Semester

I

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Advanced Structural Analysis	**Course Code**: CEPL103	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Indeterminacy**: Static and kinematic indeterminacy, Principle of virtual work, Force-displacement Relationship and methods, element approach.	10
3	**Stiffness Matrix Assembly of Structures:** Stiffness and flexibility Matrix in local and Global Coordinates, Boundary Condition Solution of Stiffness Matrix Equations, Calculation of Reactions and Member Forces.	10
4	**Applications to Simple Problems:** Beams, Plane Trusses, Plane Rigid Jointed Frames and Grids by Structure Approach and Member Approach.	12
5	**Boundary Value Problems (BVP):** Approximate Solution of Boundary Value Problems, Modified Galerkin Method for One-Dimensional BVP, Matrix Formulation of the Modified Galerkin Method.	12
	Total	**45**

Text Books:

1. Matrix Analysis of Framed Structures, Weaver and Gere. CBS Publication.

Reference Books:

1. The Finite Element Method, Lewis P. E. and Ward J. P., Addison-Wesley Publication Co.
2. Computer Methods in Structural Analysis, Meek, J. L., E and FN, Span Publication.
3. The Finite Element Method, Desai and Abel, CBS Publication.

Prerequisite:

Basics of Structural Engineering studied at the B.Tech. level.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Advanced Concrete Technology	**Course Code**: CEPL104	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Concrete containing supplementary cementitious materials:** Specifications of fly ash, silica fume and GGBFS for use in concrete, reaction mechanism, properties of fresh and hardened concrete.	6
3	**Microstructure of Concrete:** Basics, Scanning Electron Microscopy, Applications of EDX with SEM, XRD, FTIR, pore analysis (MIP).	4
4	**Concrete of Today and Trends:** Characteristics and detailed understanding of mix proportioning, properties and placement of RMC, Self-compacting concrete, Architectural concrete with materials, admixtures, applications and properties in fresh and hardened concrete.	10
5	**3D Concrete Printing**: 3D printing in construction, extrusion-based 3D concrete printing, powder-based 3D concrete printing, building applications, concrete mixtures for additive construction, concrete formwork for 3D printing, case studies of applications (in Europe)	8
6	**Durability of concrete:** Carbonation, chloride ingress, corrosion, sulphate attack, freezing and thawing: Factors affecting, effects, mechanisms, Corrosion mapping, prevention and control.	10
7	**Creep and Shrinkage**: Factors affecting, effects, mechanisms, control, etc.	6
	Total	**45**

Text Books:

1. Santha Kumar, A.R. (2018), Concrete Technology, Second Edition. Oxford University Press.
2. Shetty, M.S. (2018), Concrete Technology Theory and Practice, Eighth Edition, S.Chand and company, New Delhi.
3. Gambhir, M.L., (2017), Concrete Technology, Fifth Edition, Tata McGraw-Hill.
4. S.S Bhavikatti, (2015), Concrete Technology, First Edition, I.K International Publishing House Pvt. Ltd.

Reference Books:

1. Diagnosis and treatment of structures in distress by R.N. Raikar, Published by R&D Centre of Structwel Designers & Consultants Pvt. Ltd., Mumbai, 1994.
2. Handbook on Repair and Rehabilitation of RCC buildings, Published by CPWD, Delhi, 2000

Prerequisite:

Basic knowledge of construction materials and concrete properties.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Analytical and Numerical Methods for Structural Engineering	**Course Code**: CEPL117	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	Fundamentals of Numerical Methods: Error Analysis, Polynomial Approximations and Interpolations, Curve Fitting; Interpolation and extrapolation. Solution of Nonlinear Algebraic and Transcendental Equations.	12
3.	**Elements of Matrix Algebra:** Solution of Systems of Linear Equations, Eigen Value Problems.	8
4.	**Numerical Differentiation & Integration:** Solution of Ordinary and Partial Differential Equations.	10
5.	Finite Difference scheme and its applications.	6
6.	**Computer Algorithms:** Numerical Solutions for Different Problems.	8
	Total	**45**

Text Books:

1. Computer-Oriented Numerical Methods by V Rajaraman, PHI Publications.

2. Introductory Methods of Numerical Analysis, Sastry S. S, Prentice Hall of India, 1998.

3. Numerical Methods for Engineering and Science, Saumyen Guha, Rajesh Srivastava, Oxford University Press.

Reference Books:

1. An Introduction to Numerical Analysis, Atkinson K.E., J. Wiley and Sons, 1989.

2. Theory and Problems of Numerical Analysis, Scheid F, McGraw-Hill Book Company, (Shaum Series), 1988.

3. Numerical Methods for Engineers by Chopra and Steven, McGraw-Hill Publications.

4. Applied Numerical Analysis, Curtis F Gerald, Patrick O. Wheatley, Pearson, 2008.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Design of Prestressed Concrete Structures	**Course Code**: CEPL118	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**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.	6
3	**Statically determinate PSC beams:** design for ultimate and serviceability limit states for flexure, analysis and design for shear and torsion, codal provisions.	8
4	Transmission of prestress in pretensioned members; Anchorage zone stresses for posttensioned members. **Statically indeterminate structures -** Analysis and design - continuous beams and frames, choice of cable profile, linear transformation and concordance.	12
5	**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, precast segmental construction techniques.	8
6	Analysis and design of prestressed concrete pipes and columns with moments.	10
	Total	**45**

Text Books:

1. S. S. Rao, Engineering Optimization: Theory and Practice, Wiley, 2008.
2. K. Deb, Optimization for Engineering Design Algorithms and Examples, Prentice Hall, 2nd edition, 2012.

Reference Books:

1. Operations Research, Hira & Gupta,
2. C.J. Ray, Optimum Design of Mechanical Elements , Wiley, 2007.
3. R. Saravanan, Manufacturing Optimization through Intelligent Techniques , Taylor & Francis Publications, 2006.
4. D. E. Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning , Addison-Wesley Longman Publishing, 1989.

Prerequisite:

Basic knowledge of construction materials and concrete properties.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Structural Health Monitoring	**Course Code**: CEPL119	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	**Structural Health:** Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. Structural Health Monitoring: Concepts, Various Measures, Structural Safety in Alteration.	6
3.	**Structural Audit:** Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.	8
4.	**Static Field Testing:** Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.	10
5.	**Dynamic Field Testing:** Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.	10
6.	**Introduction to Repairs and Rehabilitations of Structures:** Case Studies (Site Visits), piezo– electric materials and other smart materials, electro-mechanical impedance (EMI) technique, adaptations of EMI technique.	10
	Total	**45**

Text Books:

1. Repair and Rehabilitation of concrete Structures by Modi, Poonam I. patel, Chirag N., PHI Publication.
2. Concrete Structures Repair, Rehabilitation and Retrofitting by J. Bhattacharjee, CBS Publication.

Reference Books:

1. Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes, John Wiley and Sons,2006.
2. Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, John Wiley and Sons,2007.
3. Structural Health Monitoring and Intelligent Infrastructure, Vol. 1, J.P.Ou, H.Li and Z.D.Duan, Taylor and Francis Group, London, UK, 2006.
4. Structural Health Monitoring with Wafer Active Sensors, Victor Giurgiutiu, Academic Press Inc,2007.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Finite Element Method in Structural Engineering	**Course Code**: CEPL120	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	**Introduction:** Concept of FEM, Applications and advantages, Steps in finite element method, Discretization, types of elements and shape functions. Review: Matrix algebra and solution of simultaneous equations. Finite element analysis of 1-D problems: formulation by different approaches (direct method and potential energy); Derivation of elemental equations and their assembly, solution and its postprocessing.	10
3.	Basic Principal of Structural Mechanics, Element Properties, Finite Element formulation; Introduction of Ritz method and Galerkin Method.	8
4.	1-D and 2-D problems from Structural Mechanics: Bar, Plane stress and plane strain problems, Axisymmetric problems. Bending of beams, analysis of truss and frame. Introduction to nonlinear FEM (material and geometric)	8
5.	Higher order elements, Isoperimetric formulation, Serendipity, and Lagrange family elements, Numerical integration, convergence Criteria.	8
6.	1-D steady state heat conduction and fluid flow: Derivation of elemental equations, Application of boundary conditions. Brief Introduction of Eigen –Value Problems & Nonlinear Problems: Review of iterative and incremental procedure for material and geometrical nonlinearity.	10
	Total	**45**

Text Books:

1. CS Krishnamoorthy, Finite Element Analysis, Tata McGraw-Hill.

2. M. Rama Narshima Reddy, K. Srinivasa Reddy, Finite Element Methods in Civil Engineering. Scitech Publication (INDIA) Pvt. Ltd.

Reference Books:

1. Finite Element Analysis, Seshu P., Prentice-Hall of India,2005.

2. Concepts and Applications of Finite Element Analysis, Cook R. D., Wiley J., New York, 1995.

3. Fundamentals of Finite Element Analysis, Hutton David, McGraw-Hill, 2004.

4. Finite Element Analysis, Buchanan G.R., McGraw-Hill Publications, New York, 1995.

5. Finite Element Method, Zienkiewicz O.C. & Taylor R.L. Vol. I, II & III, Elsevier, 2000.

6. Finite Element Methods in Engineering, Belegundu A.D., Chandrupatla, T.R., Prentice Hall India, 1991.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Design of High-Rise Structures	**Course Code**: CEPL121	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme: CI (45) + TW & SL (45) = 90 hrs. per semester**	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	Design of Framed Structures, Shear Wall.	6
3.	Design of transmission/ TV tower, Mast and trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads.	10
4	Analysis and Design of RC and Steel Chimney, Foundation design for varied soil strata	6
5	**Tall Buildings**: Structural Concept, Configurations, various systems, Wind and Seismic loads, Dynamic approach, structural design considerations for gravity and IS codal provisions. Firefighting design provisions. Introduction to performance based design.	10
6	Modelling and Analysis on Structural Analysis Software.	8
7	Application of software in design.	4
	Total	**45**

Text Books:

1. Structural Analysis and Design of Tall Buildings, Taranath B. S., McGraw-Hill,1988.

2. Structural Design of Multi-storeyed Buildings, Varyani U. H., 2nd Ed., South Asian Publishers, New Delhi, 2002.

3. Illustrated Design of Reinforced Concrete Buildings (GF+3storey), Shah V. L. & Karve S. R., Structures Publications, Pune, 2013

Reference Books:

1. Design of Multi Storeyed Buildings, Vol. 1 & 2, CPWD Publications,1976.

2. Tall Building Structures, Smith Byran S. and Coull Alex, Wiley India, 1991.

3. High Rise Building Structures, Wolfgang Schueller, Wiley,1971.

4. Tall Chimneys, Manohar S. N., Tata McGraw-Hill Publishing Company, New Delhi

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Bridge Design and Construction Practices	**Course Code**: CEPL122	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	Classification and components of bridges– layout and planning. **Structural forms of RC bridge decks –**Analysis of slab decks, beam and slab decks, cellular decks, design.	8
3.	**Standard specifications for Bridges** – IRC loadings for road bridges – design of RC slab, skew slab and box culverts. Design of T beam bridges – balanced cantilever bridges – rigid frame bridges – Arch bridges – bow string girder bridges, flyovers.	10
4.	Introduction to long-span bridges: cable-stayed bridges and suspension bridges; instability in bridges.	10
5.	**Forces on Piers and Abutments** – Design of piers and abutments – types of wing walls, Special provisions for forces on abutments in case of integral bridges, relevant design features, types of bearings – design of bearings for conventional types and modern bridges.	8
6.	**Integral bridges:** Introduction with case studies of such bridges constructed in South Asia after 2000. Construction practice of RC bridges, including Form Traveller.	8
	Total	**45**

Text Books:

1. N. Krishna Raju, Design of bridges, Oxford & IBH Publishing Co. Ltd., New Delhi.

Reference Books:

1. E.C. Hambly, Bridge deck behaviour, Chapman and Hall, London

2. D.Johnson Victor, Essentials of bridge engineering, Oxford & IBH Publishing Co. Ltd., New Delhi.

3. Jaikrishna and O. P Jain, Plain and reinforced concrete-vol.II, NemChnand & Bros, Roorkee.

4. IRC: 5, Standard specifications and code of practice for road bridges, Sections I to V, Indian Roads Congress, New Delhi.

5. Indian railway standard code of practice for the design of steel or wrought iron bridge carrying rail, road or pedestrian traffic, Govt. of India, Ministry of Railways, 2000

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Optimization Techniques	**Course Code**: CEPL140	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to optimization:** Engineering applications of optimization, Mathematical Modeling and simulation, Formulation of structural optimization problems as programming problems. Graphical method.	8
3	**Linear Programming:** Theory of Simplex Method, Standard form of LPP, feasible solution and basic feasible solution, Improving BFS, Optimality condition, Unbounded solution, Alternative optimal solution, Simplex method, Big M Method, Two phase method.	10
4	**Metaheuristics in Optimization:** Genetic algorithms, Tabu search, particle swarm intelligence and their applications in Engineering	8
5	**PERT & CPM:** Objective of CPM & PERT, elements of network, network rules, constraints, error in network, Critical Path Analysis, Activity time and floats, optimization through CPM techniques, PERT and three estimates, critical path analysis of a PERT network, probability of completion of project, controlling and monitoring.	8
6	**Non-linear Programming:** Local and global minima of one and two variables, constraints optimization, Lagrange's Method, K-T conditions, Steepest descent method, Conjugate gradient method.	10
	Total	**45**

Text Books:

1. S. S. Rao, Engineering Optimization: Theory and Practice, Wiley, 2008.
2. K. Deb, Optimization for Engineering design algorithms and Examples, Prentice Hall, 2nd edition 2012.

Reference Books:

1. C.J. Ray, Optimum Design of Mechanical Elements , Wiley, 2007.
2. R. Saravanan, Manufacturing Optimization through Intelligent Techniques , Taylor & Francis Publications, 2006.
3. D. E. Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning , Addison-Wesley Longman Publishing, 1989.

Prerequisite:

Basic knowledge of calculus.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Advanced Concrete Lab	**Course Code**: CEPP132	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs.	**Teaching Scheme:** LI (60)	

Module No.	Content
1	Determination of bond strength of specimens with M25 Grade and M50 Grade concrete.
2	Preparation of M40 Grade pumpable concrete with superplasticizer and supplementary cementitious materials.
3	Preparation of M60 Grade self- compacting concrete and testing it for properties in fresh and hardened states.
4	Determine the stress-strain curve of high-strength concrete specimens (M60 or higher grade).
5	Determine correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture with normal strength concrete and high strength concrete mixes.
6	Non-Destructive testing of existing concrete members through rebound hammer, Ultrasonic pulse velocity meter, resistivity meter, carbonation test and core test.
7	Behaviour of Reinforced Concrete Beam specimen- measurement of strains at various levels through LVDTs, strain Gages- determination of moment curvature relationship.
8	Determine tensile strength of reinforcement bar.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: I
Course Name: Statistical and Numerical Analysis Lab	**Course Code**: CEPP133	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs.	**Teaching Scheme:** LI (60)	

Module No.	Content
1	Newton's forward interpolation method
2	Newton's backward interpolation method
3	Lagrange's interpolation method
4	Newton-Raphson method
5	Solution of ODE by Runge-Kutta method
6	Calculation of eigen values and eigen vector method
7	Analysis of variance
8	Linear regression analysis
9	Multiple regression analysis

Semester

II

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Structural Dynamics	**Course Code**: CEPL203	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction**: Objective, scope and outcome of the course.	1
2.	**Introduction to Dynamics of Structures**: Types of Dynamic Loads, Static vs Dynamic Analysis; Basic Concept of Vibration: Mass, Stiffness and Damping, Torsional Stiffness, Equivalent Stiffness; Mathematical Modeling, Degrees of Freedom, Continuous System, Lumped Mass Idealization; Free and Forced Vibrations; Consequences of Vibration and its Control; Simple Harmonic Motion: Vector representation of S.H.M.	5
3.	**Free Vibrations of Undamped SDOF System;** Free Body Diagram; Formulation of Differential Equation of Motion by Newton's Law of Motion, D'Alembert's Principle and Energy Approach, Natural Frequency and Time Period of Vibration; Various methods of Solution of Differential Equation of Motion. Torsional Vibration.	5
4.	**Free Vibrations of Damped SDOF System:** Types of Damping, Formulation and Solution of Differential Equation of Motion, Characteristic Equation, Critical Damping; Critically Damped, Over Damped and Under Damped System: Characteristic of their Resulting Response, Damped Natural Frequency; Logarithmic Decrement.	6
5.	**Forced vibration (under Harmonic Excitation)**: Undamped and Underdamped SDOF System: Formulation and Solution of Differential Equation of Motion; Dynamic Magnification Factor, Frequency Ratios and Damping Factors, and Phase angles.	6
6.	**Base Excited Vibrations:** Underdamped SDOF System: Formulation and Solution of Differential Equation of Motion and its Solution; Transmissibility and vibration Isolation. Application to Rotary and Reciprocating Unbalance; Seismic Instrument: Basic Principle, Types of Seismic Instruments.	6
7.	**Two Degree of Freedom Systems**: Formulation of equations of motion. Undamped free vibrations and Principle Mode of Vibration and mode shapes: Analysis of Dynamic response, Normal co-ordinates, Uncoupled equations of motion, Orthogonal, properties of normal modes; Coordinate Coupling: Static and Dynamic Coupling.	6
8.	**Introduction to MDOF Systems**: Selection of the degrees of Freedom, Evaluation of structural property matrices; Undamped Free Vibrations; Formulation of the MDOF equations of motion, Solutions of Eigen value problem for natural frequencies; Approximate Methods of Determining Fundamental Frequencies: Basic Procedure of Stodola Method, Dunkerley's Method. Natural frequencies and mode-shapes of simple beams.	10
	Total	**45**

Text Books:

1. Dynamics of Structures by Clough and Penzien, McGraw-Hill, New York
2. Dynamics of Structures by Anil K. Chopra, Pearson Education (Singapore), Delhi.
3. Structural Dynamics by Mario Paz, C.B.S Publishers, New Delhi.

Reference Books:

1. Theory of vibrations by W.T. Thomson, CBS Publishers and Distributors.
2. Structural Dynamics by Roy. R. Craig, John Wiley & Sons.
3. I.S: 1893 (Part 1) - 2016, "Code of practice for Earthquake resistant design of Structures.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Advanced Concrete Design	**Course Code**: CEPL204	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	**Limit State Design:** Revision of Basic Concepts of Limit State Design of Prismatic Members in Flexure, Shear & Bond. Limit State Analysis and Design of Continuous Beams using Coefficient, Reinforcement Detailing & Curtailment provisions as per Code.	6
3	**Redistribution of Moment:** Concept of Redistribution of Moments in Fixed & Two Span Continuous Beams.	4
4	**Serviceability Requirements:** Limit State of Serviceability of Beams and Slabs in Deflection. Calculation of Deflection due to Loads, Shrinkage & Creep; Calculation of Crack Width as per IS Code.	5
5.	**Flat Slabs:** Direct design method: Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns. Shear in Flat Slabs-Check for one way and two-way shears. Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip sketch showing reinforcement details.	6
6	**Yield Line Analysis:** Yield Line Analysis for slabs: Upper bound and lower bound theorems – yield line criterion – Virtual work and equilibrium methods of analysis – For square and circular slabs with simple and continuous end conditions, special aspects, introduction to Hillerborg's strip method	6
7	**Columns and Footing:** Design of Slender Columns. Analysis and Design of (i) Isolated Footing subjected to Axial Load and Moment (ii) Combined Rectangular Footing for Two Columns subjected to Axial Loads and moments. Reinforcement Detailing	5
8	**Retaining walls:** Structural behavior of retaining walls, Analysis and design of Counterfort Retaining Wall, Stability of Retaining Walls, Reinforcement Detailing.	6
9	**Ribbed Floor and Shell Roofs:** Introduction to Structural Behavior and Construction & Design Features of Ribbed floor, Shell Roofs and Stresses in Simple Semicircular Shell. **Stair Case:** Types and Planning of Staircases, Analysis and Design of Staircase spanning longitudinally on Waist slab. Reinforcement detailing.	6
	Total	**45**

Text Books:

1. "Reinforced Concrete Design" S. Unnikrishna Pillai &Devdas Menon; Tata Mc. Graw-Hill Publishing Company Ltd., New Delhi 2010.
2. "Advanced Reinforced Concrete" P.C. Varghese Prentice Hall of INDIA Private Ltd. 2008.
3. "Limit State Theory and Design of Reinforced Concrete" Dr S. R. Karve and V.L Shah. Standard Publishers, Pune 2004.

Reference Books:

1. "Design of Reinforced Concrete Structures" by N.Subramanian, Oxford University Press.
2. Reinforced concrete structural elements – behaviour, Analysis and design by P. Purushotham, Tata Mc.Graw-Hill, 1994.
3. Design of concrete structures – Arthus H. Nilson, David Darwin, and Chorles W. Dolar, Tata Mc. Graw-Hill, 3rd Edition, 2005.
4. Reinforced Concrete design by KennathLeet, Tata Mc. Graw-Hill International, editions, 2nd edition, 1991.
5. "Design Reinforced Concrete Foundations" P.C. Varghese Prentice Hall of INDIA Private Ltd.
6. IS 456-2000

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Design of Masonry Structures and Retrofitting	**Course Code**: CEPL217	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	Introduction and Historical Perspective; Behaviour of Masonry Structures: Common modes of failure, effect of unit shapes and mortar type, effect of roof and floor systems; Common deficiencies; Masonry Design Approaches; Overview of Load Conditions. Compression Behaviour of Masonry: Prism strength, Failure mechanism, types of construction and bonds; Eccentric loading; Slenderness – effective length and effective height, effect of openings.	12
3	Masonry Under Lateral Loads: In-plane and out-of-plane loads, bending parallel and perpendicular to bed joints; Shear and flexure behaviour of piers; Interactions.	10
4	Introduction to Repair, Restoration and rehabilitation/strengthening of existing buildings. Causes of deterioration/decay and flexural & shear distress of concrete structures.	6
5	Corrosion mechanisms: corrosion protection, corrosion inhibitors, corrosion-resistant steels, coatings, and cathodic protection. Strengthening of existing walls & RCC members, stitching, routing & sealing, Jacketing.	8
6	Materials for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur-infiltrated concrete, Ferro-cement, Fiber reinforced concrete.	8
	Total	**45**

Text Books:

1. Bhattacharjee J; Concrete Structure Repair, Rehabilitation and Retrofitting; CBS Publishers (First)

2. Santha Kumar, A.R.; Concrete Technology; Oxford University Press (Second)

3. T. Paulay, M. J. N. Priestley; Seismic Design of Reinforced Concrete and Masonry Buildings; Wiley-Interscience (First).

4. Andrew J. Jefferson, Vellayaraj Arumugam and HomNath Dhakal; Repair of Polymer Composites, Methodology, Techniques and Challenges; Woodhead Publishing (First)

5. P. Dayaraatnam and P. Sarah, "Brick and Reinforced Structures (2/e)", Medtech.

6. K. S. Jagadish, "Structural Masonry", Dreamtech Press.

Reference Books:

1. Shetty, M.S.; Concrete Technology Theory and Practice; S.Chand and Company, New Delhi, 2005, Fifth Edition.

2. R.N.Raikar; Handbook on Repair and Rehabilitation of RCC buildings; CPWD, Govt. of India, Delhi, 2002, First Edition.

3. P. Kumar Mehta, Paulo J.M. Monteiro; Concrete Microstructure Properties and Materials; McGraw-Hill; Third Edition.

Prerequisite: Basics of Concrete Technology

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Advanced Steel Structure Design	**Course Code**: CEPL218	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	**Properties of Steel:** Mechanical Properties, Hysteresis, Ductility. **Hot Rolled Sections:** compactness and non-compactness, slenderness, residual stresses.	8
3.	**Design of Steel Structures**: Inelastic Bending Curvature, Plastic Moments, Design Criteria Stability, Strength, Drift. **Stability of Beams:** Local Buckling of Compression Flange &Web, Lateral Torsional Buckling.	8
4.	**Stability of Columns:** Slenderness Ratio, Local Buckling of Flanges and Web, Bracing of Column about Weak Axis.	10
5.	**Method of Designs:** Allowable Stress Design, Plastic Design, Load and Resistance Factor Design. **Strength Criteria:** Beams - Flexure, Shear, Torsion, Columns - Moment Magnification Factor, Effective Length, PM Interaction, Biaxial Bending, Joint Panel Zones**.**	8
6.	**Drift Criteria:** P-Δ Effect, Deformation-Based Design.	4
7.	**Connections:** Welded, Bolted, Beam Column joint, Small Moment resistant, Column Foundation, Splices.	6
	Total	**45**

Text Books:

1. Limit State Design in Structural Steel by Shiyekar M.R., PHI Publications.

2. IS 800: 2007 – General Construction in Steel - Code of Practice, BIS, 2007.

Reference Books:

1. Design of Steel Structures - Vol. II, Ramchandra. Standard Book House, Delhi.

2. Design of Steel Structures - Arya A. S., Ajmani J. L., Nemchand and Bros., Roorkee.

3. The Steel Skeleton- Vol. II, Plastic Behavior and Design - Baker J. F., Horne M. R., Heyman J., ELBS.

4. Plastic Methods of Structural Analysis, Neal B. G., Chapman and Hall London.

5. SP – 6 - Handbook of Structural Steel Detailing, BIS,1987

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Theory of Elasticity	**Course Code**: CEPL219	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	**Introduction to Elasticity:** Displacement, Strain and Stress Fields, Constitutive Relations, Cartesian Tensors and Equations of Elasticity. **Strain and Stress Field:** Elementary Concept of Strain, Stain at a Point, Principal Strains and Principal Axes, Compatibility Conditions, Stress at a Point, Stress Components on an Arbitrary Plane, Hydrostatic and Deviatoric Components.	8
3.	**Equations of Elasticity:** Equations of Equilibrium, Stress- Strain relations, Strain Displacement and Compatibility Relations, Boundary Value Problems.	6
4	**Two-Dimensional Problems of Elasticity:** Plane Stress and Plane Strain Problems, Airy's stress Function, Two-Dimensional Problems in Polar Coordinates.	8
5	**Torsion of Prismatic Bars:** Saint Venant's Method, Prandtl's Membrane Analogy, Torsion of Rectangular Bar, Torsion of Thin Tubes.	8
6	**Plastic Deformation:** Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, Von Mises Yield Criterion.	6
7.	**Miscellaneous Topics:** Unsymmetrical bending, beams on elastic foundation, bending of bars with initial curvature, rings, hooks.	8
	Total	45

Text books:

1. Theory of Elasticity, Timoshenko S. and Goodier J. N., McGraw-Hill, 1961.

2. Advanced Mechanics of Solids, Srinath L.S., Tata McGraw-Hill,2000.

Reference Books:

1. Elasticity, Sadd M.H., Elsevier,2005.

2. Engineering Solid Mechanics, Ragab A.R., Bayoumi S.E., CRCPress,1999.

3. Computational Elasticity, Ameen M., Narosa,2005.

4. Solid Mechanics, Kazimi S. M. A., Tata McGraw-Hill,1994.

5. Theory of Plasticity by J. Chakrabarty, Butterworth-Heinemann Publications.

6. Theory of Elasticity and Plasticity by H. JANE HELENA PHI publications.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Ground Improvement Techniques	**Course Code**: CEPL220	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Methods of ground improvement**: mechanical compaction, dynamic compaction, impact loading, compaction by blasting, vibro-compaction, pre-compression, dynamic consolidation, use of admixtures, injection of grouts, mechanical, cement and chemical stabilization.	8
3	**Design aspects** of stone columns, design examples on preloading with sand drains, reinforced earth, basic mechanism, constituent materials and their selection; engineering applications – shallow foundations on reinforced earth, design of reinforced earth retaining walls	8
4	**Geosynthetics:** selection and engineering applications, design examples, stabilization/improvement of ground using geomembranes, geocells, geonets, geosynthetic walls, road designs with geosynthetics.	10
5	**Soil nailing**: construction of underground structures, landslide controls, deep vertical cuts, contiguous piles	8
6	**Case studies** on Problematic soils, improvement of saline soils, and black cotton soils.	10
	Total	45

Text Books:

1. P.Purushothama Raj;Ground Improvement Techniques; Laxmi Publications, Second Edition.

2. Saran, S., “Reinforced Soil and Its Engineering Applications”, I.K. international, Second Edition.

3. Shukla, S.K. “An Introduction to Geosynthetic Engineering” , CRC Press, First Edition.

Reference Books:

1. Moseley, M. P. and Kirsch K.,”Ground Improvement”, Spon press, Second Edition.

2. Shukla, S.K., Yin, Jian-Hua, “Fundamentals of Geosynthetic Engineering”, Taylor & Francis, First Edition

3. Jones, CJFP, “Earth Reinforcement and soil structure”, Thomas Telford, Third Edition.

4. Koerner, R., Designing with Geosynthetics, Prentice Hall, 2005, Sixth Edition.

Prerequisite:

1. Background of Basic Soil Mechanics
2. Geotechnical Engineering and Design

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Design of Plates and Shells	**Course Code**: CEPL221	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Content	Classroom Instruction (CI) Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	**Prismatic folded Plate Systems**: analysis and design of RCC folded plate roofs. Introduction to stability of plates and stiffened plates	6
3.	Shell behaviour, shell surfaces and characteristics, equilibrium equations in curvilinear co-ordinates. Stress-strain and force displacement relations. Membrane analysis of shells of revolution and cylindrical shells under different loads. Shallow shells, membrane solution of elliptic paraboloids and hyperboloids. Solution of some typical problems.	10
4.	Approximate Solutions, Analysis and Design of Cylindrical Shells with and without edge beams	10
5.	Approximate Design methods for Doubly Curved Shells, HYPAR shells, Helicoids.	10
6.	Structural design and detailing of various types of RCC shell roofs and folded plates through software,	8
	Total	**45**

Text Books:

1. Design and Construction of Concrete Shell Roofs, Ramaswamy G.S.,2005.

2. Design of Reinforced Concrete Shells & Folded Plate, Varghese P.C., PHI.

3. Advanced Reinforced Concrete Design, N Krishna Raju, CBS Publishers and Distributors

Reference Books:

1. Theory of Plates and Shells, Timoshenko and Woinowsky-Krieger S.,Tata McGraw Hill Edition,2010.

2. Design of Plate and Shell Structures, Jawad Maan H.,Springer Science.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Soil Structure Interaction	**Course Code**: CEPL222	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	General soil-structure interaction problems: Contact pressures and soil-structure interaction for shallow foundations. Concept of sub-grade modulus, effect/parameters influencing subgrade modulus. Analysis of foundations of finite rigidity, Beams on elastic foundation concept, introduction to the solution of beam problems. Dynamic SSI applications.	6
3	Analytical Method of Analysis of Finite Beams on Wrinkler Foundation: Introduction, analysis of finite and infinite beam on Wrinkler foundation, method of superposition, method of initial parameters and its application to analysis of regular beams, analysis of continuous beams and frames on Wrinkler foundation, analysis of frames on Wrinkler foundation, analysis of rigid piles with horizontal and vertical loads. Analysis of Beams on Elastic Half Space: Introduction analysis of Rigid Beams, short beam analysis, long beam Analysis, Analysis of Frame on Elastic Half Space.	12
4	Dynamic soil structure Interaction: Direct and Sub-structure method of Analysis, Equation of Motion for flexible and rigid base, kinematic interaction, inertial interaction and effect of embedment, Temporal and special variation of external loads including seismic loads, continuous models, discrete models and finite element models.	10
5	Wave propagation for SSI: Waves in Semi-Infinite Medium, one, two and three-dimensional wave propagation, dynamic Stiffness matrix for out-of-plane and in-plane motion.	6
6	Free Field Response of Site: Control point and control motion for seismic analysis, dispersion and attenuation of waves, half space, and single layer on half space, modeling of boundaries, elementary, local, consistent and transmitting boundaries. Engineering Application of soil-structure interaction: Low-rise residential building and multistory building.	10
	Total	**45**

Text Books:

1. Wolf, J.P., "Dynamic Soil-Structure Interaction", Prentice Hall.
2. Kramer, S. L., "Geotechnical-Earthquake Engineering", Pearson Education.

Reference Books:

1. Edward Tsudik, "Analysis of structure on Elastic Foudation", Cengage Learning India Pvt. Ltd.
2. Wolf, J.P. and Song C. "Finite Element Modelling of Unbounded Media", John Wiley & Sons.

Prerequisite:

1. Basics of Structural Analysis and Dynamics.
2. Basics of Geotechnical and Foundation Engineering.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Structural Design Lab	**Course Code**: CEPP232	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs.	**Teaching Scheme:** LI (60)	

Module No.	Content
1	Analyse RCC framed structures by Equivalent Frame Method (EFM)
2	Analyse a typical intermediate floor of a four storeyed office multi-bay building through EFM.
3	Analyse a four storeyed multi bay (in both the directions) RCC residential /commercial framed structure for different load combinations and determination of design forces, moments etc.
4	Structural design of an RCC building for the forces and moments etc determined in exercise no 3 by IS Codes.
5	Reinforcement detailing of the structure designed at exercise no 4 as per IS codes.

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Model Testing Lab	**Course Code**: CEPP233	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs.	**Teaching Scheme:** LI (60)	

Module No.	Content
1	Verify Strain energy concept by finding displacement in a curved member apparatus.
2	Verify unsymmetrical bending concept using cantilever beam apparatus.
3	Plot influence line diagram for deflection in a simply supported beam
4	Verify Muller Breslau's principal of influence line diagram in portal frame.
5	Calculate support reaction in a two hinge /three hinge Arch.
6	Response of structures and its elements against horizontal and vertical loading events.
7	Determine forces in a member of pin jointed truss apparatus.
8	Study buckling behavior of columns with apparatus.
9	Study behavior of a rigid joint (through an apparatus)

Syllabus

Name of the Programme: M.Tech. in Structural Engineering	**Year**: I	**Semester**: II
Course Name: Mini Project With Seminar	**Course Code**: CEPD250	**Credit**: 2
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 2 hrs.	**Teaching Scheme:** LI (60)	

Students are required to work on a mini project related to themselves and also deliver a seminar on the same.

S No.	Some suggested topics are:
1	Analysis and design a G + 5 Building with the proper Detailed Drawings.
2	Analysis and design a G + 7 Structure with the different lateral load resisting systems.
3	Present Live observations on site construction and safety.
4	Repair and rehabilitation report on the old monuments of the city.
5	Condition Assessment of Reinforced Concrete High-Level Bridges in your city and Recordation for Rehabilitation and Strengthening
6	Condition Assessment of Steel High-Level Bridges in your city and Recordation for Rehabilitation and strengthening
7.	Study of Ready-Mix Concrete plants in your city and preparation of comprehensive reports.

Note: *The student can take a real-time problem, collect data, analyse, and present it in a seminar. Latest developments in the area of Structural Engineering can be studied from the literature and presented in the form of a seminar.*