PG Program [M. Tech. Civil Structural Engineering] Curriculum Structure

W.e.f AY 2019-20 and Applicable for batches admitted from AY 2019-20 to 2022-23

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.9%
PSBC	Program Specific Bridge Course	1	3	4.4%
DEC	Department Elective Course	3	9	13.2%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	6	22	32.4%
LC	Laboratory Course	2	2	2.9%
IOC	Interdisciplinary Open Course	1	3	4.4%
LLC	Liberal Learning Course	1	1	1.5%
SLC	Self-Learning Course	2	6	8.8%
SBC	Skill Based Course	2	18	26.5%

Semester - I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PSMC	CSE-19001	Numerical Methods in Structural Engineering	3	1	--	4
2.	PSBC	CSE-19002	Advanced Analysis of Structures	3	0	--	3
3.	DEC	CSE(DE)-19001	Advanced Design of RC Structures	3	--	--	3
		CSE(DE)-19002	Advanced Design of Steel Structures				
4.	PCC	CSE-19003	Structural Dynamics	3	1	--	4
5	PCC	CSE-19004	Solid Mechanics	3	1	--	4
6	LC	CSE-19005	Lab Practice - I: NDT and Structural Dynamics	--	--	3	2
7	LC	CSE-19006	Lab Practice -II: Computer Aided Design	--	--	3	2
Total Credits							**22**

Interdisciplinary Open Course (IOC): Every department shall offer one IOC course (in Engineering/Science/Technology). A student can opt for an IOC course offered by a department except the one offered by his /her department.

Semester - II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	IOC		MATLAB for Engineers	3	--	--	3
2.	DEC	CSE(DE)-19003	High Rise Structures	3	--	--	3
		CSE(DE)-19004	Bridge Engineering				
3.	DEC	CSE(DE)-19005	Structural Health Monitoring	3	--	--	3
		CSE(DE)-19006	Nonlinear Analysis of Structures				
		CSE(DE)-19007	Earthquake Analysis and Design of Structures				
		CSE(DE)-19008	Design of Prestressed Concrete Structures				
4.	MLC	ML-19011	Research Methodology and Intellectual Property Rights	2	--	--	--
5	MLC	ML-19012	Effective Technical Communication	1	--	--	--
6	LLC	LL-19010	Liberal Learning Course	--	--	--	1
7	PCC	CSE-19007	Finite Element Method	3	1	--	4
8	PCC	CSE-19008	Theory of Thin Plates and Shells	3	1	--	4
9	LC	CSE-19009	Mini Project			3	2
10	LC	CSE-19010	Lab Practice - III: Experimental Concrete Technology			3	2
Total Credits							**22**

Semester - I

(PSMC) [CSE-19001] Numerical Methods in Structural Engineering

Credits: 4 (L: 3, T: 1, P: 0)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3Hrs/week	T1 and T2: 20 Marks each
Tutorial: 1 Hr/week	End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be able:

1. to mathematically model and analyze physical system
2. to solve structural engineering problems using numerical methods
3. to write the code for a mathematical problem

Syllabus content:

Unit 1: Fundamentals of numerical methods [7Hrs]

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 [7Hrs]

Power method, Relaxation Method, Diagonalization method.

Unit 3: Numerical Differentiation and Integration [7Hrs]

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 [7Hrs]

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 [7Hrs]

Applications to beam bending, beam vibration, plate bending and plate vibration problems

Unit 6: Partial Differential Equations [7Hrs]

Elliptic and parabolic Equations, Explicit and Implicit Methods Computer algorithms; Numerical solution for different structural problems using abovementioned numerical 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

(PSBC) [CSE-19002] Advanced Analysis of Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be able to

1. Analyze indeterminate structures using Flexibilty method.
2. Develop member stiffness matrices for Framed structures.
3. Develop computer program for Plane Frame structure.
4. Analyze Framed structures using computer program.

Syllabus content:

Unit 1: Basic Concepts of Structural Analysis [7Hrs]

Types of Framed Structures, Deformations in Framed Structures, Actions and Displacements, Equilibrium, Compatibility, Static and Kinematic Indeterminacy, Principle of Superposition, Action and Displacement Equations, Flexibility and Stiffness Matrices, Equivalent Joint Loads, Energy Concepts, Virtual Work

Unit 2: Fundamentals of the Flexibility Method [7Hrs]

Flexibility Method, Temperature Changes, Pre-strains, and Support Displacements, Joint Displacements, Member End-Actions and Support Reactions, Flexibilities of Prismatic Members, Formalization of the Flexibility Method.

Unit 3: Fundamentals of the Stiffness Method [7Hrs]

Stiffness Method Temperature Changes, Pre-strains and Support Displacements, Stiffness of Prismatic Members, Formalization of the Stiffness Method

Unit 4: Direct Stiffness Method [9Hrs]

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: Stiffness Program for Framed Structures [7Hrs]

Flow Charts for the Programs, Program Notation, Preparation of Data, Description of Programs, Continuous Beam Program, Plane Truss Program, Plane Frame Program, Grid Program, Space Truss Program.

Unit 6: Additional Topics in Stiffness Method [7Hrs]

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.

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

(DEC) [CSE(DE)-19001] Advance Design of Steel Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3 Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be able to

1. Design and detail the beam to beam and beam to column connections.
2. Analyze and design the plate girder for railway bridges.
3. Analysis of Bridge Substructures, bearings and wing walls.
4. Analysis and Design of PEB frames

Syllabus content:

Unit 1: Bridging the Gap **[6Hrs]**

Design of Tension and compression members, Design of column and column base -gusseted base.

Unit 2: Design of Connections **[6Hrs]**

Design of rigid and semi-rigid connections - beam to beam, beam to column, Design of splices, Haunched connections

Unit 3: Torsion **[6Hrs]**

Lateral torsional bucking of beams, Beam columns: Design for torsion, elastic torsional buckling.

Unit 4: Design of Plate Girder for Bridges **[6Hrs]**

Design of plate Girder for earthquake, fatigue, fire and temperature variations. Introduction to design of Plate Girder for Bridges for high speed trains as per IRS

Unit 5: Bracing Systems **[6Hrs]**

Design of different types of bracings.

Unit 6: PEB Structures **[6Hrs]**

Design of gable framed 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
9. Indian Railways-Codes.

(DEC) [CSE(DE)-19002] Advanced Design of RC Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3 Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be able to

1. Analyze the special structures by understanding their behavior
2. Design and prepare detail structural drawings for execution
3. Cite relevant IS codes

Syllabus content:

Unit 1: Theory and Design of long span slab, grid floors, flat slabs, folded plates & shells. **[7Hrs]**

Unit 2: Theory and Design of silos, bunkers, Aqueduct. **[7Hrs]**

Unit :3 Analysis and Design of Ground Resting Reservoir, Elevated Service Reservoir. **[7Hrs] Unit**

4: Design of RC Deep Beams and Corbels, Design of Beams Curved in Plan **[7Hrs]**

Unit 5: Design of Domes., Intze Tank. **[7Hrs]**

Unit 6: Design of Formwork [**7Hrs]**

Reference Books:

1) P. C. Varghese, Advanced Reinforced Concrete Design; Prentice Hall of India, New Delhi.
2) T.Y. Lin and N. H. Burns, Design of Prestressed Concrete Structures, John Wiley Publication.
3) N. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co.
4) Relevant Indian Codes.

(PCC) [CSE-19003] Structural Dynamics

Credits: 4 (L: 3, T: 1, P: 0)

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1 and T2: 20 marks each
Tutorial: 1 hr/week	End-Sem Exam: 60 marks

Course Outcomes (COs):

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

1. Apply fundamental theory of structural dynamics and equation of motion to field problems.
2. Analyze and interpret dynamic response of single and multi-degree-of-freedom systems.
3. Perform dynamic analysis of single and multi-degree-of-freedom systems using MATLAB programs / software.

Syllabus content:

Unit 1: Introduction [7Hrs]

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 [7Hrs]

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: Multiple Degree of Freedom (MDOF) System (Lumped parameter) [7Hrs]

Multiple 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. Reduction of dynamic matrices. Time history response of MDOF systems using Newmark β method.

Unit 4: Multiple Degree of Freedom (MDOF) System (Distributed parameter) [7Hrs]

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 [7Hrs]

Theory and development of response spectra, Codal provisions, tripartite response spectra.

Unit 6: Applications of structural dynamics [7Hrs]

Design of machine foundations for harmonic loading, Vibration isolation. Introduction to techniques of vibration response control. Vibration control of SDOF system.

Reference books:

1. Anil K. Chopra, "Dynamics of Structures – Theory and Applications to Earthquake Engineering", Pearson, 3rdEdition, 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, Updated With 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 2974 (2008) Code of practice for design & construction of machine foundation for reciprocating type machines.
8. IS 13301(1997) Vibration isolation of machine foundations - Guidelines
9. 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.

(PCC) [CSE-19004] Solid Mechanics

Credits: 4 (L: 3, T: 1, P: 0)

Teaching Scheme:	Examination Scheme
Lectures: 3 hrs./week	T1 and 2: 20 marks each
Tutorial: 1 hr./week	End-sem. Exam: 60 marks

Course Outcomes (COs):

Students will be able to:

1. Understand Principles of Solid Mechanics to be used for the analysis of structures.
2. Solve simple elasticity problems.
3. Apply above principles to solve complex problems of mechanics.

Syllabus content:

Unit 1: Introduction **[7Hrs]**

Strength of Materials and Theory of Elasticity, Fundamentals, History of mechanics of materials.

Unit 2: Stress **[7Hrs]**

Cauchy Stress, Plane Stress, Stress Transformation, Principal Stresses, Stress, Tensor, Invariant of stress tensor.

Unit 3: Strain **[7Hrs]**

Normal Strain, Strain-Displacement Relationships, Strain Transformation, Plane Strain, Strain Tensor.

Unit 4: Constitutive Equations **[7Hrs]**

Normal Stress –Strain Response, Shear Stress –Strain Response, Generalized Hooke's Law,

Plastic deformations, Yield Criteria, Theories of Failure, Plastic stress- strain Relations.

Unit 5: Applications **[7Hrs]**

Torsion of Cylindrical Bars, Shear Strain, Maximum Shear Stress, Non-circular Prismatic Bars, Beam Bending, Stresses under Transverse Loading, Thermal Strains, Thermal Stresses.

Unit 6: Composite Materials **[7Hrs]**

Introduction to Laminated Composites, Plane Stress of Orthotropic Material, Classical Lamination Theory, Effective Laminate Properties, Effective Axial Modulus, and Effective Coefficient of thermal Expansion.

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.

(LC) [CSE-19005] Lab Practice - I: NDT and Structural Dynamics

Credits: 2 (L: 0, T: 0, P: 3)

Teaching Scheme

Practical: 3hrs/week

Course Outcomes (COs):

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

1. Apply appropriate tools to design and conduct experiments.
2. Select and apply appropriate techniques
3. Function as team member for laboratory work

Laboratory Experiments:

1. Estimation of compressive strength of concrete using Rebound Hammer,
2. Estimation of compressive strength of concrete using UPV
3. Corrosion prediction and analysis for RC member
4. Structural audit of residential building
5. Structural audit of public building
6. Free vibration response of Reinforced Concrete Beam
7. Free vibration response of Frames
8. Determination of principal stresses using strain-gauges
9. Response of Plane Frames under lateral loading.

References:

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, 201

(LC) [CSE-19005] Lab Practice - II: Computer aided design and Software based modeling

Credits: 2 (L: 0, T: 0, P: 3)

Teaching Scheme

Practical: 3hrs/week

Course Outcomes (COs):

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

1. Apply appropriate tools to design and conduct experiments.
2. Select and apply appropriate numerical techniques
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 frame for lateral loading
- Analysis of plane frame using different types of bracing systems

B) Analysis and Design of RCC structures

- Analysis of RCC building
- Analysis of building for lateral loading using shear walls

Semester - II

(IOC) MATLAB for Engineers

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3hrs/week

Examination Scheme

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

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

1. Understand the basics of MATLAB programming
2. Develop the computer programs in MATILAB
3. Apply MATLAB for solving engineering problems

Syllabus Content:

Unit 1: Basics of MATLAB: [7Hrs]

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: [7Hrs]

Mathematical functions and applications, user defined functions, plotting functions, curve fitting.

Unit 3: Mathematical operations: [7Hrs]

Integration and differentiation, symbolic expressions and algebra, File input output operations

Unit 4: Introduction to SCILAB [7Hrs]

Unit 5: Introduction to SIMULINK [7Hrs]

Unit 6: Computer Implementation: [7Hrs]

Development of simple programs. Applications to engineering problems

References:

1. Stephen Chapman: MATLAB for Engineers: Thompson Publications
2. Steven C Chapra: Applied Numerical Methods with MATLAB: TATA McGRAW-HILL

(DEC) [CSE(DE)-19003] High Rise Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be

1. Able to analyze and understand the design concept of special structures.
2. Familiar to different design codes & their applications in high rise structures.
3. Exposed to real projects /data application and structural detailing.

Syllabus Content

Unit 1: Design of transmission/TV tower, Mast and trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads. **[10 hrs]**

Unit 2: Analysis and Design of RC and Steel Chimney for gravity and lateral loads. Foundation design for varied soil strata. **[10 hrs]**

Unit 3 : Tall Buildings , Structural Concept, Configurations, various systems, Wind and Seismic loads, Dynamic approach , structural design considerations and current code provisions. Fire fighting design provisions. **[20 Hrs]**

References

1. Structural Analysis and Design of Tall Buildings S. Taranath, McGraw Hill International edition.
2. Steel Structures by AS Arya+ P. Dayaratnam
3. O.P. Jain and Jaikrishna., Plain and Reinforced Concrete Structures – Vol II, Nemchand and Bros, Roorkee
4. S. N. Manohar, Tall Chimneys, Tata Mc Graw Hill Publishing Company, New Delhi

(DEC) [CSE(DE)-19004] Bridge Engineering

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be able to

4. Analyze the superstructure of bridges - slab, T-beam and Box type
5. Design the superstructure of bridges - slab, T-beam and Box type
6. Analysis of Bridge Substructures, bearings and wing walls.

Syllabus Content:

Unit 1: Introduction, Classification and Types. IRC Specifications for Road Bridges. Earthquake Resistant Design Considerations. **[7Hrs]**

Unit 2: Analysis of Bridges - Effect of concentrated loads on slabs, Load Distribution Theories - Courbon's method, Hendry-Jaeger method and Guyon-Massonet method. **[7Hrs]**

Unit 3: Design of PSC Bridges - Slab Type, T-beam Type, Box Type. **[7Hrs]**

Unit 4: Classification and Design of Bearings - Metallic bearings, Elastomeric bearings, POT and PTFE bearings. **[7Hrs]**

Unit 5: Analysis and Design of Abutment and Pier. Introduction to Design of Open Well, Pile and Caisson Foundations. **[7Hrs]**

Unit 6: Analysis and Design of Wing Walls. **[7Hrs]**

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 Codes -
    i. **IRC 6** (2014), Section II: **Loads and Stresses**.
    ii. IRC 78 (2000), Section VII: **Foundations and Substructures**
    iii. **IRC 83** (1982), Section IX: Bearings, Part I: **Metallic Bearings** (1994)
    iv. **IRC 83** (1987), Section IX: Bearings, Part II: **Elastomeric Bearings** (1994)
    v. **IRC 83** (1987), Section IX: Bearings, Part III: **POT and PTFE Bearings** (1994)
    vi. IRC 112 (2012), **Design Criteria for RCC and PSC Bridges**

(DEC) [CSE(DE)-19005] Structural Health Monitoring and Retrofitting

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1 and T2: 20 marks each
	End-Sem Exam: 60 marks

Course Outcomes (COs):

Students will be able to:

1. Observe the status of structure from Visual observation and NDT Test
2. Conduct structural audit
3. Suggest repairing methods and or retrofitting technique for strengthening of structural member and or structure.

Syllabus content:

Unit 1: **[8Hrs]**

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: **[6Hrs]**

Visual Inspection of structure, techniques. Different types of NDT tests.

Unit 3: **[6Hrs]**

Structural audit, Role of Engineer, Purpose, survey of structural defects, Guidelines for structural audit, Case studies.

Unit 4: **[6Hrs]**

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: **[6Hrs]**

Carbonation of concrete, concept, deterioration of concrete, corrosion of reinforcement. Settlement of structures.

Unit 6: **[8Hrs]**

Structural repairs and retrofitting, Different techniques, case studies, safety of structures.

Reference Books and Journals

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.
4. Journals available in the library.

(DEC) [CSE(DE)-19007] Earthquake Analysis and Design of Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

At the end of the course, students will demonstrate the ability to:

1. Apply fundamentals of structural dynamics to different structures. (PEO: I), (PO: a)
2. Analyze RC and steel structural components from seismic considerations. (PEO: I, II), (PO: a, e)
3. Design RC and steel building components from seismic considerations. (PEO: III), (PO: c)

Syllabus Content:

Unit 1: Seismic Design Considerations for RC Buildings **[7Hrs]**

Choice of earthquake resisting systems for low rise, medium rise and high-rise buildings, Principles of member design, ductile detailing,Earthquake Resistant Design of beams and columns, Design of Beam-Column Joints, Design of Shear walls with ductile detailing, Drift and lateral stability criteria, Analysis of buildings considering soil - structure interaction

Unit 2: **[7Hrs]**

Performance of steel structures in the past earthquakes, Design philosophy for steel structures, Capacity design concept, Ductility of steel buildings, Seismic design and detailing of Moment Resistant Frames (MRFs): Beams and Columns, Panel Zones and Connections, Seismic design and detailing of Concentric Brace Frames (CBFs)

Unit 3: Wave propagation analysis **[7Hrs]**

Theory, development and construction of response spectrum, Inelastic Response Spectrum, Modal analysis method, Linear Time history analysis, P-Δ effect, Missing mass correction, Torsion response of buildings.

Unit 4: Nonlinear time history analysis **[7Hrs]**

Non-Linear time history analysis of Structures, State space method, Inelastic dynamic state space response of SDOF systems, Inelastic dynamic state space response of MDOF systems

Unit 5: Seismic soil structure interaction **[7Hrs]**

Force-based design and displacement-based design, Modelling and Analysis of Structures for Displacement Based Design, back-bone curve, Displacement Based Design - Structure

Performance, Objectives and Performance Levels, Pushover analysis, Capacity spectrum method, Seismic coefficient method

Unit 6: Applications of structural dynamics [7Hrs]

Types of structural control, Energy Dissipation Devices: General requirements; Implementation, Elastomeric and friction isolators, Viscous dampers, friction dampers and tuned mass dampers.

Reference books:

1. Anil K. Chopra, "Dynamics of Structures – Theory and Applications to Earthquake Engineering", Pearson, 3rd Edition, 2011
2. Farzad Naeim, "The Seismic Design Handbook", 2nd Edition, Kluwer Academic Publishers Group, 2003
3. Gary Hart and Kevin Wong, "Structural Dynamics for Structural Engineers", John Wiley and Sons, 2000
4. James Kelly and Farzad Naeim, " Design of Seismic Isolated Structures: From Theory to Practice", 1999, John Wiley and Sons
5. J. W. Smith, "Vibration of Structures. Application in Civil Engineering Design", Chapman and Hall, 1988
6. Mario Paz and William Leigh, "Structural Dynamics - Theory and Computation, Updated With Sap 2000", 5th Edition, Kluwer Academic Publishers
7. R. W. Clough and J. Penzien, "Dynamics of Structures", Tata Mc Graw Hill, 2nd Edition, 2003.
8. Sharad Manohar and Suhasini Madhekar, Seismic Design of RC Buildings – Theory and Practice, 2015, Springer
9. Tushar Kanti Datta, "Seismic Analysis of Structures", John Wiley and Sons, 2010
10. Thomas Paulay and M.J.N Priestley , "Seismic Design for R.C. and Masonry Building", John Wiley and Sons, 1992
11. William Robinson and Ivan Skinner, "An Introduction to Seismic Isolation", 1993, John Wiley and Sons
12. IS 1893: 2016, "Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings", 5th Revision
13. IS 13920: 2016, "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces"

(DEC) [CSE(DE)-19008] Design of Prestressed Concrete Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3Hrs/week	T1 and T2: 20 Marks each
	End-Sem Exam: 60 Marks

Course Objectives:

1. To understand the basic aspects of prestressed concrete fundamentals, including pre and post-tensioning processes.
2. To analyse and design of prestressed concrete flexural members
3. To analyse and design prestressed concrete deck slab and beam/ girders
4. To design end blocks for prestressed concrete members.

Course Outcomes (COs):

On successful completion of this course students will be able to

1. Apply the basic concepts of prestressed concrete fundamentals, including pre and posttensioning processes.
2. Analyse and design prestressed concrete flexural members
3. Analyse and design prestressed concrete deck slab and beam/ girders
4. Design of end blocks for prestressed concrete members.

Syllabus Content:

Unit I: 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 II: Statically determinate PSC beams
Design for ultimate and serviceability limit states for flexure, analysis and design for shear and torsion, code provisions.

Unit III: Anchorage Zones
Transmission of prestress in pretensioned members; Anchorage zone stresses for posttensioned members.

Unit IV: Statically indeterminate structures

Design of two span continuous beams, choice of cable profile, linear transformation and concordancy.

Unit V: 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 VI: 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 Prestressed Concrete, Guyan Y., 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

(MLC) [ML-19011]- Research Methodology and Intellectual Property Rights

Credits: 0 (L: 2, T: 0, P: 0)

Teaching Scheme:	Evaluation Scheme:
Lectures: 2 hrs/week	Continuous evaluation: Assignments/Presentation/Quiz/Test

Course Outcomes (COs):

Student will be able to:

1. Understand research problem formulation and approaches of investigation of solutions for research problems
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
3. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits

Syllabus content:

Unit 1: **[5Hrs]**

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 problem, data collection, analysis, interpretation, necessary instrumentations.

Unit 2: **[5Hrs]**

Effective literature studies approaches, 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

Unit 3: **[5Hrs]**

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 4: **[4Hrs]**

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 5: **[7Hrs]**

Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act, Patent 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,

Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

Unit 6: **[4Hrs]**

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

(MLC) [ML-19012] Effective Technical Communication

Credits: 0 (L: 1, T: 0, P: 0)

Teaching Scheme:	Evaluation Scheme:
Lectures: 1hr/week	100M: 4 Assignments - (25M each)

Course Outcomes (COs):

Student will be able to

1. Produce effective dialogue for business related situations
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
3. Analyze critically different concepts / principles of communication skills
4. Demonstrate productive skills and have a knack for structured conversations
5. Appreciate, analyze, evaluate business reports and research papers

Syllabus content:

Unit 1: Fundamentals of Communication: **[4Hrs]**

7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Unit 2: Aural-Oral Communication: **[4Hrs]**

The art of listening, stress and intonation, group discussion, oral presentation skills

Unit 3: Reading and Writing: **[4Hrs]**

Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers**.**

Reference Books

1. Raman Sharma, “Technical Communication”, Oxford University Press.
2. Raymond Murphy “Essential English Grammar” (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock “English Pronunciation in Use” Cambridge University Press.
4. Shirley Taylor, “Model Business Letters, Emails and Other Business Documents” (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen “Technical writing and Professional Communications for Non-native speakers of English”, McGraw Hill.

(DEC) [CSE(DE)-19006] Non-Linear Analysis of Structures

Credits: 3 (L: 3, T: 0, P: 0)

Teaching Scheme:

Lectures: 3Hrs/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

Student will be able to

1. Use numerical technique to solve nonlinear system of equilibrium equations.
2. Develop geometric stiffness matrix for plane frame structures.
3. Develop computer program for geometric non-linearity.
4. Analyze structures considering geometric as well a material non-linearity.

Syllabus content:

Unit 1: Introduction: **[7Hrs]**

Behavior of idealized structures, linearized load-deformation behavior 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: **[7Hrs]**

Non-linear behavior, 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: **[7Hrs]**

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: **[7Hrs]**

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: **[7Hrs]**

Nonlinear material behavior, 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: **[7Hrs]**

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.

(PCC) [CSE-19007] Finite Element Method

Credits: 4 (L: 3, T: 1, P: 0)

Teaching Scheme:

Lectures: 3Hrs/week

Tutorial: 1Hr/week

Examination Scheme:

T1 and T2: 20 Marks each

End-Sem Exam: 60 Marks

Course Outcomes (COs):

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

1. Solve structural engineering problems using one dimensional finite elements.
2. Solve structural engineering problems using two and three dimensional elements.
3. Use the commercial software/ Computer programs for the analysis.

Syllabus Contents:

Unit 1: **[7Hrs]**

Introduction History and applications, General steps of finite Element Method, Concept of stiffness matrix and load vector. Application of boundary conditions.

Unit 2: **[7Hrs]**

One dimensional Finite Element Analysis Bar elements, analysis of plane and space trusses, beam element and analysis of beams.

Unit 3: **[7Hrs]**

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: **[7Hrs]**

Two dimensional Finite Element Analysis Tetrahedral and hexahedral elements. Analysis of Axi-Symmetric solids.

Unit 5: **[7Hrs]**

Plate Bending and Flat Shell Elements The rectangular and quadrilateral elements based on Classical Plate Theory and First Order Shear Deformation Theory.

Unit 6: **[7Hrs]**

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.

A. D. Belegundu and T. R. Chandrupatla: Finite Element Methods in Engineering: Prentice-Hall of India

2. Y. M. Desai, T. I. Eldho and A. H. Shah: Finite Element Method with Applications in Engineering: PEARSON
3. D. V. Hutton: Fundamentals of Finite Element Analysis: TATA McGRAW-HILL
4. J. N. Reddy: An Introduction to Finite Element Method: TATA McGRAW-HILL

(PCC) [CSE-19008] Theory of Thin Plates and Shells

Credits: 4 (L: 3, T: 1, P: 0)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3Hrs/week	T1 and T2: 20 Marks each
Tutorial: 1Hr/week	End-Sem Exam: 60 Marks

Course Outcomes (COs):

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

1. Understand the basic concepts of theory of thin plates and shells
2. Solve problems based on thin plates and shells
3. Understand the basic concepts of laminated composite plates

Syllabus content:

Unit 1: **[7Hrs]**

Introduction to Plate Theory, Assumptions made in the Poission-Kirchoff plate theory, Plate equation and behavior of thin plates in Cartesian coordinates.

Unit 2: **[7Hrs]**

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: **[7Hrs]**

Analysis of Circular Plates Circular plates, governing differential equation in Polar coordinates

Unit 4: **[7Hrs]**

Theory of Surfaces Introduction to space curves and surfaces, shell surfaces and characteristics, classifications of shells.

Unit 5: **[7Hrs]**

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: **[7Hrs]**

Introduction to classical theory of laminated plates, Assumptions made in the analysis, Strain-displacement relations, Constitutive relations for lamina and laminates, Equations of motion, Static Bending Analysis of laminates.

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: Mc – Graw Hill
4. J. N. Reddy: Mechanics of Laminated Composite Plates and Shells: CRC Press
5. A. C. Ugural: Stresses in Plates and Shells: Mc Graw Hill
6. K. Chandrashekhara: Theory of Plates: Universities Press

(LC) [CSE-19010] Lab Practice – III: Experimental Concrete Technology

Credits: 2 (L: 0, T: 0, P: 3)

Teaching Scheme

Practical: 3hrs/week

Course Outcomes (COs):

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

1. Design a concrete mix as per the requirement at the field.
2. Select and apply appropriate techniques to design and conduct experiments.
3. Function as team member for laboratory work

Syllabus content:

1. Advances in Concrete Technology
   a) Mix design of Fiber Reinforced Concrete
   b) Mix design of High Strength concrete (M60 and above), High Performance Concrete
2. Tests for measuring Corrosion parameters using Electro-chemical methods
   a) Open Circuit Potential
   b) Linear Polarization Resistance
   c) Electrochemical Impedance Spectroscopy
   d) Mott Schottky Test
   e) Cyclic Polarization test
3. Site visits demonstrating Special concreting methods: Vacuum dewatering-under water concrete, Temp controlled concrete for mass concrete.

S.Y M.Tech (Structural Engineering)

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	DEC	**Elective – II** a. Bridge Engineering b. Advanced Steel Design c. Advanced Finite Element Method	3	--	--	3
2.	Dissertation	Dissertation Phase – I	--	--	--	14
3.	LLC	Liberal Learning Course	--	--	--	1
4.	MLC	Research Methodology	1	--	--	--
		Total	**--**	**--**	**--**	**18**

Semester-IV

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	Dissertation	Dissertation Phase – II	--	--	--	18
2.	MLC	Intellectual Property Rights	1	--	--	--
		Total	**--**	**--**	**--**	**18**

Dissertation Phase-I
Credits(14)

Course outcomes:

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

1. identify structural engineering problems reviewing available literature.
2. identify appropriate techniques to analyze complex structural systems.
3. apply 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 monitored by the departmental committee. 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.

Dissertation Phase-II
Credits(18)

Course outcomes: At the end of the course students will be able to, 1. apply appropriate techniques and tools to solve complex structural problems. 2. students will exhibit good communication and demonstrate professional ethics and work culture. 3. show contribution in efficient technology transfer to the society.
Dissertation – II will be related to work on the topic identified in Dissertation – I. Mid semester presentation and pre submission seminar at the end of academic term will be monitored by the departmental committee. After the approval the student has to submit the detail report and has to present the work to external examiner. Continuous assessment of Dissertation – I and Dissertation – II is mandatory.