SEMESTER I

PMA16101 ADVANCED MATHEMATICAL METHODS 3 2 0 4

COURSE OBJECTIVES

- To analyze the treatment involved in solving differential equations by means of Laplace transformation.
- To study the significance of the distribution of heat, signals and frequency.
- To familiarize with single and multi-dimensional problems of variation calculus
- To discuss about the suitable transformation of a function in a particular plane to another plane.
- To expose the mathematical applications of vectors and tensor analysis to handle diverse problems.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 15

Laplace transform, Definitions, properties – Transform of some simple function, Transform of error function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations; Heat equation, Wave equation.

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 15

Fourier transform: Definitions, properties – Transform of elementary functions, Dirac Delta function – Convolution theorem – Parseval‟s identity – Solutions to partial differential equations; Heat equation, Wave equation, Laplace and Poisson equations.

UNIT III CALCULUS OF VARIATIONS 15

Concept of variation and its properties – Euler‟s equation – Functional dependent on first and higher order derivatives – Functional's dependant on functions of several independent variables – Variational problems with moving boundaries – Problems with constraints – Direct methods – Ritz and Katorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 15

Introduction to analytic functions – conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications; Fluid flow and heat flow problems.

UNIT V TENSOR ANALYSIS 15

Summation convention – Contravariant and covaraiant vectors – Contraction of tensors – Innerproduct – Quotient law – Metric tensor – Chrirstoffel symbols – Covariant differentiation – Gradient, divergence and curl.

TOTAL : 75 PERIODS

COURSE OUTCOMES

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

- solve the differential equations using Laplace Transform by applying its boundary conditions
- gain knowledge in fourier transform techniques in distribution of heat and signal processing.
- understand the concepts of solving a variational problem using the Euler equation.
- solve fluid flow and heat flow problems using conformal mapping.
- apply the physical applications and simplifications of tensors.

REFERENCES

1. Larry C. Andrews, Bhimsen K. Shivamoggi, "Integral Transforms for Engineers", SPIE Optical Engineering press, Washington USA (1999).
2. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2004.
4. Ramaniah.G. "Tensor Analysis", S.Viswanathan Pvt. Ltd., 1990.
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6. Spiegel, M.R., "Theory and Problems of Complex Variables and its Application (Schaum's Outline Series)", McGraw Hill Book Co., 1981.
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8. E. B. Saff, Arthur David Snider., "Fundamentals of Complex Analysis with Applications to Engineering and Science" , Prentice Hall, 2003.

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2. https://www.youtube.com/watch?v=Vg-EjShqy3M
3. https://www.youtube.com/watch?v=GiPOQC5nYMs&list=PL521C2DFD15FF568C
4. https://www.youtube.com/watch?v=DxD2Vx39YH8
5. https://www.youtube.com/watch?v=Hiaoe7USQd4

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	2	-	-	-	-	-	-	-	1	2	3
CO2	3	3	2	3	-	-	-	-	-	-	-	1	2	3
CO3	3	2	2	3	-	-	-	-	-	-	-	1	2	3
CO4	3	2	3	1	-	-	-	-	-	-	-	1	2	3
CO5	3	2	2	2	-	-	-	-	-	-	-	1	2	3

PSE16101 STRUCTURAL DYNAMICS 3 2 0 4

COURSE OBJECTIVES

- To understand the response of structural systems to time-varying dynamic loads and displacements.
- To apply the behaviour and response of linear and nonlinear two degree of freedom structures with various dynamic loading, analysis with viscous dampers.
- To study the behaviour and response of MDOF structures with various dynamic loading.
- To determine the behaviour of structures subjected to dynamic loads such as wind, earthquake and blast.
- To compute the different dynamic analysis procedures for calculating the response of structures.

UNIT I PRINCIPLES OF DYNAMICS 15

Vibration and its importance to structural engineering problems - Elements of vibratory systems and simple harmonic motion - Generalized mass – D Alembert's principle - Mathematical modelling of dynamic systems - Degree of freedom - Equation of motion for S.D.O.F - Damped and undamped free vibrations - Undamped forced vibration - Critical damping - Response to harmonic excitation - Damped or undamped - Evaluation of damping - resonance - band width method to evaluate damping - Force transmitted to foundation - Vibration isolation.

UNITII TWO DEGREE OF FREEDOM SYSTEMS ` 15

Equations of Motion of two degree of freedom systems - Damped and undamped free vibrations - Undamped forced vibration - Normal modes of vibration - Applications.

UNIT III DYNAMIC ANALYSIS OF MDOF 15

Multi degree of freedom system- undamped free vibrations - Orthogonality relationship - Approximate methods - Holzer - Rayleigh - Rayleigh-Ritz - mode superposition technique - Numerical integration procedure- Central Difference – Newmark's method.

UNIT IV DYNAMIC ANALYSIS OF CONTINUOUS SYSTEMS 15

Free and forced vibration of continuous systems- axial vibration of a beam- Flexural vibration of a beam - Rayleigh - Ritz method; Formulation using Conservation of Energy; Formulation using Virtual Work.

UNIT V PRACTICAL APPLICATIONS 15

Idealisation and formulation of mathematical models for wind, earthquake, blast and impact loading; Principles of analysis - Linear and Non-linear.

TOTAL : 75 PERIODS

COURSE OUTCOMES

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

- understand the response of structural systems to dynamic loads and displacements.
- realize the behaviour and response of linear and non-linear SDOF and MDOF structures with various dynamic loading.

- determine the behaviour and response of MDOF structures with various dynamic loading.
- find suitable solution for continuous system.
- understand the behaviour of structures subjected to dynamic loads such as wind, earthquake and blast .

REFERENCES

1. Anil K.Chopra, "Dynamics of Structures", Pearson Education, 2009.
2. Mario Paz, Structural Dynamics, "Theory and Computation", Kluwer Academic Publication, 2004.
3. Craig.R.R, "Structural Dynamics - An Introduction to Computer methods", John Wiley & Sons, 1989.
4. Manickaselvam ,V.K., "Elementary Structural Dynamics", DhanpatRai& Sons, 2001.
5. Madhujit Mukhopadhyay - Structural Dynamics Vibrations and Systems, Ane Books India Publishers,2010.

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CO PO MAPPING:

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	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO2	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PSE16102 THEORY OF ELASTICITY AND PLASTICITY 3 2 0 4

COURSE OBJECTIVES

- To study the classical theory of linear elasticity for two and three dimensional state of stress.
- To obtain solutions for elasticity problems in rectangular and polar coordinates as well as torsion of prismatic bars.
- To introduce the energy principles and energy method of solution of solid continuum mechanics.
- To gain knowledge on torsion of non-circular sections and thin walled sections.
- To understand the plastic stress strain relations, criteria of yielding and elasto- plastic problems.

UNIT I ELASTICITY 15

Analysis of stress and strain, equilibrium equations - Compatibility equations - Stress strain relationship - Generalized Hooke's law.

UNIT II FORMULATION AND SOLUTION OF ELASTICITY PROBLEMS 15

Methods of formulation of elasticity problems, methods of solution of elasticity problems, Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar co-ordinates.

UNIT III ENERGY METHODS 15

Numerical and Energy methods - Castiglianos theorem - Principle of Virtual work - Principle of stationary potential energy - Principle of least work – Rayleigh's method - Rayleigh-Ritz method- Finite difference method - Simple applications.

UNIT IV TORSION 15

Introduction, general solution of torsion problems, boundary conditions, stress function method - Torsion of non-circular sections, Prandtl's membrane analogy, Torsion of thin walled open and closed sections - Thin walled multiple cell closed sections.

UNIT V INTRODUCTION TO PLASTICITY 15

Physical assumptions - Criterion of yielding, plastic stress and strain relationship - Elastic plastic problems in bending; Torsion and thick cylinder.

TOTAL : 75 PERIODS

COURSE OUTCOMES

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

- understand the stresses and strains.
- determine the solution of elasticity problems.
- compute the beams and columns deformation using energy methods.
- analyze torsion of non-circular sections and thin walled sections.
- solve problems of plasticity.

REFERENCES

1. Timeshenko.S.P and Goodier.J.N, "Theory of Elasticity", McGraw Hill International Edition, 2010.
2. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, 2005.
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CO PO MAPPING:

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Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PSE16103 ADVANCED REINFORCED CONCRETE STRUCTURES 3 2 0 4

COURSE OBJECTIVES

- To simplify a standard reinforced concrete building into a number of manageable idealized substructures, structural elements and to construct their load paths.
- To interpret ultimate and serviceability limit state approaches in current structural design philosophy.
- To estimate primary design loads on structural elements such as beams and columns consulting appropriate standards and handbooks.
- To combine primary design load cases as per design standards to find critical load combination that governs design.
- To model building structure and analyze structural elements for design actions such as design bending moment, design shear force and deflections.

UNIT I DESIGN REGULATIONS 15

Review of limit state design of beams, slabs and columns according to IS code - Serviceability limit states - Deflection and cracking - Calculation of deflection and crack width according to IS Code.

UNIT II DESIGN OF SPECIAL RC ELEMENTS 15

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 THEORY 15

Design of Column-Supported Slabs (with/without Beams) under Gravity Loads - Direct design method - Equivalent frame method - Shear in Column - Supported two-way slabs; Design of spandrel beams; Yield line theory and Hillerborg's strip method of design of slabs.

UNIT IV PLASTIC DESIGN 15

Limit analysis - Moment redistribution - Codal recommendations for Moment redistribution; Baker's method of plastic design; Design of cast-in-situ joints in frames.

UNIT V DETAILING AND FIELD PRACTICE 15

Detailing for ductility - Measures of ductility - Flexural yielding in frames and walls - Flexural members in ductile frames - Columns and frame members subject to bending and axial load; Joints in ductile frames; Shear walls; Fire resistance of structural members - Code requirements; Quality control of concrete.

TOTAL : 75 PERIODS

COURSE OUTCOMES

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

- understand and analyze the behaviour of reinforced concrete subjected to flexure, shear and axial loading.
- identify underlying plastic concepts in modern concrete design methods

- design reinforced concrete beams, slabs and columns in accordance to IS code.
- enumerate the concept of reinforced concrete, using moment redistribution and Baker‟s method.
- produce design calculations and drawings in appropriate professional formats.

REFERENCES

1. Unnikrishna Pillai and Devdas Menon "Reinforced concrete Design‟, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2010.
2. Varghese, P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, 2007.
3. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2005.
4. Dr.B.C.Punmia, Ashok kumarjain, Arun Kumar Jain, "Limit state design of Reinforced Concrete",Laxmi Publicatiions (P) Ltd, New Delhi, 2007.
5. Sinha.N.C. and Roy S.K., "Fundamentals of Reinforced Concrete", S.Chand and Company Limited, New Delhi, 2003.

CODE BOOKS

1. IS:13920-1993 - Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of Practice.
2. IS:456-2000 - Indian Standard Code of Practice for Plain and Reinforced Concrete.
3. SP16-Design Aid for RC to IS 456-1978.

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2. https://en.wikipedia.org/wiki/Reinforced_concrete
3. http://searchworks.stanford.edu/view/317818

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CO2	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	2	-	2	2	-	-	-	-	-	-	2

ELECTIVE I

PSE16151 MATRIX METHODS OF STRUCTURAL ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To develop flexibility and stiffness matrices for the single and two coordinate system.
- To transform stiffness and flexibility matrices from system coordinate to element coordinate
- To expose flexibility method and its application to pin jointed plane truss, continuous beams, frames and grids.
- To develop stiffness matrix and their application to two and three dimensional pin- jointed trusses.
- To analyse substructures by iteration methods.

UNIT I FUNDAMENTAL CONCEPTS- STIFFNESS AND FLEXIBILITY 9

Introduction-Force and displacement measurement - Generalized or Independent measurement - Constrained or Dependent measurements- Behaviour of structures; Principle of superposition - Methods of Structural analysis - Introduction structure with single coordinate - Two coordinates - Flexibility and stiffness matrices in N coordinates- Examples, symmetric nature of matrices - Stiffness and flexibility matrices in constrained measurements - Stiffness and flexibility of systems and elements - Computing displacements and forces from virtual work- Computing stiffness and flexibility coefficients.

UNIT II ENERGY CONCEPTS & TRANSFORMATION IN STRUCTURES 9

Strain energy in terms of stiffness & flexibility matrices - Properties of stiffness and flexibility matrices - Interpretation of coefficients – Betti's law (forces not at the coordinates) - Other energy theorems - Using matrix notations - Determinate, indeterminate structures - Transformation of system forces to element forces - Element flexibility to system flexibility -System displacement to element displacement - Element stiffness to system stiffness - Transformation of forces and displacements in general - Stiffness and flexibility in general - Normal coordinates and orthogonal transformation - Principle of contragradience.

UNIT III FLEXIBILITY METHOD 9

Statically determinate structures - Indeterminate structures - Choice of redundant leading to ill and well-conditioned matrices - Automatic choice of redundant- Rank technique - Transformation to one set of redundant to another - Internal forces due to thermal expansion and lack of fit - Reducing the size of flexibility matrix - Application to pin jointed plane truss - continuous beams - Frames -Grids.

UNIT IV STIFFNESS METHOD 9

Introduction - Development of the stiffness method - Stiffness matrix for structures with zero force at some coordinates- Analogy between flexibility and stiffness - lack of fit - Stiffness matrix with rigid motions - Application of stiffness approach to pin jointed plane & space trusses - Continuous beams - Frames - Grids - Space frames introduction only - Static condensation technique- Choice of method; Stiffness or flexibility - Direct stiffness approach - Application to two & three dimensional pin- Jointed trusses.

UNIT V ANALYSIS BY SUBSTRUCTURES &ITERATION 9

Analysis by substructures using the stiffness & the flexibility method with tridiagonalisation - Iteration method for frames with non-prismatic members - Iteration method applied to rigidly connected members; Computer program for the analysis of rigidly connected beams - Efficiency of the iteration method.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- understand the basic concept of flexibility and stiffness, principle of superposition and methods of structural analysis.
- transform the flexibility and stiffness matrices from system coordinates to element coordinates.
- identify the degree of freedom and ability to formulate flexibility matrix of components of structure.
- formulate the stiffness matrix and apply to 2D and 3D structure.
- analyze the frame through the iteration methods.

REFERENCES

1. Rubinstein F.M., "Matrix Computer methods of Structural Analysis", Prentice Hall, 1966.
2. William Weaver JR. and James M. Gere, "Matrix Analysis of framed Structures", CBS Publishers and Distributers,1990.
3. Manicka Selvam V.K, "Elements of Matrix Stability Analysis of Structures", Khanna Publishers, 2006.
4. Pandit G.S, Gupta S.P, "Structural Analysis-A matrix Approch", Tata McGraw Hill Publishing Company Ltd, 2008.
5. C. Natarajan and P.Revathy, "Matrix methods of structural analysis, (Theory and Practice)", PHI Publications, 2011

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CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
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CO1	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PAAVAI ENGINEERING COLLEGE
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Civil Engineering
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PSE16152 ADVANCED CONCRETE TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

- To summarize the properties of concrete making materials such as cement, aggregates and admixtures.
- To categorize the properties and tests on fresh and hardened concrete.
- To acquire the practical knowledge on mix design principles, concepts and methods.
- To acquire knowledge in the special concretes and their applications in the diverse construction field.
- To study the concrete manufacturing processes, concreting methods and different special formworks.

UNIT I MATERIALS FOR CONCRETE 9

Cement - Manufacturing - Types and grades of cement - Chemical composition - Hydration of cement - micro structure of hydrated cement - Testing of cement - Special cements; Aggregates - classifications - IS specifications - Properties - Grading and specified grading - Methods of combining aggregates - Testing of aggregates; Water - Physical and chemical properties; Admixtures - chemical & mineral admixtures - Mineral additives.

UNIT II PROPERTIES OF CONCRETE 9

Properties of fresh concrete - Workability - Segregation – Bleeding - Laitance - Tests on fresh concrete - Properties & tests on hardened concrete - Structural properties - Strength, factors affecting the strength of concrete - Maturity of concrete, modulus of elasticity, creep-shrinkage, factors affecting creep and shrinkage of concrete - Microstructure of concrete - Micro cracking; Testing of existing and aged structures using NDT - Variability of strength in concrete; Durability of concrete - Chemical attack on concrete.

UNIT III CONCRETE MIX DESIGNS 9

Principles of mix design - Methods of concrete mix design - Factors influencing mix proportions - IS, ACI and British methods of mix design; Statistical quality control - Sampling and acceptance criteria.

UNIT IV SPECIAL CONCRETES 9

Light weight concrete and types - Fly ash concrete - Fibre reinforced concrete types & applications - Sulphur concrete - Sulphur impregnated concrete - Polymer concrete & its types - Super plasticized and hyper plasticized concretes - Epoxy resins and screeds, properties - Their applications in rehabilitation works - High performance concrete, high performance fibre reinforced concrete - Roller compacted concrete - Self-compacting concrete and its applications - Bacterial concrete - Recycled aggregate concrete - Smart concrete - Ferro cement and its applications.

UNIT V CONCRETING METHODS 9

Concrete manufacturing process - Stages of manufacturing - Transportation, placing and curing methods - Extreme weather concreting - Special concreting methods - Vacuum dewatering - Underwater concreting; Special form work types.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

- execute and test the concrete made with cement, aggregates and admixtures.
- describe the properties and durability of fresh and hardened concrete.
- execute mix proportioning of concrete and describe how the strength of concrete can be modified by changing the proportions.
- select suitable concrete for different structures considering the prevailing weathering conditions.
- decide the correct concreting methods in the field depending upon the requirement and site conditions

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2. Neville A.M., “Properties of Concrete”, Prentice Hall,5th Edition 2012.
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4. Pierre-Claude Aitcin, “High Performance Concrete”, Taylor & Francis, 2011.
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CO PO MAPPING:

Mapping of course objectives with Programme Outcomes:
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CO3	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	-	-	-	-	2	2	-	-	-	-	2	-	2

PSE16153 DESIGN OF TALL BUILDINGS 3 0 0 3

COURSE OBJECTIVES

- To paraphrase various aspects of planning of tall buildings and know about different types of loads
- To establish various structural systems for high rise buildings with their behaviour and analysis.
- To illustrate knowledge about analysis involved in tall structures.
- To formulate about sectional shapes and design for differential movement, creep and shrinkage effects.
- To gain knowledge on stability analysis of various systems and to know about advanced topics.

UNIT I DESIGN PRINCIPLES AND LOADING 9

General - Factors affecting growth, height and structural form - Design philosophy - Loading - Gravity loading - Wind loading - Earthquake loading - Combinations of loading; Strength and Stability - Stiffness and drift limitations - Human comfort criteria- Creep effects - Shrinkage effects - Temperature effects - Fire - Foundation settlement - Soil- structure interaction, Material.

UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9

High rise behaviour - Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, futrigger; Braced and hybrid mega systems.

UNIT III ANALYSIS OF TALL BUILDINGS 9

Modeling for analysis - Assumptions - Modeling for approximate analyses - Modeling for accurate analysis - Reduction techniques; Dynamic analysis - Response to wind loading - Along-wind response - Across-wind response - Estimation of natural frequencies & damping - Types of excitation - Design to minimise dynamic response - Response to earthquake motions - Response to ground accelerations - Response spectrum analysis - Estimation of natural frequencies and damping - Human response to building motions.

UNIT IV STRUCTURAL ELEMENTS 9

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow; Design for differential movement; Creep and shrinkage effects - temperature effects and fire resistance.

UNIT V STABILITY 9

Overall buckling analysis of frames - wall-frames - Approximate methods second order effects of gravity of loading; P-Delta analysis - simultaneous first-order and P Delta analysis - Translational - Torsional instability - out of plumb effects - stiffness of member in stability - effect of foundation rotation.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- know design principles and different types of loading
- describe the various structural systems used in the construction of tall structures.

- capable of analysing the tall structures
- design of structural elements for secondary effects
- execute stability analysis, overall buckling analysis of frames, analysis for various secondary effects such as creep, shrinkage and temperature.

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1. Bryan Stafford Smith and Alexcoull, "Tall Building Structures -
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WEB LINKS

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2. http://www.sciencedirect.com/science/article/pii/S016761050700089X
3. http://www.crcnetbase.com/isbn/9781439850893

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	-	2

PSE16154 STRUCTURAL OPTIMIZATION 3 0 0 3

COURSE OBJECTIVES

- To describe the fundamentals of optimization concepts and their applications in the structural engineering field.
- To categorize the linear programming methods of the optimization.
- To discriminate the constrained and unconstrained variables of the various structural engineering problems.
- To prepare the various methods of optimality involving geometric and dynamic programming.
- To summarize on the various advanced techniques in the structural optimization.

UNIT I OPTIMIZATION FUNDAMENTALS 9

Optimization methods - Introduction, Problem formulation, Introduction to mathematical principles in optimization - Mathematical models - Activity - Design methodology- Civil engineering case study- Unconstrained functions - single variable- several variable- equality constraints - inequality constraints- optimization- design space- Feasible and Infeasible- Convex and concave - Active constraints- Local and Global optima - differential Calculus- Optimality criteria- Lagrange multiplier method- Kuhn- tucker Criteria.

UNIT II LINEAR PROGRAMMING 9

Formulation of problems - Graphical solution -Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - Simplex method - Two phase method -Penalty method - Duality theory - Primal - Dual algorithm.

UNIT III NON-LINEAR PROGRAMMING 9

Introduction to non-linear problems - One dimensional minimization methods - unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci method- Golden section method - Interpolation methods; Unconstrained multivariable function - Univariate method- Cauchy's steepest descent method- conjugate gradient method (Fletcher Reeves) - Variable metric methods (Davison-Fletcher-Powell) - Direct and indirect methods - Interior Penality function - External Penalty function method.

UNIT IV GEOMETRIC PROGRAMMING AND DYNAMIC PROGRAMMING 9

Geometric Programming- Polynomial - Degree of difficulty- Reducing G.P.P. to a set of simultaneous equations - Concepts of solving problems with zero difficulty and one degree of difficulty; Dynamic Programming – Bellman's principle of optimality - Representation of a multi stage decision problem - Concept of sub - optimisation problems - Truss optimization.

UNIT V NON-TRADITIONAL METHODS 9

Genetic Algorithm - Terminology - Natural Law of Evolutions - Genetic operators - steps for solution of problems - Simulated Annealing - Algorithm – Boltzman's equation - ANT Colony optimization – Algorithm Pheromone trail - Travelling salesman problem- Introduction to TABU search - sample problem; Artificial Neural Network - Application characteristics.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- apply the basic ideas in optimization to make the structures as lightly as possible.
- classify the linear programming techniques in engineering optimization.
- formulate the unconstrained and constrained optimization problems in structural design.
- identify the methods in solving the problems related to geometric and dynamic programming.
- standardize in advanced techniques of optimization such as genetic algorithm and artificial neural networks.

REFERENCES

1. Rao. S.S., "Optimisation Theory and Applications", New Age International Private Limited Publisher, New Delhi, 2002.
2. Belegundu, A.D.and Chandrapatla,T.R., "Optimisation Concepts and Applications in Engineering", Pearson Education, 2011.
3. Deb K., "Optimisation for Engineering Design", Algorithms and examples, Prentice Hall, New Delhi, 2012.
4. Arora J.S., "Introduction to Optimum Design", McGraw -Hill Book Company, 2011.
5. Taha, H.A., "Operations Research - An Introduction", Prentice Hall of India, 2004.

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1. http://www.structures.ethz.ch/education/master/optimization
2. http://web.mit.edu/16.810/www/16.810_L8_Optimization
3. http://nptel.ac.in/courses/105108127

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CO1	2	3	1	2	1	-	-	-	-	-	-	1	2	2
CO2	2	3	2	2	1	-	-	-	-	-	-	1	2	2
CO3	2	3	2	2	1	-	-	-	-	-	-	1	2	2
CO4	2	3	2	2	1	-	-	-	-	-	-	1	2	2
CO5	2	2	2	2	1	-	-	-	-	-	-	1	2	2

SEMESTER II

PSE16201 ADVANCED STRUCTURAL STEEL DESIGN 3 2 0 4

COURSE OBJECTIVES

- To understand the concepts of limit state design, working stress design and design philosophies of tension and compression members.
- To study the various connections (welded and riveted), seated connections (Unstiffened and Stiffened connections) and to design them.
- To focus on the study and design of steel structures subjected to torsion.
- To study the plastic analysis of steel structures.
- To design concepts of light gauge steel structures.

UNIT I DESIGN METHODOLOGIES 15

Concept of design methodologies -Philosophies of Limit State Design, Working stress design, LRFD-TENSION MEMBERS: Introduction – net sectional area for concentrically and eccentrically loaded members – tension splices - bending of tension members – stress concentrations; COMPRESSION MEMBERS: Introduction – practical end conditions and effective length factors – elastic compression members – restrained compression members.

UNIT II DESIGN OF CONNECTIONS 15

Types of connections - Welded and riveted - Throat and root stresses in Fillet welds - Seated connections - Unstiffened and stiffened seated connections - Moment resistant connections - Clip angle connections - Split beam connections - Framed connections.

UNIT III TORSION MEMBERS 15

Introduction – uniform torsion – non uniform torsion – torsion design – torsion and bending – distorsion.

UNIT IV PLASTIC ANALYSIS OF STRUCTURES 15

Introduction - shape factor - Moment redistribution - combined mechanisms - analysis of portal frames - Effect of axial force - Effect of shear force on plastic moment; Connections - requirement – Moment resisting connections - Design of straight corner connections - Haunched connections; Design of continuous beams.

UNIT V DESIGN OF LIGHT GAUGE STEEL STRUCTURES 15

Cold formed light gauge section - Type of cross sections - stiffened - multiple stiffened and unstiffened element - flat width ratio - effective design width - Design of light gauge compression member - Effective width for load and deflection determination - Design of tension members - Design of flexural members - Shear lag - Flange curling.

TOTAL : 75PERIODS

COURSE OUTCOMES

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

- design various tension and compression members.
- design different types of steel connections and joints.
- design steel structures subjected to torsion.
- design for plasticity.
- design light gauge steel structures.

REFERENCES

1. Subramanian .N, " Design of Steel Structures", Oxford University Press, 2008.
2. Dayarathnam.P, "Design of Steel Structures", A.H.Wheeler, India, 2007.
3. John E. Lothers, " Design in structural steel", Prentice Hall of India, New Delhi 1990.
4. Lynn S. Beedle, "Plastic Design of Steel Frames", John Wiley and Sons, New York 1990.
5. Wie Wen Yu, "Design of Cold Formed Steel Structures" ,McGrawHIll Book Company, New York, 2010.

CODE BOOKS

1. IS:800-2007 - Indian Standard Code of Practice for general construction in steel (Limit State).
2. IS:875 (Part I to V) - Code of Practice for Design loads.
3. IS:801-1975 - Code of practice for use of cold formed light gauge steel structural members in general building construction.
4. IS:811 -1987 - Cold formed light gauge structural steel sections.
5. IS:6533-1989 (Part I & II) - Code of Practice for Design and Construction of Steel Chimney.
6. IS:802-1977 - Code of Practice for use of structural steel in Overhead Transmission Line Towers.
7. SP:6 - Handbook on Structural Steel Section.

WEB LINKS

1. https://engineering.purdue.edu/~ahvarma/CE%20470/
2. http://www.learnerstv.com/Free-engineering-Video-lectures-ltv323-Page1.html
3. http://peer.berkeley.edu/~yang/courses/ce248/CE248_LN_Floor_vibrations.pdf

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Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO2	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PSE16202 ASEISMIC ANALYSIS AND DESIGN OF STRUCTURES 3 2 0 4

COURSE OBJECTIVES

- To understand the concepts of engineering seismology
- To analyze building for earthquake forces and introduce design concepts
- To explain the design guidelines for earthquake resistant masonry and earthen buildings
- To analyze rigid frames and shear wall for earthquake loading
- To gain knowledge on vibration control techniques

UNIT I EARTHQUAKE GROUND MOTION 15

Engineering Seismology - Elastic rebound theory - Plate tectonic theory - Seismic waves - earthquake size - measurement of earthquakes - Strong ground motions - Tsunami - Seismic zoning map of India Information on some disastrous earthquakes.

UNIT II EARTHQUAKE ANALYSIS AND DESIGN CONCEPTS 15

Response spectra - Introduction to methods of seismic analysis - Equivalent static analysis IS 1893 provisions - Response spectrum method - Time history method - Push over analysis - Mathematical modeling of multi-storey RC Building; Design methodology - Architectural consideration - geotechnical consideration - structural design consideration - Capacity design - Techniques of aseismic design.

UNIT III EARTHQUAKE DESIGN OF MASONRY BUILDINGS 15

Guidelines for earthquake resistant earthen buildings and masonry buildings - Design considerations.

UNIT IV EARTHQUAKE DESIGN OF RC STRUCTURES 15

Earthquake resistant design of RCC. Buildings - Material properties - Lateral load analysis - Design and detailing - Rigid frames; Shear wall - Coupled shear wall.

UNIT V SPECIAL TOPICS 15

Liquefaction, vibration control - Tuned mass dampers - Principles and application, Basic concept of seismic base Isolation - Various systems- Case studies

TOTAL :75 PERIODS

COURSE OUTCOMES

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

- describe ground motion and its relationship to seismic design of structures.
- calculate earthquake induced lateral force on the structure.
- include earthquake resistant features in masonry buildings.
- apply the basic principles of conceptual design for earthquake resistant RC buildings and carry out the detailed design of earthquake resistant RC buildings.
- adopt vibration control methods for buildings located in earthquake zone.

REFERENCES

1. Chopra A K, “Dynamics of Structures - Theory and Applications to Earthquake Engineering”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
2. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures, Prentice”, Hall ofIndia Pvt. Ltd., New Delhi, 2006.
3. Taranath B S, “Wind and Earthquake Resistant Buildings - Structural Analysis & Design”, Marcell Decker, NewYork, 2005.
4. Chen WF & Scawthorn, “Earthquake Engineering Hand book”, CRC Press, 2003.
5. S.K.Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, 2007

CODE BOOKS

1. IS:13920-1993 - Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of Practice.
2. IS:1893 (Part I) - 2002 - Indian Standard Criteria for Earthquake Design of Structures - General Provisions and Buildings.
3. IS:4326 - 1993 - Earthquake Resistant Design and Construction of Buildings - Code of Practice.
4. IS:13827-1993 - Improving Earthquake Resistance of Earthen Buildings - Guidelines.
5. IS:13828 - 1993 - Improving Earthquake Resistance of Low Strength Masonry Buildings -- Guidelines.

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1. http://www.tylin.com/en/services/seismic_analysis_retrofit_and_design
2. http://www.trb.org/Main/Blurbs/160387.aspx
3. http://www.sciencedirect.com/science/article/pii/S0886779801000517

PAAVAI ENGINEERING COLLEGE Approved BOARD OF STUDIES Civil Engineering AUTONOMOUS

CO PO MAPPING:

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CO1	3	2	-	-	-	-	2	-	-	-	-	2	2	-
CO2	3	2	-	-	-	-	2	-	-	-	-	2	2	-
CO3	3	2	-	-	-	-	2	-	-	-	-	2	2	-
CO4	3	2	-	-	-	-	2	-	-	-	-	2	2	-
CO5	3	2	-	-	2	-	2	-	-	-	-	2	2	-

PSE16203 DESIGN OF PRE-STRESSED CONCRETE STRUCTURES 3 2 0 4

COURSE OBJECTIVES

- To analyze various systems of prestressing using basic principles.
- To design flexural members for shear, bond and torsion and end blocks.
- To analyze and design continuous beams using the concept of linear transformation and cable profile.
- To design the tension and compression members and evaluate their application in design of pipes, water tanks, piles and flag mast.
- To analyze and design composite section and prestressed concrete bridges.

UNIT I PRINCIPLES AND BEHAVIOUR OF PRESTRESSING 15

Principles of Prestressing - Types and systems of prestressing, need for high strength materials; Analysis methods, losses, deflection (short-long term), camber, cable layouts.

UNIT II DESIGN OF FLEXURAL MEMBERS 15

Behaviour of flexural members - Determination of ultimate flexural strength - Codal provisions; Design of flexural members; Design for shear - bond and torsion; Design of end blocks.

UNIT III DESIGN OF CONTINUOUS BEAMS 15

Analysis and design of continuous beams - Methods of achieving continuity - Concept of linear transformations, concordant cable profile and gap cables

UNIT IV DESIGN OF TENSION AND COMPRESSIONMEMBERS 15

Design of tension members - Application in the design of prestressed pipes and prestressed concrete cylindrical water tanks; Design of compression members with and without flexure - application in the design of piles, flag masts and similar structures.

UNIT V DESIGN OF PRESTRESSED CONCRETE BRIDGES 15

Composite Beams - Analysis and design - Composite sections - Ultimate strength - Application in prestressed concrete bridges; Design of pre- tensioned and post tensioned girder bridges - Partial prestressing - advantages and applications.

TOTAL : 75 PERIODS

COURSE OUTCOMES

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

- explain the principle, types and systems of prestressing and analyze the deflections.
- determine the flexural strength and design the flexural members, end blocks.
- analyze the statically indeterminate structures and design the continuous beam.
- design the tension and compression members and apply it for design of piles.
- analyze the stress, deflections, flexural and shear strength and apply it for the design of bridges.

REFERENCES

1. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co, 2007.
2. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete",S.Chand and Co., 2011.
3. Lin.T.Y., "Design of Prestressed Concrete Structures", John Wiley and Sons Inc,1981.
4. Evans, R.H. and Bennett, E.W., "Prestressed Concrete", Champman and Hall, London, 1998.
5. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi, 2008.

CODE BOOKS

1. IS456 - 2000 - IS Code of Practice for Plain and Reinforced Concrete.
2. IS1343 - 1980 - IS Code of Practice for Prestressed Concrete.
3. IS1678-1998-Specification for Prestressed Concrete Pole for verhead Power Traction and Telecommunication lines.
4. IRC:6-2010 Standard Specifications and Code of Practice for Road Bridges, Section II - Loads and Stresses (Fifth Revision).
5. IRC:18-2000 Design Criteria for Prestressed Concrete Road Bridges(Post-Tensioned Concrete) (3rd Revision).
6. IRS - Indian Railway Standard Specifications.
7. BS8110 - 1985 - Code of Practice for Design and Construction.
8. IS784 - 2001 - IS Specification for Prestressed Concrete Pipes.
9. IS3370 - 1999 - Part III - IS Code of Practice for Concrete Structures for the storage of liquids.
10. IS875 - 1987 - Part I - IV - IS Code of Practice for Design loads.

WEB LINKS

1. http://www.assakkaf.com/ence_454_lecture_notes.htm
2. http://faculty.delhi.edu/hultendc/AECT480-Lecture%2024.pdf
3. http://www.colincaprani.com/structural-engineering/courses/lecture-notes/

CO PO MAPPING:

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	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	-	2	-	1	-	-	-	-	2	-	2
CO2	3	2	2	-	-	-	1	-	-	-	-	2	-	2
CO3	3	2	2	-	-	-	1	-	-	-	-	2	-	2
CO4	2	2	2	-	-	-	1	-	-	-	-	2	-	2
CO5	2	2	2	-	-	-	1	-	-	-	-	2	-	2

PSE16204 **FINITE ELEMENT METHOD** **3 2 0 4**

COURSE OBJECTIVES

- To equip with the finite element analysis fundamentals.
- To formulate the design problems into FEA.
- To perform engineering simulations using finite element analysis software (ANSYS).
- To understand the ethical issues related to the utilization of FEA in the industry.
- To execute the CAD interfaces, joints and connections, non-linear behavior, optimization and analysis to code.

UNIT I FORMULATION OF BOUNDARY VALUES 15

Basic steps in finite element anlaysis - Boundary value problems – Approximate solutions – Variational and weighed residual methods – Ritz and Galerkin formulations – Concept of piecewise approximation and finite element – Displacement and shape functions – Weak formulation – Minimum potential energy – Generation of stiffness matrix and load vector.

UNIT II STRESS ANALYSIS 15

Two dimensional problems – Plane stress, plane strain and axisymmetric problems – Triangular and rectangular elements – Natural coordinates – Computation of stiffness matrix for isoparametric elements - Numerical integration (Gauss quadrature) - Brick elements - Elements for fracture analysis; Introduction to plate bending and shell elements

UNIT III MESHING AND SOLUTION 15

Higher order elements – P and H methods of mesh refinement – Ill conditioned elements – Discretisation errors; Auto and adaptive mesh generation techniques - Error evaluation

UNIT IV DYNAMIC ANALYSIS 15

Introduction – Vibrational problems – Equations of motion based on weak form – Longitudinal vibration of bars – Transverse vibration of beams – Consistent mass matrices – Element equations – Solution of eigenvalue problems – Vector iteration methods – Normal modes – Transient vibrations – Modeling of damping – Direct integration methods

UNIT V PLATE AND SHELL ELEMENTS 15

Formation of stiffness matrix for plate bending elements of triangular and quadrilateral elements; Concept of four node and eight node isoparametric elements; Cylindrical thin shell elements.

TOTAL : 75 PERIODS

COURSE OUTCOMES

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

- develop finite element formulations of single degree of freedom problems and solve them
- use finite element analysis programs based upon either "p-method" or "h-method" finite element mathematical formulations
- use ansys software to perform stress, thermal and modal analysis
- compute the stiffness values of noded elements
- determine its natural frequencies, and analyze harmonically-forced vibrations

REFERENCES

1. S. S. Bhavikatti, "Finite Element Analysis", New Age Publishers,2007.
2. C. S. Krishnamoorthy, "Finite Element Analysis: Theory and Programming", Tata McGraw-Hill, 2008.
3. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", McGraw - Hill, 2005.
4. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2011.
5. Moaveni, S., "Finite Element Analysis Theory and Application with ANSYS", Prentice Hall Inc., 2003.

WEB LINKS

1. http://www.colorado.edu/engineering/CAS/courses.d/IFEM.d/Home.html
2. http://nptel.ac.in/courses/112104115/
3. http://freevideolectures.com/Course/2357/Finite-Element-Method

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CO2	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PSE16205 ADVANCED STRUCTURAL ENGINEERING LABORATORY 0 0 4 2

COURSE OBJECTIVE

- To design concrete mixes and study strength properties of concrete.
- To perform advanced laboratory experiments that emphasize the structure-propertyrelationship, statistical analysis, technical manuscript preparation.
- To get a practical knowledge about the Non destructive tests.
- To know about measuring devices and their field applications.

LIST OF EXPERIMENTS

1. Concrete mix design and study of mechanical properties of concrete
2. Fresh properties of Self Compacting Concrete using slump flow, L Box and V Funnel Tests
3. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
4. Testing of simply supported steel beam for strength and deflection behaviour.
5. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
6. Dynamic testing of cantilever steel beam
    a. To determine the damping coefficients from free vibrations.
    b. To evaluate the mode shapes.
7. Static cyclic testing of single bay two storied steel frames and evaluate
    a. Drift of the frame.
    b. Stiffness of the frame.
    c. Energy dissipation capacity of the frame.
8. Determination of in-situ strength and quality of concrete using
    a. Rebound hammer.
    b. Ultrasonic Pulse Velocity Tester.
9. Study of Measuring devices such as
    a. Beggs Deformeter
    b. Mechanical Strain Gauge
    c. Optical strain gauge
    d. Electrical Strain Gauges

TOTAL :60 PERIODS

COURSE OUTCOME

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

- describe the strength properties of concrete and design the concrete mixes.
- perform advanced laboratory experiments.
- know about various Non-destructive testing methods.
- explain about measuring devices and their field applications.

REFERENCES

1. Dally J W, and Riley W F, “Experimental Stress Analysis”, McGraw- Hill Inc. New York, 1991.
2. L.S Srinath, Experimental Stress Analysis‟, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1992.

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CO2	3	-	-	-	-	1	2	-	3	-	-	2	-	2
CO3	3	-	-	-	-	1	2	-	3	-	-	2	-	2
CO4	3	-	-	-	-	1	2	-	3	-	-	2	-	2

ELECTIVE II

PSE16251 MAINTENANCE AND REHABILITATION OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To expertise the students to procure the accurate idea about the maintenance of repair strategies of building.
- To identify and apply appropriate structural and construction technologies to rectify maintenance problems.
- To formulate the students comprehend the basic concepts related to materials available for repair.
- To articulate the students to deal in practice with the recent repair and demolition.
- To create an ability to prepare repair and rehabilitation method for various deteriorated structure.

UNIT I MAINTENANCE AND REPAIR STRATEGIES 9

Maintenance - Repair and Rehabilitation - facets of maintenance, importance of maintenance - various aspects of inspection; Assessment procedure for evaluating a damaged structure - causes of deterioration

UNIT II SERVICEABILITY AND DURABILITY OF CONCRETE 9

Quality assurance for concrete - concrete properties- strength - permeability - thermal properties and cracking - Effects due to climate - temperature - chemicals – corrosion; Design and construction errors - Effects of cover thickness and cracking

UNIT III MATERIALS FOR REPAIR 9

Special concretes and mortar - concrete chemicals - special elements for accelerated strength gain - Expansive cement - Polymer concrete - Sulphur infiltrated concrete - Ferro cement - Fibre reinforced concrete.

UNIT IV TECHNIQUES FOR REPAIR AND DEMOLITION 9

Rust eliminators and polymers coating for rebars during repair - foamed concrete, mortar and dry pack - vacuum concrete - Gunite and Shotcrete - Epoxy injection - Mortar repair for cracks - shoring and underpinning. Methods of corrosion protection - corrosion inhibitors - corrosion resistant steels - coatings and cathodic protection; Engineered demolition techniques for dilapidated structures - Case studies.

UNIT V REPAIRS, REHABILITATION AND RETROFITTING OF STRUCTURES 9

Repairs to overcome low member strength - Deflection, cracking, chemical disruption; Weathering corrosion, wear, fire, leakage and marine exposure.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- execute and test the concrete made with cement, aggregates and admixtures.
- describe the properties and durability of fresh and hardened concrete.

- execute mix proportioning of concrete and describe how the strength of concrete can be modified by changing the proportions.
- select suitable concrete for different structures considering the prevailing weathering conditions.
- decide the correct concreting methods in the field depending upon the requirement and site conditions

REFERENCES

1. Shetty M.S., Concrete Technology - Theory and Practice, S.Chand and Company, New Delhi, 2005.
2. Santhakumar, A.R., Training Course notes on Damage Assessment and repair in Low Cost Housing , “RHDC-NBO” Anna University, July 1992.
3. Raikar, R.N., Learning from failures - Deficiencies in Design, Construction and Service - R&D Centre (SDCPL), RaikarBhavan, Bombay, 1987.
4. Dension Campbell, Allen and Harold Roper, ”Concrete Structures, materials, maintenance and repair”, Longman Scientific and Technical, UK, 1991.
5. Dr. B. Vidivelli, “Rehabilitation Of Concrete Structures”, Standard Publishers Distributors, 2007.

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1. http://theconstructor.org/concrete/design-of-concrete-structures-for-durability/7268/
2. http://www.sustainableconcrete.org/?q=node/171
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Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO2	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO3	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO4	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO5	2	-	-	-	-	-	-	-	1	-	1	1	1	-

PSE16252 NON - LINEAR ANALYSIS OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To read the concept of nonlinear behaviour of beams and vibrations of beams.
- To distinguish the elastic analysis of statically determinate and indeterminate flexural members.
- To differentiate the inelastic analysis of statically determinate and indeterminate flexural members.
- To evaluate the nonlinear analysis of plates and its governing equation.
- To discuss the governing equation of circular and non-circular shells.

UNIT I NONLINEAR BENDING AND VIBRATION OF BEAMS 9

Introduction - Types of nonlinearities - Nonlinear governing equation for beams - Geometrically nonlinear beam problems; Vibrations of beams with various boundary conditions - Forced vibration of beams - Post buckling-cantilever column - Behaviour of beams with material nonlinearity - Nonlinear vibration and instabilities of elastically supported beams.

UNIT II ELASTIC ANALYSIS OF FLEXURAL MEMBERS 9

Flexural behaviour - Statically determinate and statically; Indeterminate bars - Uniform and varying thickness.

UNIT III INELASTIC ANALYSIS OF FLEXURAL MEMBERS 9

Inelastic analysis of uniform and variable thickness members subjected to small deformations; Inelastic analysis of flexible bars of uniform and variable stiffness; Members with and without axial restraints.

UNIT IV NONLINEAR STATIC AND DYNAMIC ANALYSIS OF PLATES 9

Introduction - Governing nonlinear equations for plates - Boundary conditions and methods of solutions - Large deflection analysis of rectangular and non-rectangular plates - Free and forced vibrations of rectangular and non-rectangular plates - Post buckling behaviour of plates - Effects of transverse shear deformations and material nonlinearity.Introduction - Derivations of governing equations; Circular and noncircular cylindrical shells - Shallow cylindrical shells - Forced nonlinear vibration of shells - Post buckling of shells.

UNIT V NONLINEAR ANALYSIS OF SHELLS 9

Introduction – Derivations of governing equations – Circular and noncircular cylindrical shells – Shallow cylindrical shells – Forced nonlinear vibration of shells – Post buckling of shells.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- describe the basic concepts of nonlinearity and its governing equation for various boundary conditions.
- categorize the elastic analysis with various boundary conditionsof thin walled structural members
- compare the inelastic analysis with various boundary conditions of thin walled structural members

- justify static and dynamic analysis of plates.
- express nonlinear analysis of shells.

REFERENCES

1. Reddy.J.N, “Non linear Finite Element Analysis”, Oxford University Press,2008.
2. Sathyamoorthy, M.,”Nonlinear Analysis of Structures”, CRC Press, Boca Raton, Florida, 1997.
3. Fertis, D. G.,”Nonlinear Mechanics”, CRC Press, Boca Raton, Florida, 1998.
4. Majid K.I., “Non Linear Structures”, Butter worth Publishers, London, 1972.
5. Iyengar N G R, “Elastic Stability of Structural elements”, Macmillan India Ltd ,2007.

WEB LINKS

1. http://ocw.mit.edu/resources/res-2-002-finite-element-procedures-for-solids-and-structures-spring-2010/nonlinear
2. https://www.andrew.cmu.edu/course/24-688/handouts/Week%2010%20-%20Nonlinear%20Structural%20Analysis/Lecture%20Material/Week%2010%20-%20Nonlinear%20Structural%20Analysis%20-%20Lecture%20Presentation.pdf
3. http://mostreal.sk/html/guide_55/g-str/gstr8.html

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	-	2

PSE16253 SMART STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To describe the basic principles and mechanisms of smart materials and devices.
- To demonstrate knowledge and understanding of the physical principles underlying the behavior of smartmaterials.
- To outline the basic principles and mechanisms of measuring techniques.
- To practice knowledge and understanding of the engineering principles in smart sensors, actuators and transducer technology.
- To propose improvement on the design, analysis, manufacturing and application issues involved in integrating smart materials and devices.

UNIT I PROPERTIES OF MATERIALS AND ER AND MR FLUIDS 9

Piezoelectric Materials and properties - Actuation of structural components - Shape Memory Alloys - Constitutive modeling of the shape memory effect, vibration control - Embedded actuators - Electro rheological and magnet orheological fluids - Mechanisms and Properties - Fiber Optics - Fibre characteristics - Fiber optic strain sensors

UNIT II VIBRATION ABSORBERS 9

Parallel damped vibration absorber - Gyroscopic vibration absorber - Active vibration, absorber; Applications - Vibration Characteristics of mistuned systems; Analytical approach

UNIT III MEASURING TECHNIQUES 9

Strain measuring techniques using electrical strain gauges - Types - Resistance - Capacitance - Inductance - Wheatstone bridges - Pressure transducers - Load cells; Temperature Compensation - Strain Rosettes.

UNIT IV CONTROL OF STRUCTURES 9

Control modeling of structures - Control strategies and limitations - Classification of control systems - Classical control, Modern control, Optimal control and Digital control; Active structures in practice.

UNIT V APPLICATIONS IN CIVIL ENGINEERING 9

Application of shape memory - Alloys in bridges - Concept of smart bridges - Application of ER fluids - Application of MR dampers in different structures - Application of MR dampers in bridges and high rise structures - Structural health monitoring; Application of optical fibres; Concept of smart concrete.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- select various smart materials and devices

- set up analytical approach on vibration absorbers
- propose various strain measurement using smart materials
- manipulate control strategies of smart structures
- apply principles of smart structures to civil engineering field

REFERENCES

1. Gandhi, M.V and Thompson, B.S., “Smart Materials and Structures”, Chapman and Hall,1992.
2. Yoseph Bar Cohen, “Smart Structures and Materials”, The International Society for Optical Engineering, 2003.
3. Srinivasan, A.V., and Michael McFarland. D., “Smart Structures - Analysis and Design”,Cambridge University Press, 2001.
4. Brian Culshaw, “Smart Structures and Materials”, Artech House, Boston, 1996.
5. P. Gaudenzi, “Smart Structures: Physical Behavior, Mathematical Modeling and Applications”, Macmillan India Ltd ,2007.

WEB LINKS

1. http://www.me.metu.edu.tr/courses/me493
2. http://nptel.ac.in/courses/112104173
3. http://theconstructor.org/structural-engg/smart-structures-and-materials/6/

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	1	2	2	-	-	-	-	2	-	2
CO2	3	-	-	-	1	2	2	-	-	-	-	2	-	2
CO3	3	-	-	-	1	2	2	-	-	-	-	2	-	2
CO4	3	-	-	-	1	2	2	-	-	-	-	2	-	2
CO5	3	-	-	-	1	2	2	-	-	-	-	2	-	2

SEMESTER III

PSE16301 **PROJECT WORK (PHASE I)** **0 0 12 6**

COURSE OBJECTIVES

- To identify a specific problem for the current need of the society
- To collect information related to the literatures.
- To develop the methodology to solve the identified problems.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL PERIODS 180

COURSE OUTCOMES

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

- have a clear idea of his/her current need of the society.
- gain knowledge from various literature reviews related to their project.
- develop methodology for identified problems.
- prepare project reports and to face reviews and viva-voce examination.

CO PO MAPPING:

Mapping of Course Objectives with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3–Strong, 2–Medium, 1–Weak

Cos	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	2	3	2	1	3	2	3
CO2	3	2	1	3	-	-	-	-	3	-	1	3	2	3
CO3	2	2	1	-	-	2	-	2	2	2	1	3	2	3
CO4	2	2	1	-	-	2	-	2	2	2	1	3	2	3

PSE16302 **PRACTICAL TRAINING (4 Weeks)** **0 0 0 1**

COURSE OBJECTIVES

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

SYLLABUS

The students individually undertake training in reputed Structural Engineering Companies during the summer vacation for a specified period of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

COURSE OUTCOMES

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

- trained in tackling a practical field/industry orientated problem related to Structural Engineering.
- solve field related problems related to their project.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	2	1	3	-	-	-	-	-	-	3	2	2
CO2	3	1	2	1	3	-	-	-	-	-	-	3	2	2

PSE16303 **TECHNICAL SEMINAR** **0 0 2 1**

COURSE OBJECTIVES

- To work on a specific technical topic in Structural Engineering and acquire the skills of written and oral presentation.
- To acquire writing abilities for seminars and conferences.

SYLLABUS

The students will work for two hours per week guided by a group of staff members. They will be asked to give a presentation on any topic of their choice related to Structural Engineering and to engage in discussion with the audience. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will defend their presentation. Evaluation will be based on the technical presentation and the report and also on the interaction shown during the seminar.

TOTAL PERIODS 30

COURSE OUTCOMES

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

- face an audience and to tackle any problem during group discussion in the Interviews.
- gain knowledge on writing abilities for seminars and conferences.

CO PO MAPPING:

Mapping of Course Objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3–Strong, 2–Medium, 1–Weak														
Cos	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	3	-	2	-	2	3	2	1	3	2	3
CO2	3	2	1	3	-	-	-	-	3	-	1	3	2	3

SEMESTER IV

PSE16401 PROJECT WORK (PHASE II) 0 0 24 12

COURSE OBJECTIVES

- To solve the identified problem based on the formulated methodology.
- To gain knowledge on experimental works.
- To develop skills to analyze field related problems.
- To discuss the test results, and make conclusions.

SYLLABUS

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL PERIODS 360

COURSE OUTCOMES

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

- solve challenging practical problem in their project
- practice various experimental work related to their project.
- develop skills to analyze field problems.
- get the test results and make possible conclusions.

CO PO MAPPING:

Mapping of Course Objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3–Strong, 2–Medium, 1–Weak														
Cos	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	-	-	-	-	-	2	1	-	2	-	2
CO2	2	2	2	-	-	-	-	-	2	1	-	2	-	2
CO3	2	2	2	-	-	-	-	-	2	1	-	2	-	2
CO4	2	2	2	-	-	-	-	-	2	1	-	2	-	2

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LIST ELECTIVES

ELECTIVE V

PSE16551 DESIGN OF PREFABRICATED STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To get introduced to the concepts of prefabrication, types and its systems.
- To have a knowledge about the structural behaviour of prefabricated structures.
- To obtain knowledge in design of cross section and the joints in structures.
- To have a detailed knowledge in designing and detailing of various prefabricated units.
- To possess a comprehensive knowledge in design of structures subjected to earthquake.

UNIT I INTRODUCTION 9

Types of prefabrication, prefabrication systems and structural schemes - Need for prefabrication - Principles - Materials; Disuniting of structures- Handling and erection - Elimination of erection stresses

UNIT II PREFABRICATED COMPONENTS 9

Production, Transportation & erection- Shuttering and mould design - Dimensional tolerances - Erection of R.C. Structures, Total prefabricated buildings; Structural behaviour of precast structures - Large panel constructions - Construction of roof and floor slabs - Wall panels - Columns - Shear walls.

UNIT III DESIGN PRINCIPLES 9

Design of cross section based on efficiency of material used - Problems in design - joint flexibility - Allowance for joint deformation; Design of construction and expansion joints.

UNIT IV STRUCTURAL MEMBERS 9

Designing and detailing of prefabricated units - industrial structures - Multi-storey buildings; Water tanks - Dimensioning and detailing of joints for different structural connections.

UNIT V DESIGN FOR ABNORMAL LOADS 9

Progressive collapse - Codal provisions - Equivalent design loads for considering abnormal effects such as earthquakes, cyclones - Importance of avoidance of progressive collapse.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the basic concepts of prefabrication and their needs in construction industry.
- know the behaviour of prefabricated structures.
- design the cross section and joints of prefabricated units
- exhibit their knowledge in designing and detailing of prefabrication units.
- design the structures for abnormal loads using the codal provisions.

REFERENCES

1. Gerostiza C.Z., Hendrikson C. and Rehat D.R., "Knowledge based process planning for construction and manufacturing", Academic Press Inc., 1994.
2. "Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete", Netherland BetorVerlag, 1978.

3. Hass, A.M. “Precast Concrete Design and Applications”, Applied Science Publishers, 1983.
4. Promislow, V “Design and Erection of Reinforced Concrete Structures”, MIR Publishers, Moscow 1980
5. Koncz T., “Manual of precast concrete construction”, Vols. I, II and III, Bauverlag,GMBH,1971.
6. IS 15916:2011 - Building Design And Erection Using prefabricated Concrete.
7. IS 11447: 1985 - Code of practice for construction with large panel prefabricates.
8. IS 1893: 2002 (Part - I)- Criteria for Earthquake Resistant Design of Structures - General.
9. IS 13920: 1993 - Ductile detailing of Reinforced Concrete Structures.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	2	2	-	-	-	-	2	-	2
CO2	3	-	-	-	2	2	2	-	-	-	-	2	-	2
CO3	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	-	-	-	-	2	2	-	-	-	-	2	-	2

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PSE16552 **THEORY OF PLATES** **3 0 0 3**

COURSE OBJECTIVES

- To get introduced to various plate theories, governing equations for bending of plates and various boundary conditions.
- To conceptualise the Navier's solution and Levy's solution and to analyse rectangular plates.
- To study the behaviour of bending of circular plates.
- To familiarise with the concepts of finite difference method.
- To use energy methods to analyse the solution of rectangular plates for the given boundary conditions.

UNIT I INTRODUCTION TO PLATE THEORY 9

Thin and thick plates - Small and large - Deflection theory of thin plate - assumptions - Moment curvature relations - stress resultants, governing - Differential equation for bending of plates - various boundary conditions.

UNIT II RECTANGULAR PLATES 9

Navier's Solution - Simply supported rectangular plates subjected to UDL and varying loads on entire area - Parabolic loads, sinusoidal loads - partly loaded plates - concentrated loads and couples - Distributed Couples - Symmetric and Antisymmetric Loadings; Levy's Solution - Plates subjected to UDL and varying loads, sinusoidal parabolic loads between the supported edges - Conditions for other two edges - Simply supported, fixed, free and Elastically restrained.

UNIT III CIRCULAR PLATES 9

Bending of circular plates with clamped and simply supported edges - plate with central hole - uniformly distributed and varying loads - conical loads, Distributed couples - Ring loads - Semi circular plates - Asymmetrically loaded plates.

UNIT IV STRUCTURAL MEMBERS 9

Solution of plate problems - Deviation of Delta / Pattern / Stencil for biharmonic form for a rectangular mesh - Two stage solutions - Solutions for various loadings and boundary conditions; Use of Symmetry and Anti - symmetry - extrapolation formula; Introduction to improved finite difference technique.

UNIT V DESIGN FOR ABNORMAL LOADS 9

Use of potential energy principle - solution of rectangular plates with various boundary conditions and loadings.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain about various plate theories
- gain the knowledge of Navier's solution, Levy's solution and solve for the rectangular plates.
- analyse circular plates for any boundary conditions.
- use finite difference method for solving plate problems.
- realise the potential energy principle and find the solution of rectangular plates for various loadings.

REFERENCES

1. Timoshenko S. and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, New York, 2003.
2. Bairagi, “Plate Analysis”, Khanna Publishers, 1996.
3. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
4. Szilard R., “Theory and Analysis of Plates”, Prentice Hall Inc., 2004.
5. Chandrashekahara, K., “Theory of Plates”, University Press (India) Ltd., Hyderabad, 2001.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO2	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO3	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO4	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO5	3	2	-	-	-	-	2	-	-	-	-	1	-	2

PSE16553 DESIGN OF SHELL STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To classify and analyse the different type of shell structures.
- To design circular domes, conical roofs and circular cylindrical shells.
- To study the behaviour of pyramidal roof.
- To be familiar with design philosophy of space frames.
- To study the finite element analysis shell structures.

UNIT I SHELL CLASSIFICATION AND ANALYSIS 9

Classification of shells - Structural actions - Membrane theory; Analysis of spherical dome - Cylindrical shells - Folded plates

UNIT II DESIGN OF SHELLS 9

Design of circular domes - Conical roofs - Circular cylindrical shells.

UNIT III FOLDED PLATES 9

Folded plate structures - Structural behaviour - Types - Design - Pyramidal roof.

UNIT IV INTRODUCTION TO SPACE FRAME 9

Space frames - Configuration - Types of nodes - General principles of design Philosophy - Behaviour.

UNIT V FINITE ELEMENT ANALYSIS 9

Finite element application on cylindrical shells - Introduction to shell elements- Flat elements - Axisymmetric elements- Degenerated elements - General shell element.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyse and design various shell and spatial structures
- design all types of domes.
- understand the behaviour of folded plates.
- know the structural behaviour and philosophy of space frames.
- proficient with finite element analysis of shell structures.

REFERENCES

1. Billington.D.P, "Thin Shell Concrete Structures", McGraw Hill Book Co., New York,2008.
2. Santhakumar.A.R and Senthil.R, "Proceedings of International Conference on Space Structures", Anna University, Chennai, 1997.
3. Subramanian.N /'Principles of Space Structures", Wheeler Publishing Co. 1999.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	1	-	-	-	-	-	-	1	1	2
CO2	2	3	1	2	1	-	-	-	-	-	-	1	1	2
CO3	2	3	1	2	1	-	-	-	-	-	-	1	1	2
CO4	2	3	1	2	1	-	-	-	-	-	-	1	1	2
CO5	2	2	1	2	1	-	-	-	-	-	-	1	1	2

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ELECTIVE VI

PSE16651 DESIGN OF INDUSTRIAL STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To impart a broad knowledge in the area of Planning and functional requirements for industrial structures
- To understand the basic idea about the materials and design of industry structural elements.
- To know the design concepts of power plant structures,
- To realise the design concepts of power transmission structures
- To understand the basic design concepts of chimneys, bunkers and silos and the construction techniques.

UNIT I PLANNING AND FUNCTIONAL REQUIREMENTS 9

Classification of Industries and industrial structures - Planning for Layout requirements regarding lighting, ventilation and fire safety - Protection against noise and vibration - Guidelines of Factories Act.

UNIT II INDUSTRIAL BUILDINGS 9

Roofs for industrial buildings - Steel and RCC - Gantry girders; Design of corbels and nibs - Machine foundations.

UNIT III POWER PLANT STRUCTURES 9

Types of power plants - Design of turbo generator foundation - Containment structures.

UNIT IV POWER TRANSMISSION STRUCTURES 9

Principles of analysis and design of lattice towers - Transmission towers - Tower foundations - Testing Towers.

UNIT V AUXILIARY STRUCTURES 9

Design of steel and RCC Chimneys - Bunkers and silos.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the planning and functional requirements of various industries.
- get an idea about the materials used and design of industry structural elements.
- realize the basic concepts and design of power plant structures.
- design power transmission structures.
- possess the ability to understand the design concepts of chimneys, bunkers and silos.

REFERENCES

1. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill, 1985.
2. Santhakumar A.R. and Murthy S.S., “Transmission Line Structures”, Tata McGrawHill, 1992.
3. Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, Tata McGraw Hill, 1976.
4. Jurgen Axel Adam, KatharriaHausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers, 2004.
5. Procs. of Advanced course on “Industrial Structures”, Structural Engineering Research Centre, Chennai, 1982.

6. IS 4995 (Part I) -1974 - Criteria for design of reinforced concrete bins for the storage of granular and powder materials.
7. IS 4995 (Part II) -1974 - General Requirements and assessment of bin Loads.
8. IS 6060 -1971 - Code of practice for Day lighting of factory buildings.
9. IS 3103 -1975- Code of practice for industrial ventilation.
10. IS 3483 -1965 - Code of practice for Noise reduction in industrial buildings.
11. IS:456-2000 - Code of Practice for Plain and Reinforced Concrete.
12. IS 6533 (Part 2) -1989 - Code of practice for design and construction of steel chimneys.
13. IS:875 (Part 1 to 5) - Code of Practice for Design loads.
14. IS:802-1977(Part 2) - Code of practice for use of structural steel in Over Head transmission line towers.
15. IS:3370-1967 - Part 2 to 4 - Code of Practice for Concrete Structures for the storage of liquids - Reinforced Concrete Structures.
16. IS:4091-1979 - Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles.
17. IS:9178-1980 - Criteria for Design of Steel Bins for Storage of Bulk Materials.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	-	2

PSE16652 STABILITY OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To study the stability of columns using theoretical and numerical methods.
- To understand the approximate methods and numerical methods of inelastic buckling.
- To get accustomed to beam column behaviour and that of frames.
- To enumerate the lateral buckling, lateral torsional buckling and flexural torsional buckling of beams.
- To study various numerical techniques and energy methods for buckling of thin plates.

UNIT I STABILITY OF COLUMNS 9

Fundamental concepts - Elastic structural stability - Structural instability; Analytical methods for the stability analysis, equilibrium, imperfections and energy methods - Non-prismatic columns- Built up columns- Buckling modes - Effect of shear on buckling load - Large deflection theory.

UNIT II METHODS OF ANALYSIS AND INELASTIC BUCKLING 9

Approximate methods - Rayleigh and Galerkin methods - Numerical methods - Finite difference and finite Element; Analysis of columns - Experimental study of column behaviour - South well plot - Column curves - Derivation of column design formula - Effective length of Columns - Inelastic behaviour- Tangent modulus and Double modulus theory

UNIT III BEAM COLUMNS AND FRAMES 9

Beam column behaviour- standard cases- Continuous columns and beam columns - Columns on elastic foundation; Buckling of frames - Single storey portal frames with and without side sway - Classical and stiffness methods - Use of Wood's charts.

UNIT IV BUCKLING OF BEAMS 9

Lateral buckling of beams - Energy method- Application to symmetric and single symmetric I beams - Simply supported and cantilever beams - Narrow rectangular cross sections - Numerical solutions; Torsional buckling - Uniform and non-uniform torsion on open cross section - Flexural torsional buckling - Equilibrium and energy approach.

UNIT V BUCKLING OF THIN PLATES 9

Isotropic rectangular plates - Governing Differential equations - Simply supported on all edges - Use of energy methods -Numerical techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyze both static and dynamic instabilities, by both theoretical and numerical methods.
- execute and work out the inelastic buckling using various methodologies.
- examine the behaviour of beam columns and frames with and without side sway using classical and stiffness methods.
- be well versed in the lateral buckling, torsional buckling, flexural torsional buckling of various beams and non-circular sections.
- evaluate buckling of thin plates using energy methods and various numerical techniques.

REFERENCES

1. Timoshenko, S., and Gere., "Theory of Elastic Stability", McGraw Hill Book Company, 2012.
2. Chajes, A. "Principles of Structural Stability Theory", Prentice Hall, 1974.
3. Ashwini Kumar, "Stability of Structures", Allied Publishers LTD, New Delhi, 2003.
4. Iyenger.N.G.R., "Structural Stability of Columns and Plates", Affiliated East West Press,1988.
5. Gambhir, "Stability Analysis and Design of Structures", springer, New York , 2004.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PSE16653 CRACKS AND CRACK CONTROL IN CONCRETE STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To equip the students with a knowledge of properties and microstructure of concrete.
- To impose a knowledge of various durability and corrosion behavior of concrete.
- To classify the different types of cracks due to any type of force including earthquake force and other factors.
- To have a knowledge of long term effects of cracking.
- To impinge a knowledge of crack detection and crack measuring techniques

UNIT I PROPERTIES OF CONCRETE 9

Historical note on Portland Cement Concrete - Basic properties of plain concrete - Microstructure - Shrinkage, creep and strength of concrete - Temperature effect on concrete; Transport properties of concrete - Tensile, shear, bend and torsional strength of plain and reinforced concrete.

UNIT II DURABILITY OF CONCRETE 9

Durability of concrete causes for inadequate durability of concrete chloride diffusion - Carbonation of concrete - Sulphate attack - Acid attack on concrete - Alkali - Silica reaction - Abrasion resistance - Fire resistance - Erosion resistance - Cavitations - Flame resistance - corrosion resistance - Chemical resistance of concrete and other durability tests methods on concrete.

UNIT III THEORY OF CONCRETE 9

Classifications of cracks in plain and reinforced concrete - Theories of cracking and fundamental mechanics of cracking - Shear cracking, Moment cracking, Torsional cracking - Settlement cracks - Cracks due to force transfer - Cracking due to earthquake forces and cracking due to other factors.

UNIT IV PROPERTIES OF CRACKS 9

Long term effects of cracking - Material and loading effects- Creep effect Bond - Slip theory - Straight line theory - Flexural stiffness - Effective moment of inertia; Computation of deflection due to short term and long term - Computation of crack width and crack spacings.

UNIT V CRACK DETECTION AND CONTROL 9

Crack detection - Crack measuring techniques - Control of cracking in plain and reinforced concrete beams and columns - Crack control by material selection - Crack reduction designs and construction practices - Advanced crack control and repair techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- gain the knowledge of properties and microstructure of concrete.
- get exposed to durability of concrete and corrosion behavior.
- familiarize with advanced knowledge of causes and propagation of cracks.
- understand the long term effects of cracking
- detect various cracks and measuring techniques for the same.

REFERENCES

1. SandorPopovics, " Concrete Materials: Properties, Specifications, and Testing", Noyes Publications, 1992.
2. Prashanthkumar, "Elements of Fracture Mechanics", by Wheeler Publishing Company, New Delhi, 2009
3. Srinath L.S., "Advanced mechanics of Solids", TataMcgraw-hill Publishing Company Ltd, New Delhi, 2009.
4. Parton V.N, Movozov E.M., "Elastic-plastic Fracture Mechanics", Mir publishers Moscow, 1984.
5. Kong F.K. and Evans R.H, "Reinforced and Prestressed Concrete", 3rd Ed- ELBS- Van no strand Reinhold (International), 1998.
6. IS 456 - 2000 Plain and Reinforced Concrete - Code of Practice.
7. SP:16 -1980 Design Aids for Reinforced Concrete to IS:456-1978.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	-	-	1	-	-	-	-	-	-	2	1	2
CO2	2	-	-	-	1	-	-	-	-	-	-	2	1	2
CO3	2	-	-	-	1	-	-	-	-	-	-	2	1	2
CO4	2	-	-	-	1	-	-	-	-	-	-	2	2	2
CO5	2	-	-	-	1	-	-	-	-	-	-	1	2	2

ELECTIVE VII

PSE16751 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To get introduced to composite construction and composite behaviour of steel concrete composite structures.
- To obtain the knowledge to conceptualize and design the composite beams, columns, floors, slabs and concrete filled steel tubes.
- To get introduced to various connections and connection design of composite structures
- To have a knowledge in the behaviour of composite box girder bridges.
- To possess practical knowledge on the skills of composite construction and seismic behaviour of composite structures through case studies.

UNIT I INTRODUCTION 9

Introduction to steel – Concrete composite construction – Behaviour of composite structures – Composite construction

UNIT II DESIGN OF COMPOSITE MEMBERS 9

Design of composite beams - slabs and composite floors - composite columns – Design of composite trusses

UNIT III DESIGN OF CONNECTIONS 9

Types of connections - Design of connections in the composite structures – Shear connections – Degree of shear connection – Partial shear interaction

UNIT IV COMPOSITE BOX GIRDER BRIDGES 9

Introduction – Behaviour of box girder bridges – Design concepts

UNIT V CASE STUDIES 9

Case Studies on steel – Concrete composite construction in buildings – Seismic behaviour of composite structures.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- possess knowledge of the composite behaviour of structures.
- design various composite structural elements such as beams,columns, floors, slabs and concrete filled steel tubes.
- analyse the connection behaviour and design.
- enumerate the behaviour of box girder bridges and the design concepts of the same.
- have practical knowledge of construction and design of various structural elements and design concepts through case studies.

REFERENCES

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications , UK 2008.
2. Oehers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental Behaviour”, Permagon Press, Oxford, 1999.
3. Proceedings of Workshop on “Steel Concrete Composite Structures”, Anna University, 2007.
4. INSDAG Materials , Volume I and II. 2000.
5. BS 5950-1 : 2000 Structural use of steel work in building. Code of practice for design - Rolled and welded sections.
6. EN 1994 Euro code 4 : Design of composite steel and concrete structures, composite slabs.
7. IS11384 - 1985 code of practice for composite construction in structural steel and concrete.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	1	2

PSE16752 MECHANICS OF COMPOSITE MATERIALS 3 0 0 3

COURSE OBJECTIVES

- To describe the composite materials and properties of composite fiber and matrix constituents.
- To state stress strain relation of orthotropic and anisotropic materials.
- To recall the static, dynamic and stability analysis for simpler cases of composite plates.
- To elucidate the failure criterion and fracture mechanism of composites.
- To identify the metal and ceramic composite & design with composites

UNIT I INTRODUCTION 9

Introduction to Composites - Classifying composite materials and their properties - Commonly used fiber and matrix constituents; Composite Construction - Properties of Unidirectional Long Fiber Composites - Short Fiber Composites.

UNIT II STRESS STRAIN RELATIONS 9

Concepts in solid mechanics - Hooke's law for orthotropic and anisotropic materials - Linear Elasticity for Anisotropic materials - rotations of stresses, strains, residual stresses.

UNIT III ANALYSIS OF LAMINATED COMPOSITES 9

Governing equations for anisotropic and orthotropic plates - Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates; Inter laminar stresses.

UNIT IV FAILURE AND FRACTURE OF COMPOSITES 9

Netting analysis - Failure criterion - maximum stress - maximum strain, fracture mechanics of composites; Sandwich construction.

UNIT V APPLICATIONS AND DESIGN 9

Metal and ceramic matrix composites - Applications of composites, composite joints; Design with composites- Review, Environmental issues

TOTAL PERIODS 45

COURSE OUTCOMES

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

- categorize the fibre types and classify the composite material.
- tell the stress –strain properties, longitudinal and transverseproperties of composites lamina.
- analyse the laminated composites and compute the lamina strength.
- locate the failure criterion and fracture mechanics of composites.
- relate the load deformation relation, residual stresses for the design of composites.

REFERENCES

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2006.
2. Jones R.M., "Mechanics of composite materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1998.
3. Agarwal.B.D. and Broutman.L.J., "Analysis and Performance of fiber composites", John-Wiley and Sons, 2006.
4. Michael W.Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw Hill, 2009.

WEB LINKS

1. http://users.fs.cvut.cz/tomas.mares/mkm/mkm.pdf
2. http://www.nptel.ac.in/courses/101104010
3. http://naca.central.cranfield.ac.uk/reports/arc/rm/3677.pdf

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
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CO1	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	2	2

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PSE16753 DESIGN OF POWER PLANT STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To familiar with various planning and lay out of power plants.
- To introduce the design of analysis and design of steel and concrete chimneys.
- To be familiar with cooling towers.
- To understand the design of machine foundations and turbo generator foundations.
- To familiarize with different material handling system

UNIT I POWER PLANTS 9

Planning and Layout of different types of Power plants.

UNIT II CHIMNEYS 9

Analysis and Design of Chimneys - IS codal provisions.

UNIT III COOLING TOWERS 9

Induced draught and natural draught cooling towers.

UNIT IV FOUNDATIONS 9

Machine foundations and Turbo generator foundations. Silos and Bunkers

UNIT V MATERIAL HANDLING STRUCTURES 9

Silos and Bunkers

TOTAL PERIODS 45

COURSE OUTCOMES

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

- formulate the planning and layout of different power plants
- analyse and design chimneys as per codal provisions.
- be efficient in design of cooling towers.
- be familiar with all types of machine foundations.
- design all types of material handling systems.

REFERENCES

1. Krishna Raju N. "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, 2nd Edition, 2008.
2. Srinivasulu, P and Vaidyanathan, G.V., "Handbook of Machine Foundations", Tata McGraw Hill, 2nd Edition, 1999.
3. Vijay K. Puri and ShamsherPrakash, "Foundations for Machines: Analysis and Design (Series in Geotechnical Engineering)", John Wiley & Sons, 2nd Edition, 2000.
4. Eldey Mc. K., Naxey Brooke K.K. "The Industrial Cooling Tower with special reference to design, construction, operation and maintenance of water cooling tower", Elsevier Publishing company, 1st Ed., 1990.
5. IS:9178-1980 - Criteria for Design of Steel Bins for Storage of Bulk Materials.
6. IS:2974 (Part I to V) - Code of practice for design and construction of machine foundations.
7. IS 4995 (Part II) -1974 - General Requirements and assessment of bin Loads.

8. IS 6060 -1971 - Code of practice for Day lighting of factory buildings.
9. IS:456-2000 - Code of Practice for Plain and Reinforced Concrete.
10. IS 6533 (Part 2) -1989 - Code of practice for design and construction of steel chimneys.
11. IS:875 (Part 1 to 5) - Code of Practice for Design loads.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	1	-	1	1	1	-	-	-	1	2	1	1
CO2	2	-	1	-	1	1	1	-	-	-	1	1	1	1
CO3	2	-	1	-	1	1	1	-	-	-	1	2	1	1
CO4	2	-	1	-	1	1	1	-	-	-	1	2	1	1
CO5	2	-	1	-	1	1	1	-	-	-	1	1	1	1