

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 1 PRINCIPLES OF DYNAMICS**9 + 6**

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.

UNIT 2 TWO DEGREE OF FREEDOM SYSTEMS**9 + 6**

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

UNIT 3 DYNAMIC ANALYSIS OF MDOF**9 + 6**

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 4 DYNAMIC ANALYSIS OF CONTINUOUS SYSTEMS**9 + 6**

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 5 PRACTICAL APPLICATIONS**9 + 6**

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

TOTAL : 45 +30 = 75 PERIODS

COURSE OUTCOMES

At the end of this course the student 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”, Dhanpat Rai & Sons, 2001.
5. Madhujit Mukhopadhyay - Structural Dynamics Vibrations and Systems, Ane Books India Publishers, 2010.

WEB LINKS

1. <http://nptel.ac.in/courses/105101006/>
2. <http://freevideolectures.com/Course/3129/Structural-Dynamics#>
3. <http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291096-9845/issues>



PO CO 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	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	2	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

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 1 ELASTICITY**9 + 6**

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

UNIT 2 FORMULATION AND SOLUTION OF ELASTICITY PROBLEMS**9 + 6**

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 3 ENERGY METHODS**9 + 6**

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 4 TORSION**9 + 6**

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 5 INTRODUCTION TO PLASTICITY**9 + 6**

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

TOTAL : 45 + 30 = 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.
- analyse torsion of non-circular sections and thin walled sections.
- solve problems of plasticity.



REFERENCES

1. Timoshenko.S.P and Goodier.J.N, “Theory of Elasticity”, McGraw Hill International Edition, 2010.
2. Sadhu Singh, “Theory of Plasticity”, Khanna Publishers, 2005.
3. Hill.R, “Mathematical theory of Plasticity”, Oxford Publishers 1998.
4. Sadhu Singh, “Theory of Elasticity and Metal Forming Processes”, Khanna Publishers, 2005.
5. Chakrabarthy, “Theory of Plasticity”, McGraw Hill Co., 2006.

WEB LINKS

1. <https://www.vidyarthiplus.com/shop/theory-of-elasticity-and-plasticity-premium-lecture-notes-evangelina-edition.html>
2. https://onderwijsaanbod.kuleuven.be/syllabi/v/e/H08W3AE.htm#activetab=doelstellingen_idp1232512
3. <http://www.faadooengineers.com/threads/10108-Theory-of-elasticity-and-plasticity-full-notes-ebook-free-download-pdf>

PO CO 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

TOTAL : 45 + 30 = 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 kumar jain, Arun Kumar Jain, "Limit state design of Reinforced Concrete", Laxmi Publications (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.

WEB LINKS

1. https://www.youtube.com/watch?v=pIdaC_I6H_M
2. https://en.wikipedia.org/wiki/Reinforced_concrete
3. <http://searchworks.stanford.edu/view/317818>

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



LIST OF ELECTIVES FOR I SEMESTER

PSEE15101

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 1 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 2 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 3 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 4 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 5 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 the 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.
- analyse 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 Distributors, 1990.
3. ManickaSelvam V.K, “Elements of Matrix Stability Analysis of Structures”, Khanna Publishers, 2006.
4. Pandit G.S, Gupta S.P, “Structural Analysis-A matrix Approach”, Tata McGraw Hill Publishing Company Ltd, 2008.
5. C. Natarajan and P.Revathy, “Matrix methods of structural analysis, (Theory and Practice)”, PHI Publications, 2011

WEB LINKS

1. <https://www.youtube.com/watch?v=O1LwyvdZdCc>
2. https://en.wikipedia.org/wiki/Direct_stiffness_method
3. <http://www.pucmmsti.edu.do/websise/estudiante/materias/201220131/ST-IC%20-424-T->

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



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 get an adequate knowledge about the special concretes and their applications in the diverse construction field.
- To study the concrete manufacturing processes, concreting methods and different special formworks.

UNIT 1 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 2 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 3 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 4 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 5 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 the 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.
- use 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. Santhakumar A.R., “Concrete Technology”, Oxford University Press India, 2006.
2. Neville A.M., “Properties of Concrete”, Prentice Hall, 5th Edition 2012.
3. Shetty, M.S., “Concrete Technology: Theory and Practice”, S.Chand and Co. Pvt. Ltd., Delhi, 2005.
4. Pierre-Claude Aitcin, “High Performance Concrete”, Taylor & Francis, 2011.
5. Mary Krumboltz Hurd, “Formwork for Concrete”, American Concrete Institute, 2005.

CODE BOOKS

1. IS:10262-2009, Indian Standard “Concrete Mix Proportioning - Guide Lines” (First Revision).
2. IS:456-2000, Plain and Reinforced Concrete - code of practice (4th Edition).
3. Charts from ACI 211.1-91 - 1991 - American Standard Practice for selecting proportions for normal, heavy weight and mass concrete, ACI Committee 211.
4. Charts from DOE 1988 Teychenne, D C, Franklin, R E and Erntrøy, H C. British Code of Practice for Design of normal concrete mixes, Department of the Environment (DOE), UK, HMSO, 1975 (1988).

WEB LINKS

1. https://en.wikipedia.org/wiki/Advance_Concrete
2. <http://www.concretematerialscompany.com/concrete/>

3. <http://www.engineeringcivil.com/concrete-mix-design-calculations.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
CO2	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO3	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	-	-	-	-	2	2	-	-	-	1	2	-	2



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 1 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 2 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 3 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 4 TECHNIQUES FOR REPAIR AND DEMOLITION 9

Rust eliminators and polymers coating for rebars during repair - foamed concrete, mortar and dry pack - vacuum concrete - Guniting 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 5 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 the 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.
- use 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.

WEB LINKS:

1. <http://theconstructor.org/concrete/design-of-concrete-structures-for-durability/7268/>
2. <http://www.sustainableconcrete.org/?q=node/171>
3. <http://www.concreteconstruction.net/repair/demolition-the-easy-way.aspx>



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	-
CO2	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO3	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO4	2	-	-	-	-	-	-	-	1	-	1	1	1	-
CO5	2	-	-	-	-	-	-	-	1	-	1	1	1	-

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 1 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 2 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 3 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 Penalty function - External Penalty function method.

UNIT 4 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 5 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 the course, the students will be able

- 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.

WEB LINKS

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>

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
C01	2	3	1	2	1	-	-	-	-	-	-	1	2	2
C02	2	3	2	2	1	-	-	-	-	-	-	1	2	2
C03	2	3	2	2	1	-	-	-	-	-	-	1	2	2
C04	2	3	2	2	1	-	-	-	-	-	-	1	2	2
C05	2	2	2	2	1	-	-	-	-	-	-	1	2	2



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 impart knowledge about stability analysis of various systems and to know about advanced topics.

UNIT 1 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 2 BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS**9**

High rise behaviour - Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, 3D analysis, cores, outrigger - braced and hybrid mega systems.

UNIT 3 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 3D analysis in 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 4 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 5 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 student 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 analyzing 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.

REFERENCES

1. Bryan Stafford Smith and Alexcoull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 1991.
2. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGrawHill, 2011."
3. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures- Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
4. Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.

WEB LINKS

1. <http://www.sciencedirect.com/science/article/pii/S0307904X09003813>
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	-	-	-	1	2	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	-	2



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 1 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 2 ELASTIC ANALYSIS OF FLEXURAL MEMBERS 9

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

UNIT 3 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 4 NONLINEAR STATIC AND DYNAMIC ANALYSIS OF PLATES 9

Introduction - Governing non linear 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 non linearity; Introduction - Derivations of governing equations - Circular and noncircular cylindrical shells - Shallow cylindrical shells - Forced nonlinear vibration of shells - Post buckling of shells.

UNIT 5 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.

COURSE OUTCOMES

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

- describe the basic concepts of nonlinearity and its governing equation for various boundary conditions.
- categorize the elastic analysis with various boundary conditions of 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



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 smart materials.
- 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 1 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 2 VIBRATION ABSORBERS 9

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

UNIT 3 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 4 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 5 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 the 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



LIST OF ELECTIVES FOR II SEMESTER

PSEE15201

DESIGN OF SUB STRUCTURES

3 0 0 3

COURSE OBJECTIVES

- To assess the soil condition at a given location in order to suggest suitable foundation based upon bearing capacity.
- To compose the design of different type of shallow foundations like isolated, raft and combined footing.
- To familiarise with the design of pile foundation and pile caps.
- To outline the design of well and caissons foundations.
- To categorize various types of design of tower foundations.

UNIT 1 SITE INVESTIGATION, SELECTION OF FOUNDATION AND BEARING CAPACITY

9

Objectives - Methods of exploration - Depth of exploration - Sample disturbance - Factors governing location and depth of foundation - In situ testing of Soils - Plate load test; Geophysical methods - Selection of foundation - Bearing capacity of shallow foundations by Terzaghi's theory, Meyerhof's theory, and codal provisions - Bearing capacity of footing subjected to inclined and eccentric loading - Problems - Types of shear failure; General principles of foundation design - Foundations on expansive soil.

UNIT 2 DESIGN OF SHALLOW FOUNDATIONS

9

Types of shallow foundations - General principles of design of reinforced concrete shallow foundations; Structural design of isolated and combined footing; Structural design of rafts by conventional method; Principles of design of buoyancy raft and basement (no design problems).

UNIT 3 PILE FOUNDATION

9

Pile foundations - Types - General principles of design - Estimation of load capacity of piles by static and dynamic formulae - Detailing of reinforcement as per IS 2911; Design of Piles and Pile caps - Settlement analysis of pile groups - Negative skin friction - Pile load tests.

UNIT 4 WELL AND CAISSON FOUNDATIONS

9

Well and caisson foundations - Structural elements of Caisson and Well foundations - Elements of well foundation - Forces acting on Caisson and well foundations; Design of individual components of Caisson and well foundation(only forces acting and design principles) - Sinking of well - Shifts and tilts in well foundations - Preventive measures.

UNIT 5 FOUNDATIONS OF TRANSMISSION LINE TOWERS

9

Introduction - Necessary information - Forces on tower foundations - General design criteria - Choice and type of foundation; Design procedure -Types of Foundations - Design of foundation for transmission towers.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

- attain the perception of site investigation to select suitable type of foundation based on soil category.
- be capable of ensuring design concepts of shallow foundation.
- be efficient in selecting suitable type of pile for different soil stratum and in evaluation of group capacity by formulation
- design different types of well foundation.
- deliver the design concepts for transmission line tower foundation

REFERENCES

1. Winterkorn. H. F., and Fang, H. Y., “Foundation Engineering Hand Book - Van Nostrand - Reinhold - 1990.
2. Tomlinson. M.J. and Boorman, R., “Foundation design and construction”, VI edition, ELBS Longman, 2001.
3. Nayak. N.V., “Foundation design manual for practicing engineers”, DhanpatRai and Sons, 1985.
4. Arora. K.R, “Soil Mechanics & Foundation Engineering”, Standard Publishers & Distributors, 2005.
5. “Dynamics of Bases and Foundations” by Barken.McGraw Hill Company.

CODE BOOKS

1. IS 2911 : Part 1 : Sec 1 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles, Section 1 Driven cast in-situ concrete piles
2. IS 2911 : Part 1 : Sec 2 : 1979 Code of practice for design and construction of pile foundations: Part 1

Concrete piles, Section 2 Bored cast-in-situ piles

3. IS 2911 : Part 1 : Sec 3 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles, Section 3 Driven precast concrete piles.
4. IS 2911 : Part 1 : Sec 4 : 1984 Code of practice for design and construction of pile foundations: Part 1 concrete piles, Section 4 Bored precast concrete piles.
5. IS 2911 : Part 2 : 1980 Code of practice for designing and construction of pile foundations: Part 2 Timber piles.
6. IS 2911 : Part 3 : 1980 Code of practice for design and construction of pile foundations: Part 3 Under reamed piles
7. IS 2911 : Part 4 : 1985 Code of practice for design and construction of pile foundations: Part 4 Load test on piles
8. IS 6403 : 1981 Code of practice for determination of bearing capacity of shallow foundations

WEB LINKS

1. <http://theconstructor.org/geotechnical/site-investigation-or-soil-exploration/312/>
2. <http://www.gic-edu.com/908/Distance--Shallow-Foundation-Design-Settlement-Analysis-Workshop-12-PDHs>
3. <http://www.nptel.ac.in/downloads/105104137/>

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	-	-	-	1	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



COURSE OBJECTIVES

- To define the errors in measurement and the principles of measurement using various electronic and physical testing machines.
- To dramatize with vibrating measuring instruments and digital and electronic display using different sensors.
- To define the wind flow measurement and pressure measurement and scale different models using direct model study and indirect model study.
- To measure the distress in concrete structures using various electrical and electronic machineries.
- To test various civil Engineering structures using Non Destructive Testing methodologies.

UNIT 1 FORCES AND STRAIN MEASUREMENT**9**

Choice of Experimental stress analysis methods, errors in measurements - Strain gauge - principle - types, performance and uses- Hydraulic jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of Testing Machines; Long-term monitoring - Vibrating wire sensors - Fibre optic sensors.

UNIT 2 VIBRATION MEASUREMENTS**9**

Characteristics of structural vibrations - Linear variable differential Transformer (LVDT) - Transducers for velocity and acceleration measurements - Vibration meter - Seismographs - Vibration Analyzer - Display and recording of signals - Cathode Ray Oscilloscope - XY Plotter - Chart Plotters - Digital data Acquisition systems.

UNIT 3 ACOUSTICS AND WIND FLOW MEASURES**9**

Principles of Pressure and flow measurements - Pressure transducers - sound level meter - Venturimeter and flow meters - Wind tunnel and its use in structural analysis; Structural modeling - Direct Model Study and Indirect Model study.

UNIT 4 DISTRESS MEASUREMENTS AND CONTROL

9

Diagnosis of distress in structures - Crack observation and measurements - Corrosion of reinforcement in concrete - Half cell, construction and use; Damage assessment - Controlled blasting for demolition - Techniques for residual stress measurements.

UNIT 5 NON DESTRUCTIVE TESTING METHODS

9

Load testing on structures, buildings, bridges and towers - Rebound Hammer - Acoustic emission - Ultrasonic testing principles and application - Holography - Use of laser for structural testing - Brittle coating; Advanced NDT methods - Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR, Ground penetrating radar (GPR).

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

- choose the methodology of measuring errors and strains and calibrate the machineries and equipment used in the laboratory.
- operate various vibration measuring instruments and analyse the structures using digital display unit.
- indicate the model using direct and indirect model analysis (Using Buckingham PI Theorem).
- measure distress in the structures using various electronic equipment.
- employ advanced NDT methods in accessing the load testing of structures.

REFERENCES

1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 1996.
2. Ganesan T.P., “Model Analysis of Structures”, Universities Press (India) Ltd 2005.
3. Dalley .J.W and Riley.W.F, “Experimental Stress Analysis”, McGraw Hill Book Company, N.Y. 1991.
4. Srinath.L.S, Raghavan.M.R, Ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, “Experimental Stress Analysis”, Tata McGraw Hill Company, New Delhi, 1984.
5. Sirohi.R.S., Radhakrishna.H.C, “Mechanical Measurements”, New Age International (P) Ltd. 1997.

WEB LINKS

1. <http://textofvideo.nptel.iitm.ac.in/112106068>
2. <http://nptel.ac.in/downloads/112104039>

3. [http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Environmental%20Air%20Pollution/air%20pollution%20\(Civil\)/Module-2/2.html](http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Environmental%20Air%20Pollution/air%20pollution%20(Civil)/Module-2/2.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



COURSE OBJECTIVES

- To familiarise with graphic primitives, transformations and 2-D drafting of computer graphics.
- To get practiced with computer methods of structural analysis.
- To understand the structural design concepts.
- To be familiar with linear programming and CPM and PERT.
- To inculcate the students with Artificial Intelligence.

UNIT 1 COMPUTER GRAPHICS 9

Graphic primitives - Transformations - Basics of 2-D drafting - Modeling of curves and surfaces; Wire frame modeling - Solid modeling - Graphic standards - Drafting software packages and usage

UNIT 2 STRUCTURAL ANALYSIS 9

Computer aided analysis of steel and RC Structural elements - Application of software.

UNIT 3 STRUCTURAL DESIGN 9

Computer aided design of steel and RC Structural elements - Detailed drawing - Bill of materials

UNIT 4 OPTIMIZATION 9

Application of linear programming - Simplex algorithm - Post-optimality analysis - Project scheduling - CPM and PERT applications

UNIT 5 ARTIFICIAL INTELLIGENCE 9

Introduction - Heuristic search - knowledge based expert systems - Rules and decision tables - Inference mechanisms- Simple applications - Genetic algorithm and applications; Principles of Neural network - Architecture and applications of KBES - Expert system shells.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- be familiar with 2 D drafting and can use drafting software.
- perform structural analysis using analysis package
- design the structures with computer methodologies.
- optimize the structural design with various computer packages and graphics.

- apply artificial intelligence to real life applications.

REFERENCES

1. Krishnamoorthy C.S and Rajeev S., “Computer Aided Design”, Narosa Publishing House, New Delhi, 2005.
2. Groover M.P. and Zimmers E.W. Jr., " CAD/CAM, Computer Aided Design and Manufacturing ", Prentice Hall of India Ltd, New Delhi, 2006.
3. Harrison H.B., “Structural Analysis and Design Vol.I and II”, Pergamon Press, 1991
4. Rao. S.S., " Optimisation Theory and Applications ", Wiley Eastern Limited, New Delhi, 2009.
5. Richard Forsyth (Ed.), “Expert System Principles and Case Studies”, Chapman and Hall, 1996.

WEB LINKS

1. <http://www.colorado.edu/engineering/cas/courses.d/IFEM.d/>
2. <http://link.springer.com/article/10.1007%2Fs40069-012-0027-7#page-1>
3. <http://www.civil.northwestern.edu/people/bazant/PDFs/Papers/S12.pdf>

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



COURSE OBJECTIVES:

- To study the various bridge forms and typical loadings on the bridges.
- To get familiarized with the design of short span bridges.
- To possess knowledge on the design concepts of long span bridges.
- To design the prestressed concrete bridges.
- To understand the concept of designing the substructure for bridges, plate girder to IRC loadings, foundation for bridges and bearings.

UNIT 1	DESIGN PRINCIPLES	9
---------------	--------------------------	----------

General basic bridge forms - Beam, arch, suspension, various types of bridges, selection of type of bridge and economic span length, drainage, road, kerb, classification, investigation and planning; Design loads for bridges - Dead load, live load, IRC loading, IRS loading, Aashto loading, wind load, longitudinal forces, centrifugal forces, buoyancy, water current forces, thermal forces deformation and horizontal forces

UNIT 2 SHORT SPAN BRIDGES 9

Design of culvert, Deck slab bridge - T - Beam girder bridge – Pigeaud's Theory – Courbon's Method

UNIT 3 LONG SPAN BRIDGES 9

Design principles of continuous bridges - Box girder bridges and balanced cantilever bridges.

UNIT 4 DESIGN OF PRESTRESSED CONCRETE BRIDGES 9

Flexural and Torsional parameters – Courbon’s Theory - Distribution Coefficient by exact analysis; Design of girder section - maximum and minimum prestressing forces - Eccentricity - Live load and dead load shear forces - Cable Zone in Girder - Check for stresses at various sections - Check for diagonal tension - Diaphragms - End Block - Short term deflections.

UNIT 5 DESIGN OF PLATE GIRDER BRIDGES , BEARINGS AND SUBSTRUCTURES 9

Design of riveted and welded plate girder bridges - Wind effects - Main section, splicing, curtailment, stiffeners - Different types of bearings - design of bearings - Design of masonry and concrete piers and abutments - Types of bridge foundations - Design of foundations - Footings - Pile foundations.

COURSE OUTCOMES

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

- understand the design theories for super structure and sub structure of bridges
- design short span bridges.
- understand the behaviour of continuous bridges, box girder bridges.
- design prestressed concrete bridges.
- design railway bridges, plate girder bridges, different types of bearings , abutments, piers and various types of foundations for Bridges

REFERENCES

1. Ponnuswamy.S “Bridge Engineering”, Tata McGrawHill, 2008.
2. Johnson Victor.D, “Essentials of Bridge Engineering”, Oxford & IBH, 2007.
3. Jagadeesh T.R. and Jayaram .M.A., “Design of Bridge Structures”, Prentice Hall of India Pvt Ltd., 2004.
4. Raina V.K., “Concrete Bridge Practice”, Tata McGraw Hill Publishing Company, New Delhi, 1994.
5. Bakht.B and Jaegar.L.G., “Bridge Analysis Simplified”, McGraw Hill, 1985.

CODE BOOKS

1. IRC:6-2010 Standard Specifications and Code of Practice for Road Bridges, Section II - Loads and Stresses (Fifth Revision).
2. IRC:18-2000 Design Criteria for Prestressed Concrete Road Bridges (Post-Tensioned Concrete) (Third Revision).
3. IRC:21-2000 Standard Specifications and Code of Practice for Road Bridges, Section III - Cement Concrete (Plain and Reinforced) (Third Revision).
4. IRC:22-2008 Standard Specifications and Code of Practice for Road Bridges, Section VI - Composite Construction (Limit States Design) (Second Revision).
5. IRC:24-2010 Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method)Third Revision).
6. IRC:83-1999 (Part-I) Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part I : Metallic Bearings (First Revision).
7. IRC:83-1987 (Part II) Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part II: Elastomeric Bearings.
8. IRC:83-2002 (Part III) Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part III: POT, POT-CUMPTFE,PIN and Metallic Guide Bearings.

9. Pigeaud's curves

WEB LINKS

1. https://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_brid/cub_brid_lesson02.xml
2. <http://handbook.uts.edu.au/subjects/49131.html>
3. <http://www.britannica.com/technology/bridge-engineering>

CO PO MAPPING:

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



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 1 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 2 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 3 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 4 FAILURE AND FRACTURE OF COMPOSITES**9**

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

UNIT 5 APPLICATIONS AND DESIGN**9**

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

COURSE OUTCOMES

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

- categorize the fibre types and classify the composite material.
- tell the stress -strain properties, longitudinal and transverse properties of composites lamina.
- analyze 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.
5. Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, University Press, India, 2005.

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														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	3	-	-	2	-	-	-	-	-	1	3	-
CO3	3	2	2	-	2	-	-	-	-	-	-	1	3	-
CO4	3	2	2	-	2	-	-	-	-	-	-	1	3	-
CO5	3	2	2	-	-	-	-	-	-	-	-	1	3	-

COURSE OBJECTIVES:

- To create awareness of the necessity of energy needed for structures.
- To study the different climate types and their influence in building design.
- To focus on the thermal environment of structures
- To equip the knowledge of appliances and their utilisation in buildings.
- To elucidate the energy audit systems in buildings.

UNIT 1 ENERGY EFFICIENT CONCEPTS 9

Need of energy in buildings - assessment - Energy consumption pattern of various types of buildings - Factors influencing the energy use in building - Concepts of energy efficient building.

UNIT 2 CLIMATE 9

Study of Climate types - their influence in building design - Environmental factors affecting building design; Analysis of thermal and visual environment.

UNIT 3 HEAT AND LIGHT 9

Heat gain and loss phenomenon in buildings - Thermal performance parameters - Role of building enclosures, openings and materials in thermal environment; Basic principles of light and daylight - Energy efficient light design of buildings – Daylight design of buildings.

UNIT 4 APPLIANCES IN BUILDINGS 9

Major appliances in building and their energy consumptions - Principles of solar heating, cooling and power (PV) systems - Integration of energy efficient appliances with the buildings.

UNIT 5 ENERGY AUDIT 9

Energy survey and energy audit of buildings - Calculation of energy inputs and utilization in buildings - Energy audit reports of buildings; Concepts of Green Buildings - energy rating of buildings.

TOTAL:45 PERIODS

COURSE OUTCOMES

At the end of the course, the student will be able to

- get introduced to various energy consumptions
- master the climate and environmental factors affecting building design.
- gain knowledge of design of buildings according to thermal environment.
- acquire the skills of utilization of appliances and the principles behind them.
- obtain the knowledge of energy audit in buildings

REFERENCE BOOKS

1. Chand, I. and Bhargava,P.K., “The Climatic Data Handbook”, Tata McGraw Hill Publishing Company Limited, New Delhi 1999.
2. Threlkeld, J.L,”Thermal Environmental Engineering”, Printice-Hall, Englewood Cliffs, NJ, 1998.
3. Lal Jayamaha, “Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance”, McGraw Hill, 2007.
4. Krishnan, A., Baker, N., Yannas, S. and Szokolay, S.V., “Climate Responsive Architecture - A Design Hand Book for Energy Efficient Buildings”, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2001.
5. Shahin Vassigh, Jason R. Chandler, “Building Systems Integration for Enhanced Environmental Performance” J. Ross Publishing, 2011.

CODE BOOK

1. Handbook on functional requirements of buildings”, Parts 1-4, SP: 41 (S&T), Bureau of Indian Standards - 1995.

WEB LINKS

1. https://en.wikipedia.org/wiki/Green_building
2. <https://www.wbdg.org/resources/efficientlighting.php>
3. <http://www.institutebe.com/Green-Net-Zero-Buildings/renewable-energy-advantages.aspx>

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



COURSE OBJECTIVES

The main objective of this course is

- to know the various types of disaster caused by the nature and disaster prone areas in India.
- to have a knowledge about the response of the structure for various disaster.
- to obtain a brief knowledge about the planning and preparedness for a disaster.
- to know about the various modern materials and tools used in disaster reduction.
- to have knowledge about the various organizations involved in disaster management.

UNIT 1 DISASTER

9

Introduction - Types of disasters - Disaster mitigating agencies and their organization structure at different levels - Overview of disaster situations in India; Vulnerability profile of India and vulnerability mapping including disaster prone areas, communities and places.

UNIT 2 RESPONSE OF THE STRUCTURE

9

Philosophy for design to resist Earthquake, Cyclone and flood -By-laws of urban and Semi-Urban areas-
Traditional and modern structures; Response of dams, bridges, buildings - Testing and evaluation -
Classification of structures from safety point of view; Methods of strengthening for different disasters -
Qualification test.

UNIT 3 SEISMIC VULNERABILITY OF URBAN AREAS

9

Seismic response of R.C frames buildings with soft first storey - Preparedness and planning for an urban earthquake disaster - Tsunami and its impact - Urban settlements.

UNIT 4 MODERN MATERIALS AND TECHNIQUES

9

Use of modern materials their impact on disaster reduction - Use of modern analysis, design and construction techniques - Optimization for performance - Damage surveys; Maintenance and modifications to improve hazard resistance - Different types of foundation and its impact on safety.

UNIT 5 DISASTER MANAGEMENT

9

Landslide hazards zonation mapping - Geo-environmental problems associates with the occurrence of

landslides - Role of remote sensing, science and technology; Rehabilitation programmes - Management of Relief Camp - information systems and decision making tools, voluntary agencies and community participation - various stages of disaster Management.

TOTAL :45 PERIODS

COURSE OUTCOMES

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

- know the various disasters, their characteristics, causes and impacts.
- know about the strengthening of structures by various methods which was affected by the disaster.
- understand the response of building with soft first storey.
- use of various modern methodology and tools to reduce destructions.
- have a brief knowledge about disaster mitigating agencies.

REFERENCES

1. Allen, R.T. and Edwards, S.C., “Repair of Concrete Structures”, Blakie and Sons, 2005.
2. Moskvina V, “Concrete and Reinforced Structures - Deterioration and Protection”, Mir Publishers, Moscow, 1983.
3. Singh R.B, “Disaster Management”, Rawat Publications, 2000.
4. Sachindra Narayan, “Anthropology of Disaster management”, Gyan Publishing house, 2000.
5. Harsh K Gupta, “Disaster Management”, Orient Blackswan Pvt. Ltd., 2003

CODE BOOKS

1. IS 1893 : 2002 (Part 1) - Criteria for Earthquake Resistant Design of Structures - General.
2. IS 4326 : 1993 - Code of Practice for Earthquake Resistant Design and Construction of Buildings .

WEB LINKS

1. https://en.wikipedia.org/wiki/Emergency_management
2. <http://www.wcpt.org/disaster-management/what-is-disaster-management>
3. <http://www.slideshare.net/chaitanyakorra/disaster-resistant-architecture>

CO PO MAPPING:

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



II SEMESTER

PSE15201

ADVANCED STRUCTURAL STEEL DESIGN

3 2 0 4

COURSE OBJECTIVES

- To study the concept of limit state design, working stress design and design philosophies of tension and compression members.
- To study 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 study the design concepts of light gauge steel structures.

UNIT 1 DESIGN METHODOLOGIES

9+6

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 2 DESIGN OF CONNECTIONS

9+6

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.

UNIT3 TORSION MEMBERS

9+6

Introduction - uniform torsion - non uniform torsion - torsion design - torsion and bending - distortion.

UNIT 4 PLASTIC ANALYSIS OF STRUCTURES

9+6

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 5 DESIGN OF LIGHT GAUGE STEEL STRUCTURES

9+6

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 :45+30 = 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.
- have an exposure to design steel structures subjected to torsion.
- design for plasticity.
- perform design of 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” , Mc GrawHill 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

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



COURSE OBJECTIVES

- To make the students to understand the concepts of Engineering seismology
- To analyse building for earthquake forces and introduce design concepts
- To explain the design guidelines for earthquake resistant masonry and earthen buildings
- To analyse rigid frames and shear wall for earthquake loading
- To have knowledge on vibration control techniques

UNIT 1 EARTHQUAKE GROUND MOTION**9 + 6**

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 2 EARTHQUAKE ANALYSIS AND DESIGN CONCEPTS**9 + 6**

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 3 EARTHQUAKE DESIGN OF MASONRY BUILDINGS**9 + 6**

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

UNIT 4 EARTHQUAKE DESIGN OF RC STRUCTURES**9 + 6**

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

UNIT 5 SPECIAL TOPICS**9 + 6**

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

TOTAL : 45 + 30 = 75 PERIODS

COURSE OUTCOMES

At the end of the 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 of India 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.

WEB LINKS

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>

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	2	-



COURSE OBJECTIVES

- To analyse various systems of prestressing using basic principles.
- To design flexural members for shear, bond and torsion and end blocks.
- To analyse 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 analyse and design composite section and prestressed concrete bridges.

UNIT 1 PRINCIPLES AND BEHAVIOUR OF PRESTRESSING 9+6

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

UNIT 2 DESIGN OF FLEXURAL MEMBERS 9+6

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 3 DESIGN OF CONTINUOUS BEAMS 9+6

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

UNIT 4 DESIGN OF TENSION AND COMPRESSION MEMBERS 9+6

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 5 DESIGN OF PRESTRESSED CONCRETE BRIDGES 9+6

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 : 45+30 = 75 PERIODS

COURSE OUTCOMES

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

- explain the principle, types and systems of prestressing and analyse the deflections.
- determine the flexural strength and design the flexural members, end blocks.
- analyse the statically indeterminate structures and design the continuous beam.
- design the tension and compression members and apply it for design of piles.
- analyse 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”, Chapman 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:

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	-	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



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 1 FORMULATION OF BOUNDARY VALUES**9 + 6**

Basic steps in finite element analysis - Boundary value problems - Approximate solutions - Variational and weighted 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 2 STRESS ANALYSIS**9 + 6**

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 3 MESHING AND SOLUTION**9 + 6**

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

UNIT 4 DYNAMIC ANALYSIS**9 + 6**

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 eigen value problems - Vector iteration methods - Normal modes - Transient vibrations - Modeling of damping - Direct integration methods

UNIT 5 PLATE AND SHELL ELEMENTS

9 + 6

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 : 45 + 30 = 75 PERIODS

COURSE OUTCOMES

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

- develop finite element formulations of 1 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.
- perform modal analysis to 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>

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



COURSE OBJECTIVES

- To design concrete mixes and study strength properties of concrete.
- To perform advanced laboratory experiments that emphasize the structure-property relationship, 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

COURSE OUTCOMES

At the end of the 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.

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



LABORATORY EQUIPMENTS REQUIREMENTS

1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring
6. Demec Gauge
7. Electrical Strain Gauge with indicator
8. Rebound Hammer
9. Ultrasonic Pulse Velocity Tester
10. Dial Gauges
11. Clinometer
12. Vibration Exciter
13. Vibration Meter
14. FFT Analyser

OUTCOMES:

- On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behaviour.
- They will be able to test dynamic testing on steel beams, static cyclic load testing of RC frames and non-destruction testing on concrete.

REFERENCES:

1. Dally J W, and Riley W F, "Experimental Stress Analysis", McGraw-Hill Inc. New York, 1991.

ST8311

PRACTICAL TRAINING

L T P C
0 0 0 1

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.

OUTCOME:

- They are trained in tackling a practical field/industry orientated problem related to Structural Engineering.

ST8312

PROJECT WORK PHASE I

L T P C
0 0 12 6

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- 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: 180 PERIODS

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

ST8313

SEMINAR

L T P C
0 0 2 1

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: 30 PERIODS

OUTCOME:

- The students will be trained to face an audience and to tackle any problem during group discussion in the Interviews.

ST8411

PROJECT WORK PHASE II

L T P C
0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and 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: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

ST8001

ANALYSIS AND DESIGN OF TALL BUILDINGS

L T P C
3 0 0 3

OBJECTIVE:

- To study the behaviour, analysis and design of tall structures.

Masonry Structures: Discoloration and weakening of stones – Biotical treatments – Preservation – Chemical preservatives – Brick masonry structures – Distresses and remedial measures.

UNIT V STRENGTHENING OF EXISTING STRUCTURES

9

General principle – relieving loads – Strengthening super structures – plating – Conversion to composite construction – post stressing – Jacketing – bonded overlays – Reinforcement addition – strengthening the substructures – under pinning – Increasing the load capacity of footing – Design for rehabilitation.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course students will be in a position to point out the causes of distress in concrete, masonry and steel structures and also they will be able to suggest the remedial measures.

REFERENCES:

1. Allen R.T and Edwards S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987
2. Dayaratnam.P and Rao.R, "Maintenance and Durability of Concrete Structures", University Press, India, 1997.
3. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical, UK, 1991.
4. Dodge Woodson.R,"Concrete Structures – protection, repair and rehabilitation", Elsevier Butterworth – Heinmann, UK, 2009.
5. Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications Pvt. Ltd., 2001.
6. Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" – Rand D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.

ST8008

MECHANICS OF COMPOSITE MATERIALS

**L T P C
3 0 0 3**

OBJECTIVE:

- To study the behaviour of composite materials and to investigate the failure and fracture characteristics.

UNIT I INTRODUCTION

9

Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites and 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, Interlaminar 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: 45 PERIODS

OUTCOME:

- On completion of this course students will have sufficient knowledge on behavior of various composite materials and they have an idea of failure and fracture mechanisms.

REFERENCES:

- Agarwal.B.D., Broutman.L.J., and Chandrashekara.K. "Analysis and Performance of Fiber Composites", John-Wiley and Sons, 2006.
- Daniel.I.M., and Ishai.O, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
- Hyer M.W., and White S.R., "Stress Analysis of Fiber-Reinforced Composite Materials", D.Estech Publications Inc., 2009
- Jones R.M., "Mechanics of Composite Materials", Taylor and Francis Group 1999.
- Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", Universities Press, India, 2005.

ST8009**NONLINEAR ANALYSIS OF STRUCTURES****L T P C
3 0 0 3****OBJECTIVE:**

- To study the concept of nonlinear behaviour and analysis of elements and simple structures.

UNIT I INTRODUCTION TO NONLINEAR ANALYSIS 9

Material nonlinearity, geometric nonlinearity; statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

UNIT II 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 III VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS 9

Vibration theory and analysis of flexible members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading

UNIT IV ELASTIC AND INELASTIC ANALYSIS OF PLATES 9

Elastic and inelastic analysis of uniform and variable thickness plates

UNIT V NONLINEAR VIBRATION AND INSTABILITY 9

Nonlinear vibration and Instabilities of elastically supported beams.

TOTAL: 45 PERIODS**OUTCOMES:**

- At the end of this course student will have enough knowledge on inelastic and vibration analysis of Flexural members.
- Also they will know the difference between elastic and inelastic analysis of plates and Instabilities of elastically supported beams.

REFERENCES:

- Fertis, D.G, "Nonlinear Mechanics", CRC Press, 1999.
- Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press, 2008.
- Sathyamoorthy.M, "Nonlinear Analysis of Structures", CRC Press, 2010.

OBJECTIVE:

- To study the concept of wave theories, forces and design of jacket towers, pipes and cables.

UNIT I WAVE THEORIES

9

Wave generation process, small, finite amplitude and nonlinear wave theories.

UNIT II FORCES OF OFFSHORE STRUCTURES

9

Wind forces, wave forces on small bodies and large bodies - current forces and use of Morison equation.

UNIT III OFFSHORE SOIL AND STRUCTURE MODELLING

9

Different types of offshore structures, foundation modeling, fixed jacket platform structural modeling.

UNIT IV ANALYSIS OF OFFSHORE STRUCTURES

9

Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V DESIGN OF OFFSHORE STRUCTURES

9

Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipe lines.

TOTAL: 45 PERIODS**OUTCOME:**

- On completion of this course students will be able to determine the forces due to ocean waves and analyze and design offshore structures like platform, helipads, jackets, towers etc.,

REFERENCES:

- API RP 2A-WSD, "Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design" - API Publishing Services, 2005
- Chakrabarti, S.K., Handbook of "Offshore Engineering" by, Elsevier, 2005.
- Chakrabarti, S.K., "Hydrodynamics of Offshore Structures", WIT press, 2001.
- Dawson.T.H., "Offshore Structural Engineering", Prentice Hall Inc Englewood Cliffs, N.J. 1983.
- James F. Wilson, "Dynamics of Offshore Structures", John Wiley & Sons, Inc, 2003.
- Reddy, D.V. and Arockiasamy, M., "Offshore Structures", Vol.1 and Vol.2, Krieger Publishing Company, 1991.
- Turgut Sarpkaya, "Wave Forces on Offshore Structures", Cambridge University Press, 2010.

PROGRESS THROUGH KNOWLEDGE

OBJECTIVE:

- To study the optimization methodologies applied to structural engineering

UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES

9

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Kuhn - Tucker Criteria).

Attested

Sahana
DIRECTOR

UNIT II LINEAR AND NON-LINEAR PROGRAMMING 9

LINEAR PROGRAMMING: 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.

NON LINEAR PROGRAMMING: One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

UNIT III GEOMETRIC PROGRAMMING 9

Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty.

UNIT IV DYNAMIC PROGRAMMING 9

Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods.

UNIT V STRUCTURAL APPLICATIONS 9

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design of R.C. structures such as multistorey buildings, water tanks and bridges.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course students will have sufficient knowledge on various optimization techniques like linear programming, non-linear programming, geometric and dynamic programming and they will also in a position to design various structural elements for minimum weight.

REFERENCES:

- Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
- Rao,S.S. "Optimization theory and applications", Wiley Eastern (P) Ltd., 1984
- Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
- Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981

ST8012

PRE-STRESSED CONCRETE

**L T P C
3 0 0 3**

OBJECTIVE:

- Principle of prestressing, analysis and design of prestressed concrete structures.

UNIT I PRINCIPLES OF PRESTRESSING 9

Basic concepts of Prestressing - Types and systems of prestressing - Need for High Strength materials, Analysis methods, losses of prestress – Short and Long term deflections – Cable layouts.

UNIT II DESIGN OF FLEXURAL MEMBERS 9

Behaviour of flexural members, determination of ultimate flexural strength – Various Codal provisions - Design of flexural members, Design for shear, bond and torsion. Transfer of prestress. Block design and cantilever beams.

UNIT III	DESIGN OF CONTINUOUS AND CANTILEVER BEAMS	9
Analysis and design of continuous beams - Methods of achieving continuity - concept of linear transformations, concordant cable profile and gap cables – Analysis and design of cantilever beams.		
UNIT IV	DESIGN OF TENSION AND COMPRESSION MEMBERS	9
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 - its application in the design piles, flag masts and similar structures.		
UNIT V	DESIGN OF COMPOSITE MEMBERS	9
Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.		

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of this course students will have sufficient knowledge on various methods of prestressing and the concepts of partial pre-stressing.
- They will be in a position to design beams, pipes, water tanks, posts and similar structures.

REFERENCES:

1. Arthur H. Nilson, "Design of Prestressed Concrete", John Wiley and Sons Inc, New York, 2004.
2. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co., New Delhi, 2008.
3. Lin.T.Y.,and Burns.H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, New York, 2009.
4. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi, 2008.
5. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Co., 1998.

ST8013	PREFABRICATED STRUCTURES	L T P C 3 0 0 3
---------------	---------------------------------	----------------------------------

OBJECTIVE:

- To Study the design principles, analysis and design of elements.

UNIT I	DESIGN PRINCIPLES	9
General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and code provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls.		
UNIT II	REINFORCED CONCRETE	9
Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column and column to column.		
UNIT III	FLOORS, STAIRS AND ROOFS	9
Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.		
UNIT IV	WALLS	9
Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.		

UNIT V INDUSTRIAL BUILDINGS AND SHELL ROOFS**9**

Components of single-storey industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hyper-prefabricated shells, Erection and jointing, joint design, hand book based design.

TOTAL: 45 PERIODS**OUTCOMES:**

- At the end of this course student will have good knowledge about the prefabricated elements and the technologies used in fabrication and erection.
- They will be in a position to design floors, stairs, roofs, walls and industrial buildings, and various joints for the connections.

REFERENCES:

1. Koncz.T., "Manual of Precast Concrete Construction", Vol.I II and III & IV Bauverlag, GMBH, 1971.
2. Laszlo Mokka, "Prefabricated Concrete for Industrial and Public Structures", Akademiai Kiado, Budapest, 2007.
3. Lewicki.B, "Building with Large Prefabricates", Elsevier Publishing Company, Amsterdam/ London/New York, 1998.
4. "Structural Design Manual", Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland Betor Verlag, 2009.
5. Warszawski, A., "Industrialization and Robotics" in Building - A managerial approach, Harper and Row, 1990.

ST8014**STABILITY OF STRUCTURES****L T P C**
3 0 0 3**OBJECTIVE:**

- To study the concept of buckling and analysis of structural elements.

UNIT I BUCKLING OF COLUMNS**9**

States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

UNIT II BUCKLING OF BEAM-COLUMNS AND FRAMES**9**

Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Use of stability function to determine the critical load.

UNIT III TORSIONAL AND LATERAL BUCKLING**9**

Torsional buckling - Combined Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported and cantilever beams.

UNIT IV BUCKLING OF PLATES**9**

Governing differential equation - Buckling of thin plates, various edge conditions -Analysis by equilibrium and energy approach - Finite difference method.

UNIT V INELASTIC BUCKLING**9**

Double modulus theory - Tangent modulus theory - Shanley's model - Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course student will know the phenomenon of buckling and they are in a position to calculate the buckling load on column, beam – column, frames and plates using classical and approximate methods.

REFERENCES:

- Ashwini Kumar, "Stability Theory of Structures", Allied publishers Ltd., New Delhi, 2003.
- Chajes, A. "Principles of Structures Stability Theory", Prentice Hall, 1974.
- Gambhir, "Stability Analysis and Design of Structures", springer, New York, 2004.
- Simitser.G.J and Hodges D.H, "Fundamentals of Structural Stability", Elsevier Ltd., 2006.
- Timoshenko.S.P, and Gere.J.M, "Theory of Elastic Stability", McGraw Hill Book Company, 1963.

ST8015**THEORY OF PLATES****L T P C
3 0 0 3****OBJECTIVE:**

- To study the behaviour and analysis of thin plates and the behaviour of anisotropic and thick plates.

UNIT I INTRODUCTION TO PLATES THEORY 9

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT II RECTANGULAR PLATES 9

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation.

UNIT III CIRCULAR PLATES 9

Symmetrical bending of circular plates.

UNIT IV SPECIAL AND APPROXIMATE METHODS. 9

Energy methods, Finite difference and Finite element methods.

UNIT V ANISOTROPIC PLATES AND THICK PLATES 9

Orthotropic plates and grids, moderately thick plates.

TOTAL: 45 PERIODS**OUTCOMES:**

- At the end of this course students will be able to analyze different types of plates (rectangular and circular) under different boundary connections by various classical methods and approximate methods.
- They will also know behavior of orthotropic and thick plates and grids.

REFERENCES:

- Ansel C.Ugural, "Stresses in plate and shells", McGraw Hill International Edition, 1999.
- Bairagi, "Plate Analysis", Khanna Publishers, 1996.
- Chandrashekhara, K. "Theory of Plates", University Press (India) Ltd., Hyderabad, 2001.
- Reddy J N, "Theory and Analysis of Elastic Plates and Shells", McGraw Hill Book Company, 2006.
- Szilar, R., "Theory and Analysis of Plates – classical and numerical methods, Prentice Hall Inc., 2004.
- Timoshenko.S.P, and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 2003.

OBJECTIVE:

- To study the concept of wind and cyclone effects for the analysis and design of structures.

UNIT I INTRODUCTION

9

Introduction, Types of wind – Characteristics of wind – Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects - Dynamic nature of wind – Pressure and suctions - Spectral studies, Gust factor.

UNIT II WIND TUNNEL STUDIES

9

Wind Tunnel Studies, Types of tunnels, - Prediction of acceleration – Load combination factors – Wind tunnel data analysis – Calculation of Period and damping value for wind design - Modeling requirements, Aero dynamic and Aero-elastic models.

UNIT III EFFECT OF WIND ON STRUCTURES

9

Classification of structures – Rigid and Flexible – Effect of wind on structures - Static and dynamic effects on Tall buildings – Chimneys.

UNIT IV DESIGN OF SPECIAL STRUCTURES

9

Design of Structures for wind loading – as per IS, ASCE and NBC code provisions – design of Tall Buildings – Chimneys – Transmission towers – Industrial sheds

UNIT V CYCLONE EFFECTS

9

Cyclone effect on – low rise structures – sloped roof structures - Tall buildings. Effect of cyclone on claddings – design of cladding – use of code provisions in cladding design – Analytical procedure and modeling of cladding.

TOTAL: 45 PERIODS**OUTCOMES:**

- On completion of this course, students will be able to design high rise structures subjected wind load, even structures exposed to cyclone.
- Students will be conversant with various code provisions for the design of structures for wind load.

REFERENCES:

- Cook.N.J., "The Designer's Guide to Wind Loading of Building Structures", Butterworths, 1989.
- Kolousek.V, Pirner.M, Fischer.O and Naprstek.J,"Wind Effects on Civil Engineering Structures", Elsevier Publications, 1984
- Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers, London, 1980.
- Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1972.

OBJECTIVE :

- To study the properties of concrete making materials, tests, mix design, special concretes and various methods for making concrete.

UNIT I CONCRETE MAKING MATERIALS

9

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, Testing of aggregates. Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, special cements. Water Chemical admixtures, Mineral admixture.

Attested


DIRECTOR

 Centre For Academic Courses
 Anna University, Chennai-600 025.

UNIT II TESTS ON CONCRETE 9
Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage – Durability of concrete.

UNIT III MIX DESIGN 9
Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method – Statistical quality control – Sampling and acceptance criteria.

UNIT IV SPECIAL CONCRETE 9
Light weight concrete, Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete – High performance concrete. High performance fiber reinforced concrete, Self-Compacting-Concrete, Geo Polymer Concrete, Waste material based concrete – Ready mixed concrete.

UNIT V CONCRETING METHODS 9
Process of manufacturing of concrete, methods of transportation, placing and curing. Extreme weather concreting, special concreting methods. Vacuum dewatering – Underwater Concrete.

TOTAL : 45 PERIODS

OUTCOME:

- On completion of this course the students will know various tests on fresh, hardened concrete, special concrete and the methods of manufacturing of concrete.

REFERENCES:

1. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
2. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2010.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Santhakumar.A.R. ;"Concrete Technology",Oxford University Press,2007.
5. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2003.

