Guru Nanak Dev Engineering College, Ludhiana

Civil Engineering Department

M.Tech. (Structural Engineering)

Program Outcomes (POs):

After completion of the program graduates will be able to

1. Apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude.
2. Identify, formulate and solve engineering problems in the domain of structural engineering field.
3. Use different software tools for Analysis and Design structural engineering domain.
4. Design and conduct experiments, analyze and interpret data, for development of simulation experiments.
5. Function as a member of a multidisciplinary team with sense of ethics, integrity and social responsibility.

First Semester

Course Type	Course Code	Course Name	Load Allocations			Marks Distribution			Credits
			L	T	P	Int	Ext	Total Marks	
Core Theory	MST-101	Advanced Structural Analysis	3	0	0	50	100	150	3
Core Theory	MST-102	Finite Element Method in Structural Engineering	3	0	0	50	100	150	3
Elective	MST- AAA	Program Elective I	3	0	0	50	100	150	3
Elective	MST-BBB	Program Elective II	3	0	0	50	100	150	3
Core Lab I	LMST-101	Structural Design Lab	0	0	4	50	50	100	2
Core Lab II	LMST-102	Advanced Concrete Technology Lab	0	0	2	50	50	100	1
MLC	MRM-101	Research Methodology and IPR	3	0	0	50	100	150	3
Audit 1	MAC-102	Disaster Management	2	0	0	50	-	50	0
		Total	**17**	**0**	**6**	**400**	**600**	**1000**	**18**

Second Semester

Course Type	Course Code	Course Name	Load Allocations			Marks Distribution			Credits
			L	T	P	Int	Ext	Total Marks	
Core Theory	MST-103	Advanced Solid Mechanics	3	0	0	50	100	150	3
Core Theory	MST-104	Structural Dynamics	3	0	0	50	100	150	3
Elective	MST- CCC	Program Elective III	3	0	0	50	100	150	3
Elective	MST- DDD	Program Elective IV	3	0	0	50	100	150	3

Core Lab III	LMST-103	Model Testing Lab	0	0	2	50	50	100	1
Core Lab IV	LMST-104	Numerical Analysis Lab	0	0	4	50	50	100	2
Core	LMPST-101	Project	0	0	4	50	50	100	2
Audit 2	MAC-101	English for research report / paper writing	2	0	0	50	-	50	0
		Total	**14**	**0**	**10**	**400**	**550**	**950**	**17**

Third Semester

Course Type	Course Code	Course Name	Load Allocations			Marks Distribution			Credits
			L	T	P	Int	Ext	Total Marks	
Elective	MST-EEE	Program Elective V	3	0	0	50	100	150	3
Open Elective	MOST-XXX	Open Elective	3	0	0	50	100	150	3
Pre-thesis	MPTST-101	Formulation of Research Problem	0	0	2*+ 18**	100	100	200	10
		Total	**6**	**0**	**20**	**200**	**300**	**500**	**16**

Fourth Semester

Course Type	Course Code	Course Name	Load Allocations			Marks Distribution			Credits
			L	T	P	Int	Ext	Total Marks	
Thesis	MTST-101	Thesis	0	0	4*+ 28**	100	200	300	16
		Total	**0**	**0**	**32**	**100**	**200**	**300**	**16**

* Max hours for teacher
** Independent study hours

List of Electives		
S. No.	**Course Name**	**Course Code**
1	Theory of Thin Plates and Shells	MST – 111
2	Theory of Structural Stability	MST – 112
3	Theory and applications of cement composites	MST – 113
4	Structural Optimization	MST – 114
5	Structural Health monitoring & Retrofitting	MST – 115
6	Bridge Engineering	MST – 116
7	Design of High Rise Structures	MST – 117
8	Design of Masonry Structures	MST – 118
9	Advanced Steel Structural Design	MST – 119
10	Advanced Design of Foundations	MST – 120
11	Industrial Structures	MST – 121
12	Soil-structure Interactions	MST – 122
13	Advanced Concrete Structural Design	MST – 123
14	Pre-stressed Concrete Structures	MST – 124
15	Fracture Mechanics of Concrete	MST – 125
16	Design of Plates and Shells	MST – 126

MST-101 Advanced Structural Analysis

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week
Course Outcomes:

On completion of the course, the student will have the ability to:
1. Develop Stiffness and flexibility matrices for skeletal structural systems
2. Analyze and evaluate the response of skeletal structural systems using force method.
3. Analyze and evaluate the response of skeletal structural systems using displacement method.
4. Apply member approach for analyzing higher order skeletal structural systems
5. Illustrate the use of matrix methods for analyzing skeletal structural systems subjected to secondary stresses due to lack of fit, temperature change and differential settlement
6. Comprehend and apply finite element approach for solving boundary value problems

Syllabus Content:
- **Application of Stiffness and Flexibility Methods:** Stiffness Matrix and Flexibility matrix in Local & Global Coordinates, Boundary Conditions, Solution of Matrix Equations, Calculation of Reactions and Member Forces; Analysis of Beams, Trusses, Rigid-Jointed Frames and Grids using the Structure Approach and the Member Approach
- **Influence Coefficients:** Physical Significance and use in structural analysis & design, their deviation for different structural elements/members; Effects of support settlements, Temperature change and Lack of Fit using the Member Approach and the Structure Approach
- **Boundary Value Problems**: Approximate Solution of Boundary Value Problems, Modified Galerkin Method for One-Dimensional problems, Matrix Formulation of the Modified Galerkin Method and its applications

Reference Books:

1. Matrix Analysis of Framed Structures, Weaver W, and Gere J. M., Van Nostrand Reinhold Company
2. Structural Analysis - A Matrix Approach, Pandit G.S. and Gupta S. P., Tata McGraw Hill
3. The Finite Element Method, Lewis P. E. and Ward J. P., Addison-Wesley Publication Co.
4. Computer Methods in Structural Analysis, Meek J. L., CRC Press
5. Introduction to Finite Element Method, Desai and Able, CBS Publishers

MST-102 Finite Element Method in Structural Engineering

(Credits- 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Learn elemental stiffness technique
2. Formulate finite element equation, equilibrium equation.
3. Apply the concepts of Finite Element Formulation and loads
4. Learn computer applications of FEM.

Syllabus Content:

- I**ntroduction:** History and Applications. Spring and Bar Elements, Minimum Potential Energy Principle, Direct Stiffness Method, Nodal Equilibrium equations, Assembly of Global Stiffness Matrix, Element Strain and Stress
- **Beam Elements:** Flexure Element, Element Stiffness Matrix, Element Load Vector.
- **Method of Weighted Residuals:** GalerkinFinite Element Method, Application to Structural Elements, Interpolation Functions, Compatibility and Completeness Requirements, Polynomial Forms, Applications.
- **Types**:Triangular Elements, Rectangular Elements, Three-Dimensional Elements, Isoparametric Formulation, Axi-Symmetric Elements, Numerical Integration, Gaussian Quadrature.
- **Application to Solid Mechanics:** Plane Stress, CST Element, Plane Strain Rectangular Element, Isoparametric Formulation of the Plane Quadrilateral Element, Axi- Symmetric Stress Analysis, Strain and Stress Computations.
- **Computer Implementation** of FEM procedure, Pre-Processing, Solution, Post-Processing, Use of Commercial FEA Software.

Reference Books:

1. Finite Element Analysis, Seshu P., Prentice-Hall of India
2. Concepts and Applications of Finite Element Analysis, Cook R. D., Wiley J., New York
3. Fundamentals of Finite Element Analysis, Hutton David, Mc-Graw Hill
4. Finite Element Analysis, Buchanan G.R., McGraw Hill Publications, New York
5. Finite Element Method, Zienkiewicz O.C. & Taylor R.L. Vol. I, II & III, Elsevier
6. Finite Element Methods in Engineering, Belegundu A.D., Chandrupatla, T.R., Prentice Hall India

MST-103 Advanced Solid Mechanics

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week
Course Outcomes:

On completion of the course, the student will have the ability to:
1. Develop stress and strain tensors and perform transformations.
2. Solve the advanced practical problems related to the theory of elasticity, concepts of stress and strain, strain energy.
3. Learn about the elastic and plastic behavior of material and evaluate stress invariants, principal stresses and their directions and determine strain invariants, principal strains and their directions.
4. Develop constitutive relationships between stress and strain for linearly elastic solid.
5. Understand the concept of stresses and strains in 2D
6. Know the different theories for Torsion

Syllabus Content:
- **Elasticity:** Displacement, Strain and Stress Fields, Constitutive Relations, Cartesian Tensors and Equations of Elasticity
- **Strain and Stress Field:** Elementary Concept of Stress and Strain at a Point; Principal Axes; Principal stresses and Strains; Compatibility Conditions; Stress Components on an Arbitrary Plane; Differential Equations of Equilibrium, Hydrostatic and Deviatoric Components.
- **Equations of Elasticity:** Equations of Equilibrium, Stress-Strain relations, Strain Displacement and Compatibility Relations, Co-axiality of the Principal Directions.
- **Two-Dimensional Problems of Elasticity:** Plane Stress and Plane Strain Problems, Airy’s stress Function, Use of Airy’s function in beam analysis; Two-Dimensional Problems in Polar Coordinates
- **Torsion of Prismatic Bars:** Saint Venant’s Method, Prandtl’s Membrane Analogy, Torsion of Rectangular Bar, Torsion of Thin Tubes
- **Plastic Deformation:** Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, von-Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Principle of Normality and Plastic Potential, Isotropic Hardening.

Reference Books:
1. Theory of Elasticity, Timoshenko S. and Goodier J. N., McGraw Hill
2. Elasticity, Sadd M.H., Elsevier
3. Engineering Solid Mechanics, Ragab A.R.and Bayoumi S.E., CRC Press
4. Computational Elasticity, Ameen M., Narosa
5. Solid Mechanics, KazimiS. M. A., Tata McGraw Hill
6. Advanced Mechanics of Solids, Srinath L. S., Tata McGraw Hill

MST – 111 Theory of Thin Plates and Shells

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Plate equation in Cartesian and polar coordinates
2. Analyze rectangular and circular plates with different boundary conditions and loads
3. Apply the concepts rectangular and circular plates with different boundary conditions and loads.
4. Analyze the shells.

Syllabus Content:

- **Introduction:** Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle of Virtual Work, Boundary Conditions.
- **Static Analysis of Plates**: Governing Equation for a Rectangular Plate, Navier Solution for Simply-Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions
- **Circular Plates:** Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Co-ordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple
- Cases in Rectangular Plates
- **Static Analysis of Shells:** Membrane Theory of Shells - Cylindrical, Conical and Spherical Shells
- **Shells of Revolution with Bending Resistance** - Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels
- **Thermal Stresses in Plate/ Shell**

Reference Books:

1. Theory of Plates and Shells, Timoshenko S. and Krieger W., McGraw Hill.
2. Stresses in Plates and Shells, Ugural Ansel C., McGraw Hill.
3. Thin Elastic Shells, Kraus H., John Wiley and Sons.
4. Theory of Plates, Chandra S. K.., Universities Press.
5. Design and Construction of Concrete Shells, Ramaswamy G.S.

MST – 112 Theory of Structural Stability

(Credits- 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week
Course Outcomes:

On completion of the course, the student will have the ability to:
1. Learn the basic requirements of structural design, including stability in addition to strength and stiffness. Understand the classical concept of stability of discrete and continuous systems, linear and nonlinear behaviour.
2. Determine the buckling loads for simple columns by analytical solution. Have appreciation of combined axial, flexural and torsion buckling.
3. Investigate stability of frames with respect to member buckling and global buckling. Find slenderness ratio of frame members.
4. Study stability of beams with respect to lateral torsion buckling.
5. Study the stability of plates like axial flexural buckling, shear flexural buckling, buckling under combined loads.
6. An appreciation of the fundamental basis of design rules concerned with structural instability.

Syllabus Content:
- **Criteria for Design of Structures:** Stability, Strength, and Stiffness, Classical Concept of Stability of Discrete and Continuous Systems, Linear and nonlinear behaviour.
- **Stability of Columns:** Axial and Flexural Buckling, Lateral Bracing of Columns, Combined Axial, Flexural and Torsion Buckling.
- **Stability of Frames:** Member Buckling versus Global Buckling, Slenderness Ratio of Frame Members.
- **Stability of Beams:** lateral torsion buckling.
- **Stability of Plates:** axial flexural buckling, shear flexural buckling, buckling under combined loads.

Reference Books:

1. Theory of elastic stability, Timoshenko and Gere, Tata Mc Graw Hill
2. Principles of Structural Stability Theory, Alexander Chajes, Prentice Hall.
3. Structural Stability of columns and plates, Iyengar, N. G. R., Eastern West Press Pvt. Ltd.
4. Strength of Metal Structures, Bleich F. Bucking, Tata McGraw Hill.

MST-113 Theory and Applications of Cement Composites

(Credits- 3:0:0=3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Know different types of composite materials and their importance, utility
2. Classify these materials based upon the engineering properties and behavior
3. Learn about the construction / production techniques and behavior of materials
4. Use different available material models in the analysis and response prediction
5. Design structural members using the composite materials
6. Explore different application areas of composites

Syllabus Content:

- **Introduction:** Classification and Characteristics of Composite Materials- Basic terminology, Advantages & uses; Orthotropic and Anisotropic Materials; Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Theories for an Orthotropic Lamina.
- **Cement Composites:** Constituent Materials and their Properties; Fibre Reinforced Concrete, Ferrocement, SIFCON, Polymer Concretes; Construction Techniques, Preparation of Reinforcement, Casting and Curing.
- **Mechanical Behaviour & Material Models:** Mechanics of cement composite materials; Different material models and their developments; Review of different available models and their applications; Behavior of Fiber Reinforced Concrete and Ferrocement in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion
- **Analysis and Design of Cement Composite Structural Elements:** Ferrocement, SIFCON and Fibre Reinforced Concrete
- **Application of Cement Composites:** Fiber Reinforced Concrete and Ferrocement- Housing, Water Storage, Boats and Miscellaneous Structures.

Reference Books:

1. Mechanics of Composite Materials, Jones R. M, 2nd Ed., Taylor and Francis, BSP Books
2. Ferrocement – Theory and Applications, Pama R. P., IFIC
3. New Concrete Materials, Swamy R. N., 1st Ed. Blackie, Academic and Professional, Chapman & Hall

MST-114 Structural Optimization

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Conceptualize and formulate an optimization research problem.
2. Understand the difference between classical and advanced optimization methodologies.
3. Select a methodology for carrying out optimization on a research problem.
4. Solve optimization problems using various techniques.
5. Perform optimization on a problem having single objective or multi-objectives.
6. Optimize a structural member under optimal conditions.

Syllabus Content:

- **Introduction:** Historical Development; Engineering applications of Optimization; Art of Modeling; Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems; Classification of optimization problems; Optimization techniques – classical and advanced techniques.
- **Optimization using Calculus:** Stationary points; Functions of single and two variables; Global Optimum**;** Convexity and concavity of functions of one and two variables**;** Optimization of function of one variable and multiple variables; Gradient vectors; Optimization of function of multiple variables subject to equality constraints;
- **Linear Programming:** Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations; Graphical method for two variable optimization problem; Simplex algorithm and construction of simplex tableau;
- **Dynamic Programming:** Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming; Discrete versus continuous dynamic programming.
- **Integer Programming:** Integer linear programming; Concept of cutting plane method
- **Applications:** Structural Steel and Concrete Members

Reference Books:

1. Elements of Structural Optimization, Haftka, Raphael T., Gürdal, Zafer, Springer.
2. Variational Methods for Structural Optimization, Cherkaev Andrej, Springer

MST-115 Structural Health Monitoring and Retrofitting

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the fundamentals of monitoring the structural health and its maintenance strategies.
2. Diagnose for serviceability and durability aspects of concrete.
3. Know the various techniques for Static and Dynamic Field Testing.
4. Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.
5. Use the modern techniques for Structural Heath Monitoring
6. Use an appropriate health monitoring technique and demolition technique.

Syllabus Content:

- **Structural Health:** Factors affecting Health of Structures, Causes of Distress, Regular Maintenance
- **Structural Health Monitoring:** Concepts, Various Measures, Structural Safety in Alteration
- **Structural Audit:** Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.
- **Static Field Testing:** Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.
- **Dynamic Field Testing:** Types of Dynamic Field Test, Stress History Data, Dynamic response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.
- **Introduction to modern techniques:** Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.

Reference Books:

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

MST-116 Bridge Engineering

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Learn bridge classification; selection of a suitable bridge type for a given set of constraints; criterion for deciding their layout; preliminary and detailed investigations *w.r.t.* the traffic and hydraulic design of bridges.
2. Understand the various primary loads, load combinations for obtaining a worst design load for the superstructure and substructure system of bridges.
3. Apply the concepts of structural design to obtain suitable member sizes/sections of bridges and they will be able to prepare and deliver rough sketches to the draftsman etc.
4. Perform the analysis and design of foundations.
5. Appreciate the role of modern construction methods and their impact on the analysis and the design of bridge components.
6. Perform necessary bridge inspection/maintenance and their rehabilitation.

Syllabus Content:

- **Introduction:** Definitions, Classification and Components of different bridge types; layout and planning of bridges; Loading.
- **Site investigations:** Preliminary data collection; Selection of appropriate bridge type; Hydraulic design of bridges; Traffic design of bridges
- **Analysis and design of superstructure** for straight and curved bridge decks -loadings details; specification-reinforced concrete and steel decks, Decks of various types, like slab, hollow and voided slab, beam-slab type, box girder etc.
- **Analysis and design of foundations:** Shallow foundations (open Foundations), Deep foundations-well foundations and caisson; design and constructional aspects of foundations.
- Latest developments in the bridge technology construction methods for concrete and steel bridges-their impact on the analysis and the design
- Inspection and maintenance and rehabilitation of bridges

Reference Books:

1. Bridge Deck Analysis, Pama & Gusens
2. Bridge deck Behavior, Edward V. Hambly
3. Essentials of Bridge Engineering, D. Johnson Vector

MST-121 Industrial Structures

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Carry out plastic design of structural elements.
2. Analyze the loads & stresses of gantry girder.
3. Analyze and design structures using light gauge material.
4. Analyze and design steel chimneys, storage structures and industrial building.

Syllabus Content:

- **Steel Gantry Girders:** Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.
- **Portal Frames:** Design of portal frame with hinge base, design of portal frame with fixed base - Gable Structures – Lightweight Structures
- **Steel Bunkers and Silos:** Design of square bunker – Jansen's andAiry's theories – IS Code provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams Design of cylindrical silo – Side plates – Ring girder – stiffeners..
- **Chimneys:** Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.
- **Water Tanks:** Design of rectangular riveted steel water tank – Tee covers – Plates – Stays – Longitudinal and transverse beams –Design of staging – Base plates – Foundation and anchor bolts
- **Design of pressed steel water tank:** Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder –Design of staging and foundation.

References Books:

1. Design of Steel Structure, Punmia B. C., Jain Ashok Kr., Jain Arun Kr., 2nd Ed., Lakshmi Publishers
2. Design of Steel Structures, Ram Chandra, 12th Ed., Standard Publishers
3. Steel Structures - Design and Practice, Subramanian N.

LMST-101 Structural Design Lab

(Credits - 0:0:4 = 2)

Teaching Scheme
Lab: 4 hrs/week
Course Outcomes:

On completion of the course, the student will have the ability to:
1. Understand the planning of multistory building.
2. Understand the latest IS code of practice for the design of steel and concrete structural elements.
3. Apply the fundamental concepts, techniques in analysis and design of reinforced concrete and steel element.
4. Apply the design principles by undertaking multistory building.
5. Apply the various codal requirements related to various members.
6. Produce structural drawing of detailing of Reinforced Concrete and Steel Elements

Syllabus Content:

Analysis, Design and detailing of multi-storied RC/Steel structures using latest relevant IS codes.

LMST-102 Advanced Concrete Technology Lab

(Credits - 0:0:2 = 1)

Teaching Scheme
Lab: 2 hrs/week
Course Outcomes:

On completion of the course, the student will have the ability to:

1. Comprehend and illustrate the design requirements of different types of concrete
2. Design different grades of concrete mixes as per Indian code requirements
3. Design and judge the experiments for evaluating various properties of concrete
4. Evaluate and relate various strength test results to judge the requirements of a given concrete type
5. Decide and implement suitability of various non-destructive tests methods for evaluating condition of existing concrete structures

List of Experiments/Assignments:
- Concrete mix design for high strength concrete, steel fiber reinforced concrete, self-compacting concrete.
- Study of stress-strain curve of concrete samples (designed and cast as above); Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
- Non-Destructive testing of existing concrete members.

Reference Books:

1. Properties of Concrete, Neville A. M., Prentice Hall
2. Concrete Technology, Shetty M. S., S. Chand and Co.

MRM-101 Research Methodology and IPR

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week
Course Outcomes:

On completion of the course, the student will have the ability to:
1. Understanding and formulation of research problem.
2. Analyze research related information.
3. Understand plagiarism and follow research ethics.
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Content:
Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,
Unit 3: 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: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development International Scenario: International cooperation on Intellectual Property. Procedure for
grants of patents, Patenting under PCT.
Unit 5: Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases. Geographical Indications
Unit 6: New Developments in IPR: Administration of Patent System, New developments in IPR; IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies, IPR and IITs

Reference Books:

1. Research methodology: an introduction for science & engineering students, Stuart Melville and Wayne Goddard,
2. Research Methodology: An Introduction, Wayne Goddard and Stuart Melville
3. Research Methodology: A Step by Step Guide for beginners, Ranjit Kumar
4. Resisting Intellectual Property, Halbert, Taylor & Francis Ltd.
5. Industrial Design, Mayall, McGraw Hill
6. Product Design, Niebel, McGraw Hill
7. Introduction to Design, Asimov, Prentice Hall
8. Intellectual Property in New Technological Age, Robert P. Merges, Peter S. Menell, Mark A. Lemley
9. Intellectual Property Rights Under WTO, T. Ramappa, S. Chand

MAC-102 DISASTER MANAGEMENT

(Credits - 2:0:0 = 0)

Teaching Scheme
Lectures: 2 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. know about the various types of disaster and their components.
2. know about the measures and precautions at the time of a disaster.
3. know about various disaster-prone areas and various concepts about disaster preparedness, GIS and remote sensing.
4. assess risk caused by a disaster and learn about various mitigation measures.

Syllabus Content:

- **Introduction:** Disaster - Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.
- **Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem; Natural Disasters - Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches; Man-made disasters - Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.
- **Disaster Prone Areas in India:** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards With Special Reference to Tsunami; Post-Disaster Diseases and Epidemics
- **Disaster Preparedness and Management:** Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.
- **Risk Assessment:** Disaster Risk - Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival
- **Disaster Mitigation:** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India

Reference Books:

1. R. Nishith, Singh A.K, Disaster Management in India: Perspectives, issues and strategies, New Royal book Company
2. Sahni P. et al., Disaster Mitigation Experiences and Reflections, Prentice Hall of India
3. Goel S.L., Disaster Administration and Management Text and Case Studies, Deep & Deep Publication Pvt. Ltd.

Guru Nanak Dev Engineering College, Ludhiana
Civil Engineering Department
M.Tech. (Structural Engineering)
Batch 2019 & Onwards

MST-104 Structural Dynamics

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:
1. specify principles of structural dynamics,
2. analyze and study dynamic responses of "Single Degree of Freedom System" using fundamental theory and equations of motion for free and forced vibration,
3. model and analyze the continuous vibratory systems,
4. analyze the response of structure of "Multiple Degree of Freedom System" for free and forced vibrations, and,
5. analyze dynamic response through numerical solution of "Multiple Degree of Freedom System".

Course Content:

Unit I
Introduction: Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modelling of Dynamic Systems.

Unit II
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 for Response.

Multiple Degree of Freedom System (Lumped parameter): Two degree of freedom system, Multiple degree of freedom system, Inverse Interaction Method for determination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal Superposition Method.

Multiple Degree of Freedom System (Distributed Mass and Load): Single Span Beams, Free and Forced Vibration, Generalized Single Degree of Freedom.

Unit III
Numerical Solution: Numerical Solution to response using Newmark Method, Central Difference Method, Average Acceleration Method and Wilson Method.

Unit IV
Practical Vibration Analysis (Free vibration): Introduction to Rayleigh's method, Stodola Method for analysis of second and higher modes, Holzer Method- Basic Procedure.

Reference/Text Books:

1. Clough, R.W. and Penzien, J., Dynamics of Structures, McGraw Hill (1993)
2. Chopra, A.K., Structural Dynamics and Introduction to Earthquake Engineering (2012)
3. Smith, J.W., Vibration of Structures- Application in Civil Engineering Design, Chapman and Hall (1988)
4. Humar, J.L., Dynamics of Structures, Prentice Hall (2012)
5. Paz Mario, Structural Dynamics - Theory and Computation, CBS Publication (1997)

LMST-103 Model Testing Lab **(Credits - 0:0:2 = 1)**

Practical Scheme
Practical: 2 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. model the material response,
2. plan experimental setup to capture the test response of concrete members,
3. conduct NDT on RC members,
4. develop computing codes for analysis & design, and,
5. develop the material models to design the concrete elements, such as beams, and, columns.

Course Content:

1. Concrete constitutive models and their development & validation
2. Theoretical development of flexural and shear models for reinforced concrete members (with both conventional and steel fiber reinforced)
3. Preparation of spread sheets for structural analysis & design of RC members
4. Design and testing of RC beams for deflections, flexure and shear
5. Destructive and Non-Destructive Tests on Concrete Members

LMST-104 Numerical Testing Lab **(Credits - 0:0:4 = 2)**

Practical Scheme
Practical: 4 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify suitable mathematical model,
2. select appropriate solution technique,
3. generate FE models, loadings, boundary conditions,
4. obtain solution for common engineering problems, and,
5. interpret the results to see the efficacy of various selections.

Course Content:

1. Discretization of geometry-meshing a rectangular plate using 4-node elements, meshing a circular plate using 3-node and 4-node elements
2. Application of loadings-displacement, load, temperature, support movements, etc.
3. Analysis of a spring assembly using 1D elements
4. Analysis of an assembly of bar elements
5. Analysis of a stepped bar
6. Analysis of a plane truss, and, space truss
7. Analysis of a fixed-fixed beam, and, continuous beams
8. Analysis of a 2D frame, and, 3D frame
9. Analysis of grid, floor systems
10. Parametric studies to infer the response of different structural systems

LMPST-101 Project **(Credits - 0:0:4 = 2)**

Practical Scheme
Practical: 4 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify problems in the field of structural engineering,
2. conduct literature survey to formulate objectives of the problem,
3. plan appropriate solution strategy,
4. analyze multiple possible solutions to decide the best possible among these for the given set of conditions, and,
5. present the results/ findings in oral and written form.

Course Content:

The purpose of this subject (Project) is to introduce, familiarize and prepare the student for research work to be carried out during thesis. Thus, there is no fixed syllabus as such (although general guidelines are given below), and the student can choose any topic considering that the work to be carried out must result in certain deliverables (conclusions). Since the report outline of this subject is similar to 'Thesis Work', it would provide an opportunity to learn and present the work in a systematic fashion.

Following broad areas (or part thereof) can be considered to be taken up as 'Project':

1. Structural design of a Multi-Storeyed Framed Building/Industrial Building/OHSR including estimation-costing and preparation of drawings.
2. Evaluation of an existing building for structural safety using established procedures and techniques.
3. Retrofitting of a deficient structure.
4. Design and evaluation of non-conventional concrete.
5. Cost and Weight optimization of a given structure.
6. Use of BIM for efficient management of design process.

MAC-101 English for Research Report/Paper Writing

(Credits - 2:0:0 = 0)

Teaching Scheme
Lectures: 2 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. apply the acquired skills and excel in the professional environment,
2. translate vast data into abstract concepts,
3. improve the writing skills and level of readability,
4. present the report / paper in oral and written form, and,
5. ensure good quality of the paper during the initial submission.

Course Content:

1. Language and Mechanics of Writing; Identifying Information, Inferring, Meaning, Interpreting text
   Activity: Reading technical papers, books, newspaper articles

2. Summarizing the report;
   Activity: Abstract, Executive Summary, Synopsis, Writing a report

3. Interpret data in tables and graphs;
   Activity: Transcoding

4. Oral Presentation using Digital Tools;
   Activity: Oral presentation on the given topic using appropriate non-verbal cues, word processor

5. Problem Solving & Conflict Resolution;
   Activity: Case Analysis of a Challenging Scenario

6. Use of Social Media, Social Networking, gender challenges;
   Activity: Creating LinkedIn profile, blogs

Reference/Text Books:

1. Bhatnagar Nitin and Mamta Bhatnagar, Communicative English For Engineers And Professionals, Dorling Kindersley (India) Pvt. Ltd. (2010)
2. Clifford A. Whitcomb & Leslie E. Whitcomb, Effective Interpersonal and Team Communication Skills for Engineers, John Wiley & Sons, Inc., Hoboken: New Jersey (2013)
3. Arun Patil, Henk Eijkman, and, Ena Bhattacharya, New Media Communication Skills for Engineers and IT Professionals, IGI Global (2012)
4. Hershey, P. A. John Adair, Decision Making and Problem Solving Strategies, Replika Press, New Delhi (2010)
5. Jon Kirkman and Christopher Turk, Effective Writing: Improving Scientific, Technical and Business Communication, Routledge (2015)
6. Goldbort, R., Writing for Science, Yale University Press (available on Google Books) (2006)
7. Day, R., How to Write and Publish a Scientific Paper, Cambridge University Press (2006)

8. Highman, N., Handbook of Writing for the Mathematical Sciences, SIAM, Highman's book (1998)

MST-113 Theory and Applications of Cement Composites

(Credits- 3:0:0=3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:
After completing this course, the students will demonstrate the knowledge and ability to:

1. classify materials as per orthotropic or anisotropic behaviour,
2. estimate strain constants using theories applicable to composite materials,
3. predict the behaviour of composite materials by use of available models,
4. analyse and design the cement composite structural elements, and,
5. suggest the use of cement composites for miscellaneous structures.

Course Content:

Unit I
Introduction: Classification and Characteristics of Composite Materials- Basic terminology, Advantages & uses; Orthotropic and Anisotropic Materials; Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Theories for an Orthotropic Lamina

Unit II
Cement Composites: Constituent Materials and their Properties; Fibre Reinforced Concrete, Ferrocement, SIFCON, Polymer Concretes; Construction Techniques, Preparation of Reinforcement, Casting and Curing

Unit III
Mechanical Behaviour & Material Models: Mechanics of cement composite materials; Different material models and their developments; Review of different available models and their applications; Behaviour of Fibre Reinforced Concrete and Ferrocement in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion

Unit IV
Analysis and Design of Cement Composite Structural Elements: Ferrocement, SIFCON and Fibre Reinforced Concrete

Application of Cement Composites: Fibre Reinforced Concrete and Ferrocement- Housing, Water Storage, Boats and Miscellaneous Structures

Reference/Text Books:

1. Jones, R. M, Mechanics of Composite Materials, 2nd Ed., Taylor and Francis, BSP Books (1998)
2. Pama, R. P., Ferrocement – Theory and Applications, IFIC (1980)
3. Swamy, R. N., New Concrete Materials, 1st Ed. Blackie, Academic and Professional, Chapman & Hall (1983)

MST-117 Design of High Rise Structures **(Credits - 3:0:0 = 3)**

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. analyze, design and detail 'Transmission/ TV tower', 'Mast and Trestles' with different loading conditions,
2. analyze, design and detail the 'RC and Steel Chimneys',
3. analyze, design and detail the tall buildings subjected to different loading conditions using relevant codes,
4. analyze and design the foundations for high rise structures, and,
5. analyze and design high rise structures using different softwares.

Course Content:

Unit I
Tall Buildings: Structural concepts, configurations, various systems, Wind and Seismic loads, Dynamic approach, structural design considerations and IS code provisions, Firefighting design provisions.

Unit II
Analysis and Design of RC and Steel Chimneys, Foundation design for varied soil strata.

Unit III
Design of transmission/ TV tower, Mast and Trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads.

Unit IV
Application of softwares in analysis and design.

Reference/Text Books:

1. Varyani, U. H., Structural Design of multi-storeyed Buildings, South Asian Publishers, New Delhi (2002)
2. Taranath, B. S., Structural Analysis and Design of Tall Buildings, McGraw Hill (1988)
3. Design of multi-storeyed Buildings, Vol. 1 & 2, CPWD Publications (1976)
4. Smith Byran, S., and, Coull Alex, Tall Building Structures, Wiley India (1991)
5. Wolfgang Schueller, High Rise Building Structures, Wiley (1971)
6. Manohar, S. N., Tall Chimneys, Tata McGraw Hill, New Delhi (1985)
7. Pinfold, G. M., Reinforced Concrete Chimneys and Towers, A View-point publication, UK (1984)
8. IS 16700 : 2017, Criteria for Structural Safety of Tall Concrete Buildings, BIS, New Delhi.
9. IS 4998 (Part1) : 1992, Indian Standard Code of Practice for 'Criteria for Design of Reinforced Concrete Chimneys - Part 1: Assessment of Loads,' BIS, New Delhi.

MST-118 Design of Masonry Structures

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify appropriate masonry materials for construction work,
2. use applicable BIS guidelines for construction of masonry works,
3. calculate the safe stress levels for brick masonry elements, such as piers, walls,
4. design different types of wall elements, such as cavity, solid, cross walls, etc., and,
5. design & detail low rise brick masonry buildings.

Course Content:

Unit I
Masonry Units, Materials, Types and Masonry Construction: Bricks, Stone and Block masonry units- strength, modulus of elasticity and water absorption of masonry materials – classification and properties of mortars. Defects and Errors in masonry construction – cracks in masonry, types, reason for cracking, methods of avoiding cracks.

Unit II
Strength and Stability: Strength and stability of axially loaded masonry walls, effect of unit strength, mortar strength, joint thickness, rate of absorption, effect of curing, effect of ageing, workmanship.

Permissible Stresses: Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric, vertical, and, lateral load, permissible tensile stress and shear stresses.

Unit III
Design Considerations: Relevant BIS guidelines; Effective height of walls and columns; openings in walls; effective length, effective thickness, slenderness ratio, eccentricity; load dispersion; arching action in lintels; Problems on design considerations for solid walls, cavity walls, wall with pillars; Walls subjected to axial loads, eccentric loads; design examples of walls under UDL, solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers; design of solid wall under wind loading; design of shear wall; design of compound walls.

Unit IV
Design of a Building: Design of load bearing masonry for building upto '3' storeys using IS 1905, IS 4326 and SP: 20 procedures.

Reference/Text Books:

1. Curtin, W.G., Design of Reinforced and Prestressed Masonry, Thomas Telford Ltd. (2015)
2. Dayaratnam, P., Brick and Reinforced Brick Structures, Oxford & IBH (2017)
3. SP: 20, Handbook on "Masonry Design and Construction" (S&T, 1991)
4. Hendry, A.W., Structural masonry, Macmillan Education Ltd. (1998)
5. IS 4326: 1993, Indian Standard Code of Practice for "Earthquake Resistant Design and Construction of Masonry Buildings" (Reaffirmed, 1998)

6. IS 1905 : 1987, Indian Standard Code of Practice for "Structural use of Unreinforced Masonry" (Reaffirmed, 2002)
7. Sinha, B. P., and, Davis, S. R., Design of Masonry structures, E & F N Spon (1997)

MST-119 Advanced Steel Structural Design

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. compute plastic moment capacity of steel members,
2. analyze beams and frames using theory of plasticity,
3. design a frame using minimum weight design concept,
4. calculate deflection of beam at ultimate and working loads, and,
5. interpret the design of a frame considering secondary design parameters.

Course Content:

Unit I
Introduction: Concepts of ductility, Theory of plastic bending, Assumptions, Plastic bending of rectangular section, Plastic hinge, Redistribution of moments, Computation of plastic moment, Shape factor, Load factor.

Unit II
Plastic Analysis: Conditions and basic theorems of Plastic Analysis, Statical and Mechanical methods of analysis, Collapse load, Single span and continuous beams, Portal Frames subjected to transverse and lateral loads, Calculation of deflection at ultimate and working loads.

Unit III
Minimum Weight Design: Concept, Assumptions, Design of frames with prismatic members, Elements of linear programming and its applications to minimum weight design problems.

Unit IV
Secondary Design Concepts: Influence of axial force and shear force on plastic moment; local buckling of flanges and webs.

Reference/Text Books:

1. Disque, Robert O, Applied Plastic Design in Steel, Robert E. Krieger Publishing Co. (2016)
2. Neal, B. G, Plastic Methods of Structural Analysis, Chapman And Hall; New York; Wiley (1977)
3. Baker, J.F., The steel skeleton. Vol. II, Plastic Behavior and Design, Cambridge University Press (1956)
4. Hodge G. Philip, Plastic Analysis of Steel Structures, Krieger Publishing Company (1981)
5. Lynn. S. Beedle, Plastic Design of Steel Frames, John Wiley & Sons. (1966)
6. Gaylord, Edwin H., and, Charles, N., Design of Steel Structures, McGraw Hill Education (India) Private Limited (1972)

7. Manicka Selvam, V. K., Fundamental of Limit Analysis of Structures, Dhanpat Rai and Sons (2012)
8. SP: 6(6)-1972, Handbook for ‘Structural Engineers’

MST-120 Advanced Design of Foundations

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the type of foundation to be provided as per site conditions,
2. calculate the bearing capacity of shallow foundations,
3. evaluate the load carrying capacity of pile and well foundations,
4. analyze and design machine foundations, and,
5. design sheet pile structures.

Course Content:

Unit I
Introduction to Geotechnical Earthquake Engineering: Ground Shaking, Liquefaction, Effects of liquefaction.

Unit II
Shallow Foundations: Terzaghi's bearing capacity equation, General bearing capacity equation, Meyerhof's and Vesic's theories, Effect of water table, Special footing problems, IS Codes, Footing pressure for settlement on sand, Soil pressure at a depth, Boussinesq's and Westergaard's methods, Computation of settlements, Inclined and Eccentric Loads.

Pile Foundations: Timber, Concrete, Steel piles, Estimating pile capacity by dynamic formula, by wave equation and by static methods, Point bearing piles, Pile load tests, Negative skin friction, Modulus of sub-grade reaction for laterally loaded piles, Lateral resistance, Pile group considerations, Efficiency, Stresses on underlying strata, Settlement of pile groups, Pile caps, Batter piles, Approximate and Exact analysis of pile groups, IS Codes.

Unit III
Well Foundations: Types (open end, closed or box, Pneumatic, Drilled), Shapes, Bearing capacity and settlements, Determination of grip length by dimensional analysis, Stability of well foundations by IRC Method, Construction, Tilts & shifts.

Machine Foundations: Types, Analysis and design by Barkan's method, Determination of coefficient of uniform elastic compression, and Design of a machine foundation, IS Method of design.

Unit IV
Sheet Pile Structures: Types, Cantilever, Anchored sheet, Design by free earth & fixed earth method, Anchored braced sheeting, Cofferdams, Stability of cellular cofferdam, Instability due to heave of bottom.

Reference/Text Books:

1. Bowles, Joseph E., Foundation Analysis and Design, Tata McGraw Hill (2017)
2. Coduto, Donald P., Foundation Design: Principles and Practice, Prentice Hall (2015)
3. Dass, B. M, Principles of Foundation Engineering, Thomson Learning (2013)
4. Kramer, Steven L., Geotechnical Earthquake Engineering, Pearson Education (2013)

5. Murthy, V. N. S., Advanced Foundation Engineering, C.B.S. Publishers (2017)

MST-122 Soil Structure Interactions

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. understand soil structure interaction concept and complexities involved,
2. evaluate soil structure interaction for different types of structure under various conditions of loading and subsoil characteristics,
3. prepare comprehensive design oriented computer programs for interaction problems based on theory of sub grade reaction such as beams, footings, rafts etc.,
4. analyze different types of frame structure founded on stratified natural deposits with linear and non-linear stress-strain characteristics, and,
5. evaluate action of group of piles considering stress-strain characteristics of real soils.

Course Content:

Unit I

General Soil-Structure Interaction Problems: Contact pressures and soil-structure interaction for shallow foundations, concept of sub grade modulus, effects/parameters influencing subgrade modulus. Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, two parameter elastic models.

Unit II

Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

Unit III

Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Unit IV

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Sub-grade reaction and elastic analysis, Interaction analysis.

Reference/Text Books:

1. Poulos, H. G., and Davis, E. H., Pile Foundation Analysis and Design, John Wiley (1980)
2. Scott, R. F., Foundation Analysis, Prentice Hall (1981)
3. Selvadurai, A. P. S., Elastic Analysis of Soil-Foundation Interaction, Elsevier (1979)
4. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers (1978)

5. ACI 336 (1988), Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute (1988)
6. Bowels, J. E., Analytical and Computer Methods in Foundation, McGraw Hill Book Co., New York (1974)
7. Desai, C. S. and Christian, J. T., Numerical Methods in Geotechnical Engineering, McGraw Hill Book Co., New York.
8. Soil Structure Interasction – The Real Behavior of Structures, Institution of Structural Engineers.
9. Elastic Analysis of Soil Foundation Interaction, Developments in Geotechnical Engineering. Vol-17, Elsevier Scientific Publishing Company.
10. Swami Saran, Analysis & Design of substructures, Oxford & IBH Publishing Co. Pvt. Ltd.
11. Kurian, N. P., Design of Foundation System- Principles & Practices, Narosa Publishing.

MST-123 Advanced Concrete Structural Design

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. analyze the behavior and calculate deflection and crack widths under different loading conditions,
2. design special structures such as Deep beams, Corbels, and, Grid floors,
3. design the flat slab as per Indian Standards,
4. understand the behavior of concrete beams under stresses, and,
5. design and detail beams, columns and joints for ductility.

Course Content:

Unit I

Design Philosophy: Limit state design-beams, slabs and columns according to IS Codes. Calculation of deflection and crack width according to IS Code. Interaction curve generation for axial force and bending.

Unit II

Design of Special RC Elements: Design of slender columns-Design of RC walls. Strut and tie method of analysis for corbels and deep beams, Design of corbels, Deep-beams and grid floors.

Unit III

Flat Slabs and Yield-Line based Design: Design of flat slabs and flat plates according to IS method–Check for shear-Design of spandrel beams-Yield line theory and Hillerborg's strip method of design of slabs.

Unit IV

Inelastic Behavior of Concrete Beams and Columns: Inelastic behavior of concrete beams and Baker's method, moment-rotation curves.

Ductile Detailing: Concept of Ductility, Detailing for ductility, Design of Beams, and, Columns for ductility, Design of cast-in-situ joints in frames.

Reference/Text Books:

1. Gambhir, M. L., Design of Reinforced Concrete Structures, Prentice Hall of India (2012)
2. Unnikrishna Pillai and Devdas Menon, Reinforced Concrete, Tata McGraw Hill (2017)
3. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice Hall of India (2007)
4. Hsu, T. T. C. and Mo, Y. L., Unified Theory of Concrete Structures, John Wiley & Sons (2010)
5. Chu-Kia Wang, Charles G. Salmon, and, Wang, C.K., Reinforced Concrete Design, Oxford University (2017)
6. Jack C. McCormac, Design of Reinforced Concrete, John Wiley & Sons (2013)
7. George F. Limbrunner, and, Leonard Spiegel, Reinforced Concrete Design (2002)
8. James K. Wight, and, James G MacGregor, Reinforced Concrete: Mechanics and Design Hardcover (2015)
9. IS 456:2000, Plain and Reinforced Concrete-Code of Practice, BIS, New Delhi (2000)

10. IS-SP 16:1980, Design Aid for Reinforced Concrete to IS 456, BIS, New Delhi (1999)

MST-124 Pre-Stressed Concrete Structures

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the concepts and principles of prestressing; tools/methods of prestressing; role of materials viz: concrete and steel in the process, principle of limit analysis,
2. evaluate different loses in the prestress and analyze the sections for resultant stresses and/or capacity,
3. characterize different modes of section failure and also identify anchorage zone,
4. analyze and comprehend upon the applications of determinate and indeterminate systems, provisions of IS 1343, and,
5. design prestressed concrete members such as prestressed slabs and tanks.

Course Content:

Unit I
Introduction: High strength concrete and high tensile steel, tensioning devices, pre-tensioning systems, post-tensioning systems.

Limit State Design of Statically Determinate Pre-stressed Beams: Limit state of collapse by flexure, shear, torsion, and limit state of serviceability, Anchorage zone stresses for post-tensioned members, Losses in prestress.

Unit II
Statically Indeterminate Structures: Analysis and design - continuous beams and frames, choice of profile, linear transformation, concordancy, omically viable profile.

Unit III
Concepts and Design of Composite Beams: Composite beam with precast pre-stressed beams and cast in situ RC slab-analysis and design. Time dependent effects such as creep, shrinkage etc. on composite construction inclusive of creep relaxation and relaxation creep- partial prestressing principles, analysis and design of simple beams, crack and crack width calculations.

Unit IV
Miscellaneous Topics: Analysis and design of pre-stressed slabs and tanks

Reference/Text Books:

1. Lin, T. Y. et al, Design of Pre-stressed Concrete Structures, Wiley India Private Limited (2010)
2. Nilson, A. H., Design of Pre-stressed Concrete, John Wiley and Sons Ltd (1987)
3. Magnel, G. G., Prestressed Concrete, Cement & Concrete Assn (1954)
4. Krishna Raju, N., Prestressed concrete, Tata McGraw Hill Education (2006)
5. Natarajan, V., Fundamentals of Prestressed Concrete, B.I. Publications (1983)
6. IS 1343: 2012, "Indian Standard Code of Practice: Prestressed Concrete"

MST-125 Fracture Mechanics of Concrete

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify and classify cracking of concrete structures based on fracture mechanics,
2. select suitable technique needed for the analysis,
3. apply fracture mechanics models to high strength concrete and FRC structures,
4. analyze the concrete elements at service and ultimate state, and,
5. apply the concepts of CTOD/CMD in the analysis of concrete elements.

Course Content:

Unit I
Fundamentals of Fracture Mechanics, Mechanisms of fracture and crack growth, Cleavage fracture, ductile fracture, fatigue cracking, Quasi brittle materials.

Unit II
Service failure analysis, linear elastic fracture mechanics, Griffith's criteria, stress intensity factors, crack tip plastic zone, Erwin's plastic zone correction, R curves, compliance, J Integral, nonlinear analysis, Review of concrete behavior in tension and compression, Basic frameworks for modeling of quasi-brittle materials.

Unit III
Nonlinear Fracture Mechanics – Discrete crack concept/ Smeared crack concept, Size effect, Plasticity models for concrete – Associated and non-associated flow, Failure surfaces for quasi-brittle materials.

Unit IV
Concept of CTOD and CMD, Material models, crack models, band models, and models based on continuum damage mechanics, Applications to composite materials such as High Strength Concrete, reinforced concrete, Fibre Reinforced Concrete, etc.

Reference/Text Books:

1. Suri, C. T. and Jin, Z.H., Fracture Mechanics, 1st Edition, Elsevier Academic Press (2012)
2. Broek David, Elementary Engineering Fracture Mechanics, 3rd Rev. Ed. Springer (1982)
3. Elfgreen, L., RILEM Report, Fracture Mechanics of Concrete Structures – Theory and Applications, Chapman and Hall (1989)
4. Victor, Li C., Bazant, Z. P., ACI SP 118, ACI Detroit, Fracture Mechanics – Applications to Concrete (1989)

MST-126 Design of Plates and Shells **(Credits - 3:0:0 = 3)**

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. analyze and design prismatic folded plate systems,
2. develop shell equations for different type of shells,
3. analyze and design shells using approximate solutions,
4. analyze and design cylindrical shells, and,
5. analyze and design doubly curved shells using approximate solutions.

Course Content:

Unit I
Classification, General introduction to shell theory, Derivation of membrane theory of shells

Unit II
Derivation of shell bending theory of shells, Analysis and design of singly curved shells, doubly curved shells and Cylindrical Shells

Unit III
Analysis and design of single Cylindrical Shells. Types of folded plates. Analysis and design of Prismatic folded Plate Systems

Unit IV
Construction Aspects, Numerical methods for shell problems, finite difference and finite elements for shell problems

Reference/Text Books:

1. Timoshenko and Woinowsky- Krieger, S., Theory of Plates and Shells, Tata McGraw Hill Edition (2010)
2. Ramaswamy, G. S., Design and Construction of Concrete Shell Roofs (2005)
3. Varghese, P. C., Design of Reinforced Concrete Shells & Folded Plates, PHI (2010)
4. Jawad Maan, H., Design of Plate and Shell Structures, Springer Science+Business Media Dordrecht (1994)