M. Tech. (Civil) Curriculum Structure
Specialization: Structural Engineering
(w. e. f. 2015-16)

List of Abbreviations

OEC- Institute level Open Elective Course
PSMC – Program Specific Mathematics Course
PCC- Program Core Course
DEC- Department Elective Course
LLC- Liberal Learning (Self learning) Course
MLC- Mandatory Learning Course (Non-credit course)
LC- Laboratory Course

Semester I

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	OEC	MATLAB for Engineers [To be offered to other programs]	3	--	--	3
2.	PSMC	Computational Methods in Engineering	3	--	--	3
3.	PCC	Structural Dynamics	3	--	--	3
4.	PCC	Solid Mechanics	3	--	--	3
5.	PCC	Theory of Thin Plates and Shells	3	--	--	3
6.	PCC	Advanced Analysis of Structures	3	--	--	3
7.	LC	Lab Practice- I	--	--	6	3
		Total	**18**	**--**	6	**21**

Semester II

Sr. No.	Course Code/Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	PCC	Finite Element Method	3	--	--	3
2.	PCC	Advanced Design of Structures	3	--	--	3
3.	PCC	Earthquake Analysis and Design of Structures	3	--	--	3
4.	DEC	**Elective – I** a. Design of Pre-stressed Concrete Structures b. Computer Aided Analysis of Structures c. Structural Health Monitoring	3	--	--	3
5.	LC	Lab Practice- II	--	--	6	3
6.	LC	Mini-Project	--	--	4	2
7.	MLC	Humanities	1	--	--	--
		Total	**14**	**--**	**8**	**17**

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**

(OEC) MATLAB for Engineering Applications
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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 Contents:

- **Basics of MATLAB**: MATLAB Environment for technical computing, Basic mathematical functions, Arrays and Array Operations, Vector arrays, matrix arrays, Relational and logical operators, loops
- **MATLAB Functions**: Mathematical functions and applications, user defined functions, plotting functions curve fitting
- **Mathematical operations**: Integration and differentiation, symbolic expressions and algebra
- **File input output operations**
- **Introduction to SIMULINK**
- **Computer Implementation**: 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

(PCC) Structural Dynamics

Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Apply fundamental theory of structural dynamics and equation of motion.
2. Analyze and study dynamics response of single and multi-degree-of freedom systems.
3. Use the available software for dynamic analysis.

Syllabus Contents:

- **Introduction**
    - Objectives of study, Importance of vibration analysis
    - Nature of exciting forces, Mathematical modeling of dynamic systems
    - Development of equation of motion for lumped mass system using Lagrangian approach.
- **Single Degree of Freedom 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, State Space solution for response
    - Numerical solution to response of linear and nonlinear systems using Newmark β method
    - Numerical solution for State Space response
- **Multiple Degree of Freedom System (Lumped parameter)**
    - Two Degree of Freedom system, Multiple Degree of Freedom System
    - Inverse iteration method for determination of natural frequencies and mode shapes

- Dynamic response by modal superposition method
- Direct Integration of equation of motion
- Dynamic analysis of beams and plane frames. Reduction of dynamics matrices
- Time history response of MDOF systems.

- **Multiple Degree of Freedom System (Distributed Mass and Load)**
  - Development of equation of motion using Hamilton's principle
  - Single span beams, free and forced vibration
  - Natural frequencies and mode shapes of uniform beams.
- Response in frequency domain
- Introduction to machine foundations and vibration isolation.

References:

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.
6. R. W. Clough and J. Penzien, "Dynamics of Structures", Tata Mc Graw Hill, 2nd Edition, 2003.

(PCC) Solid Mechanics
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Understand basic concepts of Elasticity and Plasticity.
2. Solve problems of elasticity and plasticity applied to isotropic materials.

Course Contents:

- Introduction to Elasticity, Strain and Stress fields, constitutive relations, Cartesian tensors and equations of Elasticity
- Strain at a point, Principal strains and principal axes, Compatibility conditions
- Stress components on an arbitrary plane, equations of equilibrium
- Stress-strain relations, co-axiality of the principal directions.
- Solution of Two-dimensional problems in Elasticity, plane stress, plane strain conditions, Airy's stress function, Elasticity problems in Polar coordinates
- Torsion of prismatic bars, Torsion of rectangular bars
- Elements of Plasticity, strain-hardening, idealized stress-strain curve, Yield criteria, von Mises, Tresca criterion
- Plastic stress-strain relations, Principle of normality, Isotropic and kinematic hardening
- Solution of simple Elasticity and Plasticity problems using computer programs

References:

1.M. Ameen, "Computational Elasticity", Narosa, 2005
2.M.H. Sadd, "Elasticity", Elsevier, 2005
3.S.M. A. Kazimi , "Solid Mechanics", Tata McGraw Hill, 1994
4.W.F. Hosford, " Fundamentals of Engineering Plasticity", Cambridge Press, 2013
5.A. R. Ragab and S. E. Bayoumi, "Engineering Solid Mechanics", CRC Press, 1999

(PCC) Theory of Thin Plates and Shells
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Understand basic concepts of theory of plates and shells.
2. Solve problems related to thin plates and shells.
3. Apply the numerical techniques and tools for the complex problems.

Course Contents:

- Introduction, space curves, surfaces, shell co-ordinates, strain displacement relations
- Assumptions in shell theory, displacement field approximations, stress resultants
- Equations of equilibrium using principle of virtual work.
- Static analysis of Plates, Governing equation for a rectangular plate, Navier solution, Levy solution for rectangular plates.
- Circular plates, governing differential equation in Polar coordinates
- Rayleigh-Ritz method for simple problems of rectangular plates.
- Static analysis of shells, membrane theory, cylindrical, conical and spherical shells
- Shells of revolutions with bending resistance, cylindrical and conical shells
- Solution of pipes and pressure vessel problems.

References:

1. S. Timoshenko and W. Krieger: Theory of plates and shells: Mc – Graw Hill.
2. A. C. Ugural: Stresses in Plates and Shells: Mc Graw Hill.
3. H. Kraus: Thin Elastic Shells: John Wiley and Sons.
4. K. Chandrashekhara: Theory of Plates: Universities Press.
5. G.S. Ramaswamy : Design and Construction of Concrete Shells

(PCC) Advanced Analysis of Structures
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1 .Solve the skeletal structures using the direct stiffness method.

2. Solve the skeletal structures using flexibility method.

3. Develop the computer programs using the direct stiffness method and Use the commercial software for the analysis.

Syllabus Contents:

- **Introduction:** Basic concepts of structural analysis, Methods of analysis of skeletal structures.
- **Direct Stiffness method:** stiffness matrix in global (system) coordinates boundary conditions. Solution of stiffness matrix equations, calculation of reactions and member forces, applications to problems of beams, plane trusses, plane rigid jointed frames and grids by member approach. Introduction to space frames.
- **Special problems:** Inclined supports, Effect of temperature change and lack of fit.
- **Force Method of analysis:** Concept of flexibility approach. Application to plane trusses, beams and plane frames.
- **Computer implementation:** Introduction to MATLAB programming**,** Computer programs for beams, plane trusses, plane rigid jointed frames and grids, Use of commercial FEA software**.**

References:

1. Weaver and Gere: Matrix Analysis of Framed Structures: CBS Publication.
2. Kassimali: Matrix Analysis of Structures: Brookes/Cole Publishing Company
3. D. J. Dawe: Matrix and Displacement Analysis of Structures: Oxford University Press

(LC) Laboratory Practice-I
Credits(0:0:6;3)

Teaching Scheme
Lab sessions: 6 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Handle appropriate equipments and tools.
2. Design simple experiments related with structural systems
3. Function as team member for laboratory work.

Laboratory Experiments:

- Free vibration response of Beams
- Free vibration response of Frames
- Determination of principal stresses using strain-gauges
- Response of Plane Frames under lateral loading
- Computer Program for analysis of Plane-Framed structures
- Estimation of compressive strength of concrete using Rebound Hammer, UPV
- Corrosion prediction and analysis for RC member
- Designing Mix for High/Ultra Strength Concrete.

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, 2014

(PCC) Finite Element Method
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Formulate the finite element model for the analysis of structural engineering problems.
2. Develop the computer program using One D and Two D finite elements for the analysis.
3. Use the commercial software for the analysis.

Syllabus Contents:

- **Introduction:** History and applications. General steps of finite Element Method. Different Approaches, concept of interpolation functions
- **One dimensional Finite Element Analysis:** Spring and bar elements, analysis of plane and space trusses, beam element and analysis of beams.
- **Two dimensional Finite Element Analysis:** Isoparametric formulation, 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.
- **Two dimensional Finite Element Analysis:** Tetrahedral and hexahedral elements. Analysis of Axi-Symmetric solids.
- **Method of Weighted Residuals:** The Galerkin Finite Element Method, Application to Structural Engineering problems
- **Computer implementation of FEM procedure:** Pre-processing, solution, Post-processing, Use of commercial FEA software**.**

References:

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. D. V. Hutton: Fundamentals of Finite Element Analysis: TATA McGRAW-HILL
5. J. N. Reddy: An Introduction to Finite Element Method: TATA McGRAW-HILL

(PCC) Advanced Design of Structures
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each,
End-Sem Exam - 60

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

1. Analyze the special structures by understanding their behaviour.
2. design and prepare detail structural drawings for execution, citing relevant IS codes.

Syllabus Contents:

- **Analysis and Design** of silos and bunkers, grid floors, water tanks, folded plates, flat slabs, domes.
- **Structural steels**: Plastic analysis and design for rectangular frames, gable frames.
- **Design of Gantry girder and plate girders**.

References:

1. P. C. Varghese, Advanced Reinforced Concrete Design; Prentice Hall of India, New Delhi.
2. B.C. Punmia, A. K. Jain, Arun K. Jain, Reinforced concrete structures Vol II, Laxmi Publications, New Delhi.
3. T.Y. Lin and N. H. Burns, Design of Prestressed Concrete Structures, John Wiley Publication.
4. N. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co.
5. Design of steel structures – Vol II by Ramchandra. Standard Book House Delhi.
6. Design of Steel Structures -- A.S. Arya, J.L. Ajmani; Nemchand and Bros. Roorkee Structural Analysis and design of Tall Buildings --Bungale S. Taranath; Mc Graw Hill International Edition
7. The Steel Skeleton Vol II Plastic Behaviour and Design - J.F. Baker, M.R. Horne, J.Heyman, ELBS.
8. Plastic Methods of Structural Analysis by Neal B.G. Chapman and Hall London.
9. SP – 6 (BIS) , IS 800 (2007)

(PCC) Earthquake Analysis and Design of Structures
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Analyze structures and structural components by understanding their behaviour during earthquake.
2. Design and prepare details for execution citing relevant IS codes.

Syllabus Contents:

- **Seismic Design**
    - Important attributes of seismic design, concepts
    - Planning for Aseismic buildings, structural response
    - Principles of member design, ductile detailing
    - Frames, diaphragms, shear walls
- **Response spectra**
    - Theory, development and construction of response spectrum
    - Tripartite response spectra
    - Response spectra for inelastic systems.
- **Earthquake response of MDOF system with reference to IS 1893**
    - Equivalent static method
    - Response spectrum method
    - Modal analysis method
    - Time history analysis
    - Free vibration of a shear building
    - P-Δ effect

- **Design considerations for structures**
  - Drift and lateral stability criteria
  - Earthquake Resistant Design of buildings
  - Choice of earthquake resisting systems for low rise, medium rise and high rise buildings
  - Behaviour of RCC members under reversible loading
  - Substructure design
  - Analysis of buildings considering Soil – structure interaction
- **Confined and Reinforced Masonry buildings**
  - Lateral force distribution among walls and brick columns
  - Reinforced masonry and brick shear walls
- **Performance based seismic design**
  - Performance levels
  - Pushover analysis
  - Capacity spectrum method
  - Seismic coefficient method.
- **Introduction to Vibration control techniques**
  - Base isolation
  - Elastomeric and friction isolators
  - Dampers for seismic response mitigation

References:

1. Bruce A. Bolt, "Earthquakes", 4th Edition, W. H. Freeman and Company, New York
2. Tushar Kanti Datta, "Seismic Analysis of Structures", John Wiley and Sons, 2010
3. Farzad Naeim, "The Seismic Design Handbook", 2nd Edition, Kluwer Academic Publishers Group, 2003
4. Thomas Paulay and M.J.N Priestley , "Seismic Design for R.C. and Masonry Building", John Wiley and Sons, 1992
5. James Kelly and Farzad Naeim, " Design of Seismic Isolated Structures: From Theory

to Practice", 1999, John Wiley and Sons

6. William Robinson and Ivan Skinner, "An Introduction to Seismic Isolation", 1993, John Wiley and Sons
7. IS 1893(Part 1) : 2002, "Criteria for Earthquake Resistant Design of Structures, Part 1: General Provisions and Buildings", 5th Revision
8. IS 1893(Part 2) : "Criteria for Earthquake Resistant Design of Structures, Part 2: Liquid Retaining Tanks - Elevated and Ground Supported"
9. IS 1893(Part 3) : 2002, "Criteria for Earthquake Resistant Design of Structures, Part 3 : Bridges and Retaining Walls"
10. IS 1893 (Part 4) : 2005, "Criteria for Earthquake Resistant Design of Structures, Part 4: Industrial Structures Including Stack Like Structures"
11. IS 1893 (Part 5) : 2005, "Criteria for Earthquake Resistant Design of Structures, Part 5: " Dams and Embankments"
12. IS 13920:1993, "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces"
13. IS 4326:1993, "Earthquake Resistant Design and Construction of Buildings"

(DEC) Design of Pre-stressed Concrete Structures
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course outcomes:

Students will be able to:

1. Understand the basic aspects of pre-stressed concrete fundamentals, including pre and post-tensioning processes.
2. Find out losses in the pre-stressed concrete.
3. Analyse and design fully pre-stressed concrete flexural members, compression members.
4. Design end blocks with pre-stressing anchorages

Syllabus Contents:

- **Introduction to prestressed concrete:** 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 in IS 1343.
- **Statically determinate PSC beams:** design for ultimate and serviceability limit states for flexure, and flexure combined with axial compression or tension; analysis and design for shear and torsion, code provisions. Transmission of pre-stress in pre-tensioned members; Anchorage zone stresses for post-tensioned members.
- **Statically indeterminate structures** - Analysis and design - continuous beams, choice of cable profile, linear transformation and concordancy.
- **Composite construction** with precast PSC beams and cast in-situ RC slab - Analysis and design, creep and shrinkage effects. Partial prestressing - principles, analysis and design concepts, crack-width calculations.

References:

1. T.Y. Lin, Design of Prestressed Concrete Structures, Asia Publishing House, 1955.
2. N. Krishnaraju, Prestressed Concrete, Tata McGraw Hill, New Delhi, 1981.
3. Y. Guyan, Limited State Design of Prestressed Concrete, Applied Science Publishers.

(DEC) Computer Aided Analysis of Structures

Credits(3:0:0;3)

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Deploy low end applications using low and high level languages on microcontroller platform.
2. Implements simple sketches on the Arduino boards involving several peripherals
3. Identify, design and implement applications on the Arduino boards producing custom shields.

Syllabus Contents:

- Introduction to Embedded System, Applications & Scope
- 32 bit Microcontroller architecture, Assembly Language and C language programming, Microcontroller based development boards
- Introduction to Arduino boards, Sketching in code
- Working with variables, Making decisions and repetitive operations
- Digital Ins and Outs, Analog Ins and Outs, Interfacing switches, buzzer, seven segment displays
- Timings functions, Random Functions, Writing new functions, Hardware Interrupts
- Arrays and Memory, Hardware Libraries
- Using Serial and I2C bus
- Case studies of a few projects using Arduino boards and Shields

References:

1. Joseph Yiu, "The definitive guide to ARM Cortex-M3", Elsevier, 2nd Edition
2. M. Paz and W. Leigh, "Integrated Matrix analysis of Structures", Kluwer Academic, 2001
3. M. Paz and W. Leigh, "Structural Dynamics Theory and Computation", Kluwer Academic,, 2004
4. Raj Kamal, " Embedded Systems – Architecture: Programming and Design", TMH

(DEC) Structural Health Monitoring
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Analyze a structure from safety point of view.

2. Analyze and do the audit of a structure.

3. Analyze and suggest suitable measures for Retrofitting of Structures

Syllabus Contents:

- **Structural Health:- factors affecting health of structures,** Structural health monitoring. Various measures, regular maintenance, structural safety in alteration. Quality control & assurance of materials of structure, durability of concrete.
- **Structural Audit:--** Assessment of health of structure, Collapse and investigation, investigation management
- **Retrofitting of Structures**:-- parameters for assessment for restoration strategies, Structural detailing for restoration, Various techniques of retrofitting.
- **Demolition of Structure:--** study of structural system and structural drawings, Need and importance for demolition, methods and their evaluation, Recycling of demolished materials.
- **Resourse Management and Safety during construction:-**human, time, materials ,finance and logistic managements
- **Case studies and site visits**

References:

1. Handbook of Material /management by Deananmmer, McGrawHills
2. Fundamentals of material Management by Gopalkrishnan, Tata McGraw Hills.
3. Financial Management by M.Y.Khan and Jain, Tata McGraw Hills
4. Properties of Concrete by A.M.Nevile, Longman
5. Durable Structures by R.N.Raikar, R&D Centre,(SDCPL), RaikarBhavan,Sector

17,Vashi,Navi Mumbai

(LC) Laboratory Practice-II
Credits(0:0:3;3)

Teaching Scheme
Lab sessions: 6 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam – 60

Course Outcomes:

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

- Creep measurement for concrete
- Free vibration response of Reinforced Concrete Beam
- Stiffness Analysis of Space-Framed structures
- Analysis and Design of Multi-storey Frames
- Finite Element Analysis for plane stress problems
- Finite Element Analysis for plane strain problems
- Finite Element Analysis of 3-D Solid Structures

References:

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

Mini-Project
Credits(0,0,4:2)

Course outcomes:

Students will be able to-

1. Carry out the literature survey
2. Identify and define formulation for small problems(Experimental/Analytical)
3. Communicate the findings of the study.

The Project work will start at the end of semester I. It should involve scientific research, design, collection and analysis of data, determining solutions and must bring out the individuals contribution for small problems. It will have mid semester presentation and end semester presentation monitored by departmental committee. Mid semester presentation will include identification of the problem based on the literature review and formulation of the problem. End semester presentation should consist of findings based on the study carried out.

(DEC) Bridge Engineering
Credits(3:0:0;3)

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

Course Outcomes:

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

1. Understand behaviour of Bridge components.
2. Analyse components of bridges.
3. Design simple bridges.

Syllabus Contents:

- Introduction to Bridges, classification and types
- IRC Specifications for road bridges (RC and PSC)
- Earthquake resistant design considerations, Design of superstructure, Load Distribution theories
- Analysis and design of Reinforced concrete and Pre-stressed concrete T-beam bridge
- PC Box girder bridge, Design of bearings, pier and abutment design, foundation design
- Design of Fly-over bridges.
- Vibration control devices, seismic isolation of bridges, design of lead rubber bearings

References:

1. N. Krishna Raju, "Design of Bridges", Oxford and IBH, 2001
2. T.R. Jagdeesh, and M. A. Jayaram, "Design of Bridge Structures", Prentice-Hall, 2003
3. V. K. Raina, "Concrete Bridge Practice: Analysis, design and economics ", Tata McGraw Hill, 1994
4. IRC Codes : IRC 6 (2000), IRC 18 (2000), IRC 21(2000), IRC 78(2000)

(DEC) Advanced Steel Design
Credits(3:0:0;3)

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Analyze steel skeleton structures.
2. Analyze and Design a framed multi-storey building using software
3. Analyze and Design a Trussed girder bridge

Syllabus Contents:

- Analysis and Design of framed multi-storey building using software:
    - Types of systems to support multi-storey buildings
    - Earthquake resistant design, Push over analysis of steel building
    - Design of rigid, semi-rigid and flexible connections,
    - Moment resisting Connections : Beam to beam, beam to column, continuous beam to column : to resist AF, SF, BM and TM, Design of splices, Haunched connections
    - Use of composite sections
    - Torsion - Lateral torsional bucking of beams
    - Beam columns: Design for torsion, elastic torsional buckling
    - Transfer girder design
    - Buckling of columns and frames, P- δ effect and P - Δ effect
    - Provision and design of steel plate shear walls
    - Design of columns and footings.
- Analysis and Design of Trussed girder bridge
    - Plate girder and Truss girder bridge design
    - Design for earthquake, fatigue, fire and temperature variations
    - Design of Tension members, Compression members

- Bracing systems, Splicing and connection design
- Design for normal speed and high speed railway trains

- Design of gable frame by pre-engineered building concept
- Introduction to international codes

References:

1. " IS 800-2007 : General Construction in Steel" - Code of Practice
2. John Baker and Jacques Heyman, " Plastic design of frames: Fundamentals", Cambridge University press, Reprinted 2008.
3. Charles Salmon and John Johnson, "Steel Structures- Design and Behaviour", Harper Collins College Publishers, 1996.
4. 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
5. N. Subramanian, "Design of Steel Structures", Oxford University Press, 2008.
6. Bungale S. and Taranath, "Structural Analysis and design of Tall Buildings", Mc Graw Hill International Edition
7. Neal B.G, "Plastic Methods of Structural Analysis", Chapman and Hall London.
8. SP – 6 (BIS) ISI Handbooks for Structural Engineers
9. Indian Railways-Codes
10. Baker, Horne and Heyman, " The steel skeleton: Plastic behaviour and design",(Vol. II)

(DEC) Advanced Finite Element Method
Credits(3:0:0;3)

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

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

1. Implement advanced concepts in Finite Element Analysis.
2. Solve plate and shell problems
3. Solve non-linear structural engineering problems.

Syllabus Contents:

- Review of Finite Element method
- Flexural stresses and strains in plates, Rectangular elements, Triangular elements, Quadrilateral and annular element
- Flat-facet shell element, Axi-symmetric shells, Non-axisymmetric loads
- Non-linear Finite Element analysis, Newton-Raphson method
- Geometric non-linear problems, Geometric stiffness,
- Material non-linearity, Tangent stiffness
- Solution of plate and shell problems
- Solution of non-linear problems

References:

1. W. Weaver and P.R. Johnston, "Finite Elements for Structural Analysis", Prentice-Hall, 1984
2. K.J. Bathe, "Finite Element Procedures", Prentice-Hall, 1996
3. M. A. Crisfield, "Non-linear Finite Element Analysis of Solids and Structures-Essentials", John Wiley, 2003
4. T. Belytschko, W.K.Liu and B. Moran"Non-linear Finite Elements for Continua and Structures", John Wiley, 2000
5.M. A. Bhatti, "Advanced Topics in Finite Element Analysis of Structures: with Mathematica and MATLAB computations", Wiley, 2005

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.