofitting, Different techniques, case studies, safety of structures.

Reference Books:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, John Wiley and Sons, 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.

CSE(PE)-23009 Non-Linear Analysis of Structures	
Teaching Scheme **Lectures:** 3 Hrs/ week	**Examination Scheme** **T1 and T2 -** 20 marks each **End Sem. Exam.** - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Use numerical techniques to solve nonlinear system of equilibrium equations.
CO 2: Develop geometric stiffness matrix for plane frame structures.
CO 3: Develop computer program for geometric non-linearity.
CO 4: Analyze structures considering geometric as well as material non-linearity.

Unit 1	**Introduction**
	Behaviour of idealized structures, linearized load-deformation behaviour of structures, effect of axial load, rigid-plastic theory, fully plastic hinge moment, load factor, proportional loading, virtual work equation, collapse mechanisms.
Unit 2	**Non-Linear Analysis**
	Non-linear behaviour, sources of non-linearity, geometric stiffness matrix, axial force member, combined bending and axial forces, combined torsion and axial forces, three dimensional geometric non-linear analysis.
Unit 3	**Solution of Non-Linear Equilibrium Equations**
	Incremental analysis, Euler Method, Runge-Kutta Methods, load Control method, displacement control method, constant Arc-length method, convergence criteria.
Unit 4	**Program for Geometric Non-Linear Analysis**
	Development of computer program for Geometric non-linear analysis of plane-frame structures. Solution of simple problems involving geometric non-linearity.
Unit 5	**Material Non-Linear Analysis**
	Nonlinear material behaviour, plasticity theory, plastic analysis, plastic hinge method for ductile frames, yield surface and plastic reduction matrix, spread of plasticity, reinforced concrete members.
Unit 6	**Non-Linear Analysis of Structures**
	Analysis of framed structures for Geometric and material non-linearity.

Reference Books:

1. Madhu Kanchi, "Matrix Methods of Structural Analysis" , New Age Publications, 2016
2. William McGuire, Richard Gallagher and Ronald Ziemian, "Matrix Structural Analysis" , Bucknell Publications , 2000.
3. J.L. Meek, " Computer Methods in Structural Analysis ", E&FN Spon, 1991.
4. K. I. Majid , "Non-linear Structures", Butterworth, 1972

ML-23001 Research Methodology and Intellectual Property Rights	
Teaching Scheme	**Examination Scheme**
Lectures: 2 Hrs/ week	**Continuous evaluation: Assignments/Presentation/Quiz/Test**

Course Outcomes: At the end of the course, the students is able to:
CO 1: Recognize research problem formulation and approaches of investigation of solutions for research problems
CO 2: Learn ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes
CO 3: Discover how IPR is regarded as a source of national wealth and mark of economic leadership in context of global market scenario
CO 4: Summarize that it is an incentive for further research work and investment in R & D, leading to the creation of new and better products and generation of economic and social benefits

Unit 1	
	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problems, data collection, analysis, interpretation, necessary instrumentations.
Unit 2	
	Effective literature studies approach, analysis: Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype, analyze your results and draw conclusions or Build Prototype, Test and Redesign Plagiarism, Research ethics, Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
Unit 3	
	Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 4	
	Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act, Patent
Unit 5	
	Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification, Plant Patenting, Idea Patenting,
Unit 6	
	Integrated Circuits, Industrial Designs, Trademarks (Registered and Unregistered Trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT

Reference Books:

1. Aswani Kumar Bansal : Law of Trademarks in India
2. B L Wadehra : Law Relating to Patents, Trademarks, Copyright, a. Designs and Geographical Indications.
3. G.V.G Krishnamurthy : The Law of Trademarks, Copyright, Patents and a. Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents
6. Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Resisting Intellectual Property by Halbert ,Taylor & Francis
10. Industrial Design by Mayall, Mc Graw Hill
11. Product Design by Niebel, Mc Graw Hill
12. Introduction to Design by Asimov, Prentice Hall
13. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

CSE-23008 Finite Element Method	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Solve structural engineering problems using one dimensional finite element.
CO 2: Solve structural engineering problems using two- and three-dimensional elements.
CO 3: Solve simple free vibration problems
CO 4: Use the commercial software/ Computer programs for the analysis

Unit 1	**Introduction**
	History and applications. General steps of finite Element Method, Concept of stiffness matrix and load vector. Application of boundary conditions.
Unit 2	**One dimensional Finite Element Analysis**
	Bar elements, analysis of plane and space trusses, beam element and analysis of beams
Unit 3	**Two-dimensional Finite Element Analysis**
	CST and LST elements for the analysis of plane stress and plane strain problems, Rectangular and quadrilateral elements for the analysis of plane stress and plane strain problems.
Unit 4	**Three-dimensional Finite Element Analysis**
	Tetrahedral and hexahedral elements. Analysis of Axi-Symmetric solids.
Unit 5	**Vibration Problems**
	Lumped Mass Matrix, consistent Mass matrix, algorithm for Free vibration
Unit 6	**Computer implementation of FEM procedure**
	Pre-processing, solution, Post-processing, Use of commercial FEA software, development of computer programs using one dimensional and two dimensional elements.

Reference books:

1. P. Seshu: Finite Element Analysis: Prentice-Hall of India.
2. A. D. Belegundu and T. R. Chandrupatla: Finite Element Methods in Engineering: Prentice-Hall of India
3. Y. M. Desai, T. I. Eldho and A. H. Shah: Finite Element Method with Applications in Engineering: PEARSON
4. V. Hutton: Fundamentals of Finite Element Analysis: TATA McGRAW-HILL
5. D.Logan : First Course in Finite Element Method, Prentice Hall Publications

CSE-23009 Theory of Thin Plates and Shells	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: To comprehend the basic concepts of classical theory of thin plates and shells
CO 2: To solve problems based on thin plates and shells
CO 3: To solve the problems based on circular plates
CO 4: To understand the different finite elements based on classical plate theory

Unit 1	**Introduction**
	Introduction to Plate Theory, Assumptions made in the Poisson-Kirchoff plate theory, Plate equation and behavior of thin plates in Cartesian coordinates.
Unit 2	**Analysis of Rectangular Plates**
	Analysis of Rectangular Plates Subjected to various loading, Navier's method of solution for simply supported plates, Leavy's method of solution for plates under different boundary conditions.
Unit 3	**Analysis of Circular Plates**
	Circular plates, governing differential equations in Polar coordinates
Unit 4	**Theory of Surfaces**
	Introduction to space curves and surfaces, shell surfaces and characteristics, classifications of shells
Unit 5	**Introduction to Shell Theory**
	Basic concepts of the theory, equilibrium equations in curvilinear coordinates, force displacement relations, Membrane analysis of shells of revolution and cylindrical shells under different loads.
Unit 6	**Finite Elements for Plates and Shells**
	Plate bending and flat shell element, rectangular and quadrilateral elements based on classical plate theory.

Reference Books:

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

CSE-23010 Earthquake Analysis and Design of Structures	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Apply fundamentals of structural dynamics to different structures.
CO 2: Apply clauses of IS 1893 and IS 13920 to RC buildings.
CO 3: Analyze RC and steel structural components with seismic and ductile detailing considerations
CO 4: Design RC and steel structural components from seismic considerations
CO 5: Analyze and design RC building on software

Unit 1	**Introduction: Seismic Design Considerations**
	Important attributes of seismic design, concepts, Planning for Aseismic buildings, structural response, Principles of member design, ductile detailing
Unit 2	**Earthquake response of MDOF system with reference to IS 1893**
	Equivalent static method, Response spectrum method, Linear Time history analysis, P-Δ effect, Torsion response of the building
Unit 3	**Seismic Design Considerations for Steel Buildings**
	Performance of Steel Structures in past earthquakes, Design philosophy for Steel Structures, Capacity Design concept, Ductility of Steel Buildings, Seismic Design and detailing of moment resisting frames
Unit 4	**Inelastic Seismic Response of Structures**
	Non-Linear time history analysis of Structures
Unit 5	**Performance based seismic design**
	Performance levels, Pushover analysis, Capacity spectrum method, Seismic coefficient method.
Unit 6	**Introduction to Vibration control techniques**
	Base isolation, Elastomeric and friction isolators, Dampers for seismic response mitigation

Reference Books:

1. Bruce A. Bolt, "Earthquakes", 4th Edition, W. H. Freeman and Company, New York
2. Farzad Naeim, "The Seismic Design Handbook", 2nd Edition, Kluwer Academic Publishers Group, 2003
3. Thomas Paulay and M.J.N Priestley , "Seismic Design for R.C. and Masonry Building", John Wiley and Sons, 1992
4. Sharad Manohar and Suhasini Madhekar, Seismic Design of RC Buildings – Theory and Practice, ISBN 978-81-322-2318-4 (Print Book), ISBN 978-81-322- 2319-1 (eBook), Springer, 2015
5. James Kelly and Farzad Naeim, " Design of Seismic Isolated Structures: From Theory to Practice", 1999, John Wiley and Sons
6. IS 1893(Part 1) : 2016, "Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings", 5th Revision
7. IS 1893(Part2) : "Criteria for Earthquake Resistant Design of Structures, Part 2: Liquid Retaining Tanks - Elevated and Ground Supported"
8. IS 13920: 2016, "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces"
9. IS 4326:1993, "Earthquake Resistant Design and Construction of Buildings

CSE-23011 Lab Practice III: Experimental Concrete Technology	
Teaching Scheme	**Examination Scheme**
Practical: 4 Hrs/ week	**Midsemester -** 40 marks
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Design a concrete mix as per the requirement at the field
CO 2: Select and apply appropriate twchniques to design and conduct experiments
CO 3: Function as a team member for the laboratory work.

1. Mix design for pavement quality Concrete
2. Mix design of Fiber Reinforced Concrete
3. Mix design of High Strength Concrete
4. Tests for measuring Corrosion parameters
5. Site visits demonstrating Special concreting methods (Atleast two)

CSE-23012 Mini Project	
Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs/ week	**Midsemester -** 40 marks
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students is able to:
CO 1: Identify a topic for study and carry out literature survey
CO 2: Write a technical report related to selected topic
CO 3: Present outcome of the study with the help of presentation

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

OEC Interdisciplinary Open Course- MATLAB for Engineers	
Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ week	**T1 and T2 -** 20 marks each
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Apprehend the basics of MATLAB programming
CO 2: Develop computer programs in MATILAB
CO 3: Apply MATLAB for solving engineering problems
CO4: Apprehend the basics of SCILAB programming

Unit 1	**Basics of MATLAB**
	MATLAB Environment for technical computing, Basic mathematical functions, Arrays and Array Operations, Vector arrays, matrix arrays, Relational and logical operators, loops
Unit 2	**MATLAB Functions**
	Mathematical functions and applications, user defined functions, plotting functions, curve fitting
Unit 3	**Mathematical operations**
	Integration and differentiation, symbolic expressions and algebra, File input output operations
Unit 4	
	Introduction to SCILAB
Unit 5	
	Introduction to SIMULINK
Unit 6	Computer Implementation
	Development of simple programs. Applications to engineering problems
Reference Books:	
1. Stephen Chapman: MATLAB for Engineers: Thompson Publications 2. Steven C Chapra: Applied Numerical Methods with MATLAB: TATA McGRAW-HILL	

Semester-III

Dissertation Phase-I	
Teaching Scheme	**Examination Scheme**
Practicals: 18 Hrs/ week	**Midsemester -** 40 marks
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Identify structural Engineering problems reviewing available literature.
CO 2: Identify appropriate techniques to analyze complex structural systems.
CO 3: Demonstrate application of engineering and management principles through efficient handling of project

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

Semester-IV

Dissertation Phase-II	
Teaching Scheme	**Examination Scheme**
Practicals: 18 Hrs/ week	**Midsemester -** 40 marks
	End Sem. Exam. - 60 marks

Course Outcomes: At the end of the course, the students will be able to:
CO 1: Apply appropriate techniques and tools to solve complex structural problems.
CO 2: Exhibit good communication skills to the engineering community and society. Students will be able to demonstrate professional ethics and work culture.
CO 3: show contribution in efficient technology transfer to the society

Dissertation Phase – II will be related to work on the topic identified in Dissertation Phase – I. Mid semester presentation, Continuous assessment. There will be a pre submission seminar at the end of academic term. After the approval, the student must submit the detail report. Continuous assessment of Dissertation – I and Dissertation – II will be monitored by the departmental committee.