College of Engineering, Pune

An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Civil Engineering

Structural Engineering

Curriculum Structure & Detailed Syllabus (PG Program)

M. Tech.

(Effective from: A.Y. 2019-23)

Program Educational Objectives (PEOs)

I. Graduate will work as an expert in the field of Structural Engineering by acquiring advanced knowledge in the area of analysis and design of structural systems.

II. Graduate will analyze and solve complex problems of Structural engineering systems.

III. Graduate will exhibit professionalism, ethical approach, communication skills, and team work in their profession and adapt to modern trends by engaging in lifelong learning.

Program Outcomes (POs)

Graduates will be able to

PO1: Apply 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.

Correlation between the PEOs and the Pos

Note: The cells filled with ✓ indicate the fulfilment/correlation of the concerned PEO with the PO.

Program Educational Objectives (PEOs)	Program Outcomes (Pos)				
	a	b	c	d	e
I	✓	✓		✓	
II	✓	✓	✓	✓	✓
III		✓	✓	✓	

Components of the curriculum

Abbreviation	Title	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
PSMC	Program Specific Mathematics Course	5.90	04	04
PSBC	Program Specific Bridge Course	4.40	03	03
DEC	Department Elective Course	13.20	09	09
MLC	Mandatory Learning Course	00	07	00
PCC	Program Core Course	32.40	16	22
LC	Laboratory Course	2.90	12	02
IOC	Institute Level Open Elective Course	4.40	03	03
LLC	Liberal Learning Course	1.50	00	01
SLC	Self-Learning Course	8.80	06	06
SBC	Skill Based Course	26.50	36	18
Total		**100**	**96**	**68**

Structure of the curriculum for 2019-2023

Semester I

Sr. No	Course Type	Course Code	Course Name	Total no of Contact Hours			Credits
				Lecture (L)	Tutorial (T)	Practical (P)	
1	PSMC	CSE-19001	Numerical Method in Structural Engineering	3	1	---	4
2	PSBC	CSE-19002	Advanced Analysis of RC 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	**22**

Semester II

Sr. No	Course Type	Course Code	Course Name	Total No. of Contact Hours			Cre dits
				Lecture (L)	Tutorial (T)	Practical (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 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	**22**

Semester III

Sr. No	Course Type	Course Code	Course Name	L	T	Teaching Scheme
1	SBC	CSE-19011	Dissertation Phase – I	---	---	18
2	SLC	CSE-19012	Massive Open Online Course – I	3	---	---
				Total		**12**

Semester IV

Sr. No	Course Type	Course Code	Course Name	L	T	Teaching Scheme
1	SBC	CSE-19011	Dissertation Phase – II	---	---	18
2	SLC	CSE-19012	Massive Open Online Course – II	3	---	---
				Total		**12**

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.

List of IOC opted by the students of Structural engineering program is attached here

- Mechanics of Composite Materials
- Finite Element Method
- Design thinking and Participatory Planning
- Application of Geoinformatics in Water Management
- Environmental Management
- Project Planning and Control
- Broadband Communication

Semester I

[PSMC] Numerical Methods in Structural Engineering	
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: At the end of the course, the students are able to,
CO_1: Understand basic concepts of various numerical methods for performing tasks, such as interpolation, differentiation, integration, solution of linear and nonlinear equations, solution of differential and integral equations
CO_2: Apply Numerical Methods to obtain approximate solutions to mathematical problems
CO_3: Analyse and evaluate accuracy of various numerical methods and their applicability
CO_4: Solve Structural engineering problems using numerical methods
CO_5: Write the code for a mathematical problem

Unit 1:	**Fundamentals of Numerical Methods**	**[7 Hrs.]**
	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 Equations, Solution of Nonlinear Simultaneous Equations.	
Unit 2:	**Eigen Values and Eigen Vectors**	**[7 Hrs.]**
	Power method, Relaxation Method, Diagonalization method.	
Unit 3:	**Numerical Differentiation and Integration**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	Applications to beam bending, beam vibration, plate bending and plate vibration problems	
Unit 6:	**Partial Differential Equations**	**[7 Hrs.]**
	Elliptic and parabolic Equations, Explicit and Implicit Methods, Computer algorithms; Numerical solution for different structural problems using above mentioned numerical methods.	

Reference Books:
1. Chapra S201 and Canale R P, Numerical Methods for engineering. Megraw-Hillnc, 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] Advanced Analysis 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 are able to,
CO_1: Analyse Indeterminate Structures using Stiffness Method
CO_2: Analyse Indeterminate Structures using Flexibility Method
CO_3: Develop Member stiffness matrices for Framed Structures
CO_4: Develop computer program for Plane Frame Structures
CO_5: Analyse Framed Structures using computer program

Unit 1:	**Basic Concepts of Structural Analysis**	**[7 Hrs.]**
	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 Methods**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	Stiffness Method Temperature Changes, Pre-strains and Support Displacements, Stiffness of Prismatic Members, Formalization of the Stiffness Method	
Unit 4:	**Direct Stiffness Method**	**[7 Hrs.]**
	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** **[7 Hrs.]**
	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** **[7 Hrs.]**
	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. MadhuKanchi, "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] Advanced Design of RCC 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 are able to,
CO_1: Analyse the Roofs and Material Storage Structures by understanding their behaviour
CO_2: Analyse the Water Storage Structures by understanding their behaviour
CO_3: Design the Roofs and Material Storage Structures by understanding their behaviour
CO_4: Design the Water Storage Structures by understanding their behaviour
CO_5: Prepare detailed structural drawings citing relevant IS codes

Unit 1:		**[7 Hrs.]**
	Theory and design of long span slab, grid floors, flat slabs, folded plates and shells.	
Unit 2:		**[7 Hrs.]**
	Theory and design of silos, bunkers, aqueduct.	
Unit 3:		**[7 Hrs.]**
	Analysis and design of ground resisting reservoir, elevated service reservoir.	
Unit 4:		**[7 Hrs.]**
	Design of RC Deep beams and corbels, Design of beams curved in plan.	
Unit 5:		**[7 Hrs.]**
	Design of Domes, Intze tank	
Unit 6:		**[7 Hrs.]**
	Design of formwork	

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

[DEC] Advanced Design of Steel 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 are able to,
CO_1: Analyse multistoried buildings using suitable software
CO_2: Design moment resisting connections
CO_3: Design beam column, frames, steel plate shear wall
CO_4: Analyse and design Trussed Girder Bridge
CO_5: Understand design procedure for earthquake, fire and temperature variation

Unit 1:	**Bridging the Gap**	**[7 Hrs.]**
	Design of Tension and Compression Members, Design of column and column base – gusseted base	
Unit 2:	**Design of Connections**	**[7 Hrs.]**
	Design of rigid and semi-rigid connections - beam to beam, beam to column, Design of splices, Hunched connections	
Unit 3:	**Torsion**	**[7 Hrs.]**
	Lateral torsional bucking of beams, Beam columns: Design for torsion, elastic torsional buckling	
Unit 4:	**Design of Plate Girder for Bridges**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	Design of different types of bracings	
Unit 6:	**PEB Structures**	**[7 Hrs.]**
	Design of gable framed pre-engineered building	

Reference Books:

1. N. Subramanian, "Design 1 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

[PCC] Structural Dynamics	
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: At the end of the course, the students are able to,
CO_1: Apply fundamental theory of structural dynamics and equation of motion of practical problems
CO_2: Analyse and interpret dynamic response of single degree of freedom system
CO_3: Analyse and interpret dynamic response of multi degree of freedom system
CO_4: Analyse and interpret dynamic response of systems with distributed parameters
CO_5: Perform dynamic analysis of single and multi-degree of freedom systems using MATLAB programs/software

Unit 1:	**Introduction**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	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 ß method.	
Unit 3:	**Multiple Degree of Freedom (MDOF) System (Lumped parameter)**	**[7 Hrs.]**
	Multiple Degree of Freedom System (up to 3 DOF). Formulation of mass, stiffness and damping matrices. Determination of natural frequencies and mass 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 ß method	
Unit 4:	**Multiple Degree of Freedom (MDOF) System (Distributed parameter)**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	Theory and development of response spectra, Codal provisions, tripartite response spectra.	
Unit 6:	**Applications of structural dynamics**	**[7 Hrs.]**
	Design of machine foundations for harmonic loading, Vibration isolation. Introduction to techniques of vibration response control. Vibration control of SDOF system.	

Reference Books:
1. 1. Anil K. Chopra, "Dynamics of Structures Theory and Applications to Earthquake Engineering", Pearson, 3rdEdition, 2011
2. Gary Sons, Kevin Wong, "Structural Dynamics for Structural Engineers", John Wiley and Sons, 2000
3. J. W. Smith 1988 "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 Sap2000", 5^{th} Edition, Kluwer Academie 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 and construction of machine foundations for reciprocating type machines.
8. IS 13301(1997) Vibration isolation of machine foundations – Guidelines

[PCC] Solid Mechanics	
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 are able to,
CO_1: Understand basic concepts of stress and strain at a point in 3-D system
CO_2: Establish constitutive relationship for different theories of failure
CO_3: Analyse cross section using different theories of failure
CO_4: Solve complex problems by applying principles of Solid Mechanics
CO_5: Understand basic concepts of laminated composites

Unit 1:	**Introduction**	**[7 Hrs.]**
	Strength of Materials and Theory of Elasticity, Fundamentals, History of mechanics of materials.	
Unit 2:	**Stress**	**[7 Hrs.]**
	Cauchy Stress, Plane Stress, Stress Transformation, Principal Stresses, Stress, Tensor, Invariant of stress tensor.	
Unit 3:	**Strain**	**[7 Hrs.]**
	Normal Strain, Strain-Displacement Relationships, Strain Transformation, Plane Strain, Strain Tensor.	
Unit 4:	**Constitutive Equation**	**[7 Hrs.]**

	Normal Stress-Strain Response, Shear Stress -Strain Response, Generalised Hooke's Law, Plastic deformations, Yield Criteria, Theories of Failure, Plastic stress- strain Relations.	
Unit 5:	**Applications**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	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. LS 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 of Soilds", 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. Martin H. Sadd, "Elasticity", Academic Press - Elsevier, 2005.

[LC] Lab Practice 1: - NDT and 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 are able to,
CO_1: Apply appropriate tools to design and conduct experiments
CO_2: Select and apply appropriate techniques
CO_3: Function as team member for laboratory work
CO_4: Analyse Steel and RCC Structures
CO_5: Design of Steel and RCC Structures

Exp. 1:	Estimation of compressive strength of concrete using Rebound Hammer
Exp. 2:	Estimation of compressive strength of concrete using UPV
Exp. 3:	Corrosion prediction and analysis for RC member

Exp. 4:	Structural audit of residential building
Exp. 5:	Structural audit of public building
Exp. 6:	Free vibration response of Reinforced Concrete Beam
Exp. 7:	Free vibration response of Frames
Exp. 8:	Determination of principal stresses using strain-gauges
Exp. 9:	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 CRC Press, 2003, "Handbook of Non-destructive Testing of Concrete",
4. K. W. Day, J. Aldred and B. Hudson, "Concrete Mix Design, Quality Control and Specification", CRC Press, 2014
5. Boresi A. P., Richard J. Schmidt., "Advanced Mechanics of Materials", (Sixth Edition) Wiley Publishing, 2003.
6. Martin H. Sadd, "Elasticity", Academic Press - Elsevier, 2005.

[LC] Lab Practice 2: - Computer Aided Design and Software based modeling

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 are able to,
CO_1: Select and apply appropriate techniques
CO_2: Apply appropriate tools to conduct experiments
CO_3: Function as team member for laboratory work
CO_4: Select and apply appropriate techniques
CO_5: Apply appropriate tools to conduct experiments

Unit 1:	**Laboratory Experiments using 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 Engineering Applications	
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 are able to,
CO_1: Understand basic MATLAB programming
CO_2: Develop the computer programs in MATLAB
CO_3: Apply MATLAB for solving engineering problems

Unit 1:	**Basics of MATLAB**	**[7 Hrs.]**
	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**	**[7 Hrs.]**
	Mathematical functions and applications, user defined functions, plotting functions, curve fitting	
Unit 3:	**Mathematical operations**	**[7 Hrs.]**
	Integration and differentiation, symbolic expressions and algebra, File input output operations	
Unit 4:	**Introduction to SCILAB**	**[7 Hrs.]**
Unit 5:	**Introduction to SIMULINK**	**[7 Hrs.]**
Unit 6:	**Computer Implementation**	**[7 Hrs.]**

Reference Books:

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

[DEC] Bridge Engineering	
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 are able to,
CO_1: Understand the IRC specifications and earthquake resistant design considerations
CO_2: Analyse the superstructure of slab, T-beam and box type bridges
CO_3: Design the superstructure of slab, T-beam and box type Bridges
CO_4: Analyse substructure- Piers, Abutments and their Foundations
CO_5: Analyse and design the type of bearings and understand the working of vibration control devices

Unit 1:		**[7 Hrs.]**
	Introduction, Classification and Types. IRC Specifications For Road Bridges. Earthquake Resistant Design Considerations.	
Unit 2:		**[7 Hrs.]**
	Analysis of Bridges - Effect of concentrated loads on slabs, Load Distribution Theories - Courbon's method, Hendry-Jaeger method and Guyon- Massonet method.	
Unit 3:		**[7 Hrs.]**
	Design of PSC Bridges - Slab Type, T-beam Type, Box Type.	
Unit 4:		**[7 Hrs.]**
	Classification and Design of Bearings - Metallic bearings, Elastomeric bearings, POT and PTFE bearings.	
Unit 5:		**[7 Hrs.]**
	Analysis and Design of Abutment and Pier. Introduction to Design of Open Well, Pile and Caisson Foundations.	
Unit 6:		**[7 Hrs.]**
	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 Codes –
    - IRC 6 (2014), Section II: Loads and Stresses.
    - IRC 78 (2000), Section VII: Foundations and Substructures
    - IRC 83 (1982), Section IX: Bearings, Part I: Metallic Bearings (1994)
    - IRC 83 (1987), Section IX: Bearings, Part II: Elastomeric Bearings (1994)
    - IRC 83 (1987), Section IX: Bearings, Part III: POT and PTFE Bearings (1994)

- IRC 112 (2012), Design Criteria for RCC and PSC Bridges

[DEC] 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 are able to,
CO_1: Apply fundamentals of structural dynamics to different structures
CO_2: Apply clauses of IS1893 and IS13920 to RC buildings
CO_3: Analyse RC and Steel structural components for seismic considerations
CO_4: Design RC and steel Structural components from seismic and ductile detailing considerations
CO_5: Analyse and design RC building on software

Unit 1:	**FE modeling of vibration problems**	**[7 Hrs.]**
	Introduction, application of FEM for 2 D beam element, examples on portal frames	
Unit 2:	**Frequency domain spectral analysis**	**[7 Hrs.]**
	Introduction, stationary random process, Analysis of response in the frequency domain. Transform methods of analysis. Fourier series and Fourier integral. Fourier series representation of a periodic function. Exponential form of Fourier series. Complex frequency response function. Response to non-periodic load. Discrete Fourier transform. Fast Fourier transform. Complex Fourier series, frequency spectrum, frequency domain representations. Auto correlation and cross correlation functions. Power Spectral Density Functions (PSDF) and cross power spectral density functions. Single input - single output (SISO) system. PSDF matrix of member end forces. Modal spectral analysis. Spectral analysis using state space formulation.	
Unit 3:	**Wave propagation analysis**	**[7 Hrs.]**
	Introduction, the phenomenon of wave propagation. Harmonic waves. I-D wave equation, propagation of waves in systems of finite extent. Reflection and refraction of waves at a discontinuity in the system properties. Characteristics of wave equation. Wave dispersion.	
Unit 4:	**Nonlinear time history analysis**	**[7 Hrs.]**
	State space method. Response of SDOF and MDOF systems with NL stiffness. Inelastic displacement and force analogy method. Response of SDOF and MDOF systems using force- analogy method. Inelastic dynamic state space response.	

	Inelastic dynamic response with state space reduction	
Unit 5:	**Seismic soil structure interaction**	**[7 Hrs.]**
	Elements of soil dynamics, wave propagation through soil, one dimensional wave propagation and ground response analysis. 2D response analysis in time domain. Soil-pile interaction. Dynamics of soil-foundation systems, dynamic interaction of rigid foundations and soil media, spring constants and damping coefficients. Aseismic design of foundations. Combined pile and raft foundation. Seismic analysis of buried structures.	
Unit 6:	**Applications of structural dynamics**	**[7 Hrs.]**
	Benchmark problems. Wind loading on structures, dynamic properties of wind, response to turbulent buffeting, across wind response of slender structures. Vibrations caused by traffic, blasting, pile driving. Human response to vibrations. Types of structural control - application of passive dampers to buildings. Response of offshore structures to wave loading	

Reference Books:

1. 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. Jagmohan L. Humar, "Dynamics of Structures", Prentice Hall, 1990
5. Mario Paz and William Leigh, "Structural Dynamics - Theory and Computation, Updated with Sap 2000", 5th Edition, Kluwer Academic Publishers

[MLC] Research Methodology and Intellectual Property Rights

Teaching Scheme:	**Examination Scheme:**
Lectures: 2 hrs./week	**Continuous Evaluation**
	Assignment/Presentation/Quiz/Test

Course Outcomes: At the end of the course, the students are able to,
CO_1: Infer that tomorrow's world will be ruled by ideas, concept, and creativity
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 an economic leadership in context of global market scenario
CO_4: Study the National & International IP system

CO_5: 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

Unit 1:		**[5 Hrs.]**
	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:		**[5 Hrs.]**
	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:		**[5 Hrs.]**
	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:		**[4 Hrs.]**
	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:		**[7 Hrs.]**
	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:		**[4 Hrs.]**
	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, Designs and Geographical Indications.
3. G.V.G Krishnamurthy: The Law of Trademarks, Copyright, Patents and Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. SK Roy Chaudhary & HK 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] Effective Technical Communication

Teaching Scheme:	**Examination Scheme:**
Lectures: 1 hrs./week	**4 Assignments** – 25 marks each
	Total – Marks

Course Outcomes: At the end of the course, the students are able to,
CO_1: Produce effective dialogue for business related situations
CO_2: Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
CO_3: Analyze critically different concepts / principles of communication skills
CO_4: Demonstrate productive skills and have a knack for structured conversations
CO_5: Appreciate, analyze, evaluate business reports and research papers

Unit 1:	**Fundamentals of Communication**	**[4 Hrs.]**
	7 Cs of communication, common errors in English, enriching vocabulary, styles and registers	
Unit 2:	**Aural-Oral Communication**	**[4 Hrs.]**
	The art of listening, stress and intonation, group discussion, oral presentation skill	
Unit 3:	**Reading and Writing**	**[4 Hrs.]**
	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] Non-Linear Analysis 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 are able to,
CO_1: Use numerical technique 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 a material non-linearity

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

	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**	**[7 Hrs.]**
	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. 4. K. I. Majid, "Non-linear Structures", Butterworth, 1972.

[PCC] Finite Element Method

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 are able to,
CO_1: Formulate stiffness matrices for regular elements using shape functions
CO_2: Solve Structural Engineering problems using one dimensional finite element.
CO_3: Solve Structural Engineering problems using two dimensional elements.
CO_4: Solve Structural Engineering problems using three dimensional elements.
CO_5: Use the commercial software/computer programs for the analysis.

Unit 1:		**[7 Hrs.]**
	Introduction History and applications. General steps of finite Element Method, Concept of stiffness matrix and load vector. Application of boundary conditions.	
Unit 2:		**[7 Hrs.]**
	One dimensional Finite Element Analysis Bar elements, analysis of plane and space trusses, beam element and analysis of beams.	
Unit 3:		**[7 Hrs.]**
	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:		**[7 Hrs.]**

	Two-dimensional Finite Element Analysis Tetrahedral and hexahedral elements. Analysis of Axi-Symmetric solids.	
Unit 5:		**[7 Hrs.]**
	Plate Bending and Flat Shell Elements The rectangular and quadrilateral elements based on Classical Plate Theory and First Order Shear Deformation Theory	
Unit 6:		**[7 Hrs.]**
	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. 1. Eldho and A. H. Shah: Finite Element Method with Applications in Engineering: PEARSON
4. D. V Hutton: Fundamentals of Finite Element Analysis: TATA MCGRAW-HILL
5. 5. J. N. Reddy: An Introduction to Finite Element Method: TATA MCGRAW-HILL

[PCC] Theory of Thin Plates and Shells

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 are able to,
CO_1: Understand the basic concepts of classical theory of thin plates
CO_2: Understand the basic concepts of classical theory of thin shells
CO_3: Solve problems based on thin plates and shells
CO_4: Solve the problems based on circular plates
CO_5: Understand the basic concepts of laminated composite plates

Unit 1:		**[7 Hrs.]**
	Introduction to Plate Theory, Assumptions made in the Poission-Kirchoff plate theory, Plate equation and behavior of thin plates in Cartesian coordinates	
Unit 2:		**[7 Hrs.]**

	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:		**[7 Hrs.]**
	Analysis of Circular Plates Circular plates, governing differential equation in Polar coordinates	
Unit 4:		**[7 Hrs.]**
	Theory of Surfaces Introduction to space curves and surfaces, shell surfaces and characteristics, classifications of shells.	
Unit 5:		**[7 Hrs.]**
	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:		**[7 Hrs.]**
	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: McGraw Hill
4. J. N. Reddy: Mechanics of Laminated Composite Plates and Shells. CRC Press
5. C. Ugural: Stresses in Plates and Shells: Mc Graw Hill
6. 6. K. Chandrashekhara: Theory of Plates: Universities Press

[LC] Lab Practice III Experimental Concrete Technology

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	

Course Outcomes: At the end of the course, the students are able to,
CO_1: Design High strength, High Performance concrete mиx (> M40 grade)
CO_2: Select and apply appropriate techniques to conduct experiments
CO_3: Function as team member for laboratory work
CO_4: Select suitable materials to control corrosion of RCC structures
CO_5: Suggest suitable concreting technique for various situations

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

Reference Books:

1. V. M. Malhotra and N. J. Cariano, "Handbook of Non-destructive Testing of Concrete", CRC Press, 2003
2. K. W. Day, J. Aldred and B. Hudson, "Concrete Mix Design, Quality Control and Specification", CRC Press, 2014

Semester III

[SBC] Dissertation Phase-I	
Teaching Scheme:	**Examination Scheme:**

Course Outcomes: At the end of the course, the students are 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 principles through efficient handling of projects.

Unit 1:	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-1 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

[SBC] Dissertation Phase-II	
Teaching Scheme:	**Examination Scheme:**

Course Outcomes: At the end of the course, the students are able to,
CO_1: Apply appropriate techniques and tools to solve complex structural problems
CO_2: Exhibit good communication skill to the engineering community and society
CO_3: Demonstrate professional ethics and work culture

Unit 1:	Dissertation - II will be related to work on the topic identified in Dissertation - L Mid semester presentation, Continuous assessment. There will be pre submission seminar at the end of academic term. After the approval the student has to submit the detail report. Continuous assessment of Dissertation - I and Dissertation - 11 will be monitored by the departmental committee.