KUMARAGURU COLLEGE OF TECHNOLOGY

(Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM

(REGULATIONS 2015)

I to IV Semester

M.E. Structural Engineering

Department of Civil Engineering

Department of Civil Engineering

Vision

Department of Civil Engineering is striving to become as a world class Academic Centre for quality education and research in diverse areas of Civil Engineering, with a strong social commitment.

Mission

Mission of the department is to achieve International Recognition by:

- Producing highly competent and technologically capable professionals and motivated young academicians.
- Providing quality education in undergraduate and post graduate levels, with strong emphasis on professional ethics and social commitment.
- Developing a scholastic environment for the state – of –art research, resulting in practical applications.
- Undertaking professional consultancy services in diverse areas of Civil Engineering.

Kumaraguru College of Technology
Coimbatore – 641 049
Regulation 2015

CBCS – PG Curriculum

M.E. Structural Engineering

Foundation Courses (FC)							
S. No.	**Course Code**	**Course Title**	**Periods /Wk & Credits**				**Preferred Semester**
			L	**T**	**P**	**C**	
1.	P15MAT101	Applied Mathematics for Structural Engineers	3	2	0	4	1

Professional Core (PC)							
S. No.	**Course Code**	**Course Title**	**Periods /Wk &Credits**				**Preferred Semester**
			L	**T**	**P**	**C**	
1.	P15SET101	Theory of Elasticity and Plasticity	3	0	0	3	1
2.	P15SET102	Matrix Methods of Structural Analysis	3	2	0	4	1
3.	P15SET103	Advanced Reinforced Concrete Structures	3	0	0	3	1
4.	P15SET104	Structural Dynamics	3	2	0	4	1
5.	P15SEP101	Computer Applications Laboratory	0	0	2	1	1
6.	P15SET201	Finite Element Analysis	3	2	0	4	1
7.	P15SET202	Design of Substructures	3	0	0	3	2
8.	P15SET203	Advanced Steel Structures	3	0	0	3	2
9.	P15SET204	Aseismic Design of Structures	3	0	0	3	2
10.	P15SEP201	Structural Engineering Laboratory	0	0	2	1	2
11.	P15SET301	Stability of Structures	3	0	0	3	3

Professional Electives (PE)							
S. No.	**Course Code**	**Course Title**	**Periods /Wk & Credits**				**Preferred Semester**
			L	**T**	**P**	**C**	
1	P15SETE11	CAAD for Structures	3	0	0	3	1
2	P15SETE12	Advanced Concrete Technology	3	0	0	3	1
3	P15SETE13	Wind and Cyclone effects on Structures	3	0	0	3	1
4	P15SETE14	Optimization in Structural Design	3	0	0	3	1
5	P15SETE15	Pre-stressed Concrete	3	0	0	3	2
6	P15SETE16	Soil Structure Interaction	3	0	0	3	2
7	P15SETE17	Design of Plates, Shells and Spatial Structures	3	0	0	3	2
8	P15SETE18	Design of Bridges	3	0	0	3	3
9	P15SETE19	Design of Steel Concrete Composite Structures	3	0	0	3	3
10	P15SETE20	Design of Tall Buildings	3	0	0	3	3
11	P15SETE21	Experimental Methods and Model Analysis	3	0	0	3	3
12	P15SETE22	Design of Structures for Dynamic Loads	3	0	0	3	3
13	P15SETE23	Design of Offshore Structures	3	0	0	3	3
14	P15SETE24	Maintenance and Rehabilitation of Structures	3	0	0	3	3
15	P15SETE25	Research Methodology	3	0	0	3	3
16	P15SETE26	Constitutive Models and Modes of Failure	3	0	0	3	3
17	P15SETE27	Design of Industrial Structures	3	0	0	3	3

Employability Enhancement Courses (EEC)							
S. No.	**Course Code**	**Course Title**	**Periods /Wk & Credits**				**Preferred Semester**
			L	**T**	**P**	**C**	
1.	P15SEP301	Project Work - Phase I	0	0	12	6	3
2.	P15SEP401	Project Work - Phase II	0	0	24	12	4
3.	P15SEP102	Technical Seminar	0	0	2	1	1
4.	P15SEP202	Industrial Training	0	0	0	1	2

SEMESTER – I

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
Theory								
1.	P15MAT101	Applied Mathematics for Structural Engineers	FC	60	3	2	0	4
2.	P15SET101	Theory of Elasticity and Plasticity	PC	45	3	0	0	3
3.	P15SET102	Matrix Methods of Structural Analysis	PC	60	3	2	0	4
4.	P15SET103	Advanced Reinforced Concrete Structures	PC	45	3	0	0	3
5.	P15SET104	Structural Dynamics	PC	60	3	2	0	4
6.	E1	Elective I	PE	45	3	0	0	3
Practicals								
7.	P15SEP101	Computer Applications Laboratory	PC	20	0	0	2	1
8.	P15SEP102	Technical Seminar	EEC	20	0	0	2	1
Total credits								
								23

SEMESTER – II

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
Theory								
1.	P15SET201	Finite Element Analysis	PC	60	3	2	0	4
2.	P15SET202	Design of Substructures	PC	45	3	0	0	3
3.	P15SET203	Advanced Steel Structures	PC	45	3	0	0	3
4.	P15SET204	Aseismic Design of Structures	PC	45	3	0	0	3
5.	E2	Elective II	PE	45	3	0	0	3
6.	E3	Elective III	PE	45	3	0	0	3
Practicals								
7.	P15SEP201	Structural Engineering Laboratory	PC	20	0	0	2	1
8.	P15SEP202	Industrial Training*	EEC	0	0	0	0	1
***** Training at the industries for 2 weeks during summer holidays at the end of second semester								
Total credits								
								21

SEMESTER – III

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
Theory								
1.	P15SET301	Stability of Structures	PC	45	3	0	0	3
2.	E4	Elective IV	PE	45	3	0	0	3
3.	E5	Elective V Self-Study	PE	0	0	0	0	3
Practicals								
4.	P15SEP301	Project Work - Phase I	EEC				12	6
Total credits								
								15

SEMESTER – IV

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
Practicals								
1.	P15SEP401	Project Work - Phase II	EEC				24	12
Total credits								
								12

Electives

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
1.	P15SETE11	CAAD for Structures	PE	45	3	0	0	3
2.	P15SETE12	Advanced Concrete Technology	PE	45	3	0	0	3
3.	P15SETE13	Wind and Cyclone effects on Structures	PE	45	3	0	0	3
4.	P15SETE14	Optimization in Structural Design	PE	45	3	0	0	3
5.	P15SETE15	Pre-stressed Concrete	PE	45	3	0	0	3
6.	P15SETE16	Soil Structure Interaction	PE	45	3	0	0	3
7.	P15SETE17	Design of Plates, Shells and Spatial Structures	PE	45	3	0	0	3
8.	P15SETE18	Design of Bridges	PE	45	3	0	0	3
9.	P15SETE19	Design of Steel Concrete Composite Structures	PE	45	3	0	0	3
10.	P15SETE20	Design of Tall Buildings	PE	45	3	0	0	3
11.	P15SETE21	Experimental Methods and Model Analysis	PE	45	3	0	0	3

12.	P15SETE22	Design of Structures for Dynamic Loads	PE	45	3	0	0	3
13.	P15SETE23	Design of Offshore Structures	PE	45	3	0	0	3
14.	P15SETE24	Maintenance and Rehabilitation of Structures	PE	45	3	0	0	3
15.	P15SETE25	Research Methodology	PE	45	3	0	0	3
16.	P15SETE26	Constitutive Models and Modes of Failure	PE	45	3	0	0	3
17.	P15SETE27	Design of Industrial Structures	PE	45	3	0	0	3

One Credit Courses

Sl.No	Course Code	Course Title	Industry that will offer the course
1.	P15SEIN01	Traditional Architecture	Temple Sthapati
2.	P15SEIN02	Form work and Scaffolding	Structural Consultants
3.	P15SEIN03	Health monitoring of structures	Structural Consultants
4.	P15SEIN04	Building Energy Audit	Green Building Consultants

Department of Civil Engineering
M.E. Structural Engineering
REGULATIONS 2015
SYLLABUS

P15MAT101 APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERS

L	T	P	C
3	2	0	4

Course Outcomes

Upon completion of the course the student should be able to:

CO1: apply Laplace transformation for one dimensional wave equations

CO2: apply functional dependence for physical problems

CO3: perform correlation and regression analysis for various distributions

CO4: explain the concepts of estimation theory

CO5: explain the concepts of soft computing

Pre-requisites: Nil

LAPLACE TRANSFORM METHODS **9 Hours**

Laplace transform method for initial value problems – Boundary value problems – Applications to one-dimensional wave equation.

CALCULUS OF VARIATIONS **9 Hours**

Variations and its properties – Euler's equation – Functionals dependent on first and higher order derivatives – Functionals dependent on functions of several dependent variables – Some applications – Direct methods – Ritz method

RANDOM VARIABLES **9 Hours**

Random variables – moment generating function – Binomial, Poisson, Geometric, Exponential and Normal distributions – Two dimensional random variables – Correlation and Regression

ESTIMATION THEORY **9 Hours**

Principles of least squares – multiple and partial correlations – parameter estimation by method of maximum likelihood estimates – method of moments

SOFT COMPUTING METHODS **9 Hours**

Fuzzy variables- fuzzy relations – neural networks – genetic algorithms (basic concepts only)

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total: 60 Hrs**

References::

1. Sankara Rao K, “ Introduction to Partial Differential Equations ”, Prentice Hall of India, 2nd Edition, 2003.
2. Grewal B.S., “ Higher Engineering Mathematics”, Khanna Publishers, 40th Edition 2007
3. S.C. Gupta & V.K. Kapoor, “ Fundamentals of Mathematical Statics”, S.Chand& Sons, 2007
4. S. Rajasekaran, G.A. VijayalakshmiPai – “Neural Network, Fuzzy Logic and Genetic Algorithm – Synthesis and Applications”, Prentice Hall of India – 2008.1. Jain R.K, Iyengar S.R.K, “Advanced Engineering Mathematics”, Narosa Publications – 2007 – (Third Edition)
5. A.S. Gupta “Calculus of Variations with Applications”, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
6. J.N. Kapur and H.C. Saxena, “Mathematical Statistics”, S. Chand & Co., 2005
7. George J.Klir, “Bo yuan – Fuggy Sets and Fuggy Logic – Theory and Applications” Prentice Hall of India Pvt. Ltd., New Delhi, 2007
8. R. Beale, T. Jacson, “Neural Computing – An Introduction”, Institute of Physics Publishing, London 2001.
9. Melanie Mitchell, “An Introduction to Genetic Algorithms”, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.
10. Andrews.L.C and Shivamoggi.B.K, “Integral Transforms for Engineers”, Prentice Hall of India Pvt. Ltd., New Delhi, 2003

L	T	P	C
3	0	0	3

P15SET101 THEORY OF ELASTICITY AND PLASTICITY

Course Outcomes

Upon completion of the course the student should be able to:

CO1: formulate equilibrium and compatibility equations for 3D problems
CO2: find out the stresses in bodies subjected to two-dimensional forces
CO3: analyze various shaped bars subjected to torsion by different methods.
CO4: analyze using plastic theories

ANALYSIS OF STRESS AND STRAIN **8Hours**

Elasticity approach - Definition and notation of stress- components of stress and strain - generalized Hooke's Law - Principal stresses and strains for three dimensional element - Equations of equilibrium and compatibility conditions for 3-D problems in Cartesian and cylindrical co-ordinates - Transformation of stresses and strains - Boundary conditions. Use of Programming Languages/ Software Packages for Stress/ Strain Analysis

TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES **8Hours**

Plane stress and plane strain problems with practical examples. Equations of equilibrium and compatibility conditions in Cartesian coordinates - Airy's stress function, bending of a cantilever of narrow rectangular cross-section under the action of couples, knife edge and varying distributed loads, bending of simply supported beams by uniform and uniformly varying loads. Use of Computer Programming/ Software Packages.

TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES **8Hours**

Equations of equilibrium and compatibility conditions in polar coordinates - axisymmetrical problems; thick cylinder under uniform pressure, shrink and force fits, circular arc beams subjected to pure bending - Stress concentrations due to circular hole in plate - effect of concentrated and uniformly distributed load on straight boundary of semi-infinite plates, stresses in circular disc subjected to diametrically opposite concentrated loads. Use of Computer Programming/ Software Packages

TORSION **8Hours**

Torsion of various shaped bars, pure torsion of prismatic bars, prandtle's membrane analogy, strain energy and finite difference method, torsion of rolled profiles, stress concentrations at re-entrant corners, torsion of thin walled tubes and hollow shafts. Plastic torsion - Elastic - plastic torsion analysis - circular section - sand heap analogy. Numerical Methods Using Software Packages

INTRODUCTION TO PLASTICITY **8Hours**

Stress - strain diagram - Ideal plastic body - Illustration of plastic Analysis - Yield criteria - Rankine's theory - St.Venant's theory - Tresca Criterion - Beltramis theory - Von Mises criterion - Mohr's theory of yielding - Yield surface - Flow rule (stress - strain relation for perfectly plastic flow)- PrandtlReuss equality - plastic work - stress - strain relation based on Tresca - plastic potential - uniqueness of a stress distribution - strain hardening – sand heap analogy.

INTRODUCTION TO FRACTURE MECHANICS **5 Hours**

Failure criteria and fracture toughness – stress intensity factor.

Theory: 45 Hr **Total: 45 Hrs**

References::

1. Timoshenko and Goodier, 'Theory of Elasticity'**,** Mc Graw Hill Book Company, New Delhi, 2010.
2. Sadhu Singh, 'Theory of Plasticity', 1990, Khanna Publishers, New Delhi.
3. Chen W.P.and Henry, 'Plasticity for Structural Engineers', D.J., SpringerVerlac, New York, 1988.
4. Hill.R., 'The Mathematical Theory of Plasticity', Oxford University Press, 1998.
5. AC Ugural& SK Fenster, 'Advanced Strength and Applied Elasticity', Edward Arnold Publishers Ltd., UK, 2003.
6. Mendelson, A., Plasticity: 'Theory & Applications', Krieger Publishing Co., 1983.

P15SET102 **MATRIX METHODS OF STRUCTURAL ANALYSIS**

L	T	P	C
3	2	0	4

Course Outcomes

Upon completion of the course the student should be able to:

CO1: explain the fundamental concepts and modern methods of analysis

CO2: analyze structures by stiffness and flexibility methods.

CO3: write simple computer programs for structural analysis using matrix methods.

BASIC CONCEPTS OF STIFFNESS AND FLEXIBILITY **9Hours**

Indeterminacy (Static, Kinematic) - Generalized measurements – Degrees of Freedom – Constrained measurements – Behaviour of Structures – Principle of Superposition – Equilibrium, Compatibility and Force displacement relations

Stiffness and Flexibility matrices in Single, two and n-coordinates; Structures with Constrained measurements; Stiffness and flexibility coefficients – Basic Stiffness and basic Flexibility method applied to spring models.

ENERGY CONCEPTS AND TRANSFORMATION OF INFORMATION **9Hours**

Strain energy; Stiffness and flexibility matrices for strain energy – Betti's law and its applications – Properties of stiffness and flexibility matrices – Contra gradient law- Co-ordinate transformations – Transformation of element matrices to structure matrices – orthogonal transformations

STIFFNESS METHOD **9Hours**

Development of the method - Structure stiffness matrix for beams , frames and trusses using displacement transformation matrix and coordinate transformation matrix – Direct stiffness methods- Static condensation _ Internal forces due to thermal expansion and lack of fit - symmetry and anti-symmetry – Analysis by substructuring.

FLEXIBILITY METHOD **9Hours**

Flexibility Method applied to statically determinate and indeterminate structures; Choice of redundant; Primary structure- General formulation- Structures flexibility matrix using force transformation matrix – Internal forces due to thermal expansion and lack of fit.

COMPUTER PROGRAMS **9Hours**

Development - computer programs for simple problems (beams, frames and trusses). Computer application and use of computer packages.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total: 60 Hrs**

REFERENCES:

1. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, Daryagang, New Delhi,2009.
2. Weaver, J.R and Gere, J.M., 'Matrix Analysis of Framed Structures', Kluwer Academic Publishers Group, 2012.
3. Fleming, J,F., 'Computer analysis of Structural Systems', Mcgraw Hill Book Co., 1989.

4. John. L.Meek., ‘Matrix Structural Analysis’, McGraw Hill Book Company, 1971.
5. Pandit G.S and Gupta S.P, ‘Structural Analysis – a Matrix Approach’, Tata McGraw Hill Publishing Company, 2008.
6. Rajasekaran, S and Sankarasubramanian G., ‘Computational Structural Mechanics’, Prentice hall of India, New Delhi, 2004.
7. Moshe.F.Rubinstein, ‘Matrix Computer Analysis of Structures’, Prentice Hall, 1986.

P15SET103 ADVANCED REINFORCED CONCRETE STRUCTURES

L	T	P	C
3	0	0	3

Course Outcomes :
Upon completion of the course the student should be able to:
CO1: calculate short term and long term deflections for structural elements
CO2: design and detail deep beams, grid floor and flat slabs in accordance with relevant IS code and standards
CO3: analyze the structure for wind forces.

SERVICEABILITY CRITERIA FOR RC BEAMS AND SLABS **9 Hours**

Deflection: Introduction – Short Term and Long Term Deflection of Beams Slabs , Continuous slabs as per IS 456 – Deflection due to Imposed Loads. Crack Width: Introduction - Factors affecting Crack width in Beams – Mechanism of Flexural Cracking – Estimation of Crack width in Beams by IS 456 and BS 8110 – Shrinkage, Creep and Thermal Cracking.

REDISTRIBUTION OF MOMENTS TO REINFORCED CONCRETE BEAMS **9 Hours**

Introduction – Redistribution of Moments in a Fixed Beam – Plate Theory Concepts - Moment Redistribution for a Two – Span Continuous Beam – Advantages and Disadvantages of Moment Redistribution – Modification of Clear Distance between Bars in Beams (for Limiting Crack width) with redistribution – Moment – Curvature (M -Φ) Relation of Reinforced Concrete Sections.

DESIGN OF REINFORCED CONCRETE DEEP BEAMS **5Hours**
Introduction – Design by IS456 – Checking for Local failures – Detailing of Deep Beams.

DESIGN OF RIBBED (Voided) SLABS **4 Hours**
Introduction – Specification regarding the slabs – Analysis of the Slabs for Moment and Shears – Ultimate Moment of Resistance – Design of Shear – Deflection – Arrangement of Reinforcements.

DESIGN OF GRID FLOORS AND FLAT SLABS **9 Hours**
Introduction – Analysis and design of Flat Grid Floors — Detailing of Steel in Flat Grids – Analysis and design of Flat slabs.

DESIGN LOADS OTHER THAN EARTHQUAKE LOADS **9 Hours**
Introduction – Dead Loads – Imposed Loads (IS 875 Part 2) – Loads due to Imposed Deformations – General Theory of Wind Effects of Structures

Theory: 45 Hrs **Total: 45 Hrs**

References::

1. P.C.Vargheese, 'Advanced Concrete Design', Prentice Hall of India Pvt. Ltd., 2009
2. Krishnaraju, N. 'Advanced Reinforced Concrete Design', CBS Publishers and Distributors, Delhi,2000. Jain, A.K. 'Reinforced Concrete - Limit State Design', Nem Chand and Bros., Roorkee.
3. Park.R. and Paulay, 'T- Reinforced Concrete Structures - John Wiley and Sons', New Delhi, 1975.
4. Jones, L.L. and Wood , RH., - 'Yield line analysis of slabs Chatto and Windus', London, 1967
5. Baker, A.L.L., 'The Ultimate Load Theory Applied to the Design of Reinforced and Prestressed concrete Frames', Concrete Publications, London, 1956.
6. Sinha,N.C. and Roy S.K., 'Fundamentals of Reinforced Concrete', S.Chand and Company, New Delhi, 2007.
7. Dayarathnam. P, 'Design of R.C.Structures', Oxford & IBH Publishing Co., Pvt Ltd., Calcutta, 1983.

P15SET104 **STRUCTURAL DYNAMICS**

L	T	P	C
3	2	0	4

Course Outcomes :

Upon completion of the course the student should be able to:

CO1: formulate the equation of motion for free and forced vibration problems.

CO2: calculate natural frequencies and mode shapes for damped and undamped systems

CO3: analyze free and forced vibration systems

SINGLE DEGREE OF FREEDOM SYSTEMS **9 Hours**

Formulation of equation of motion - Free and forced vibrations - Response to dynamic loading - Effect of damping - Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral

MODAL ANALYSIS **9 Hours**

Free and forced vibration of undamped and damped MDOF systems. Equation of motions - Evaluation of natural frequencies and mode shapes - Approximate methods - Mode superposition method - Numerical integration procedures

CONTINUOUS SYSTEMS **9 Hours**

Dynamics of distributed parameter systems - Free and forced vibration of flexural beams – Analysis of undamped free vibrations of beams in flexure- natural frequencies and mode shapes of simple beams with different end conditions - Principles of application to continuous beams - shear beams and columns.

TRANSIENT AND DYNAMIC RESPONSE OF STRUCTURES **9 Hours**

Idealisation of structures to mathematical models - Mode superposition method - Numerical integration procedures – Vibration analysis with Rayleigh's variational method – Rayleigh-Ritz method

RANDOM AND STOCHASTIC VIBRATION **9 Hours**

Random Variables and random processes - Models of random dynamic loads - Stochastic response of SDOF systems.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total: 60 Hrs**

References::

1. Clough R.W, and Penzien J, 'Dynamics of Structures', Second Edition, McGraw-Hill InternationalEdition, 2004
2. Mario Paz, 'Structural Dynamics – Theory and Computations', Third Edition, CBS publishers, 2011.Roy R Craig, 'Structural Dynamics – An Introduction to Computer Methods', John Wiley and Sons, 2007.
3. Anderson R.A, 'Fundamentals of Vibration', Amerind Publishing Co., 2006.
4. Humar J L, 'Dynamics of Structures', Prentice Hall, 2005.
   Smith J W, 'Vibration of Structures – Application in Civil Engineering', Design Chapmat Hill 2010.

6. Craig.R.R, “Structural Dynamics – An Introduction to Computer Methods”, John Wiley & Sons, 1989
7. Anil K Chopra, “Dynamics of Structures – Theory and Applications to Earth Quake Engineering”, Prentice Hall, New Delhi, 2007

P15SEP101 COMPUTER APPLICATIONS LABORATORY

L	T	P	C
0	0	2	1

Course Outcomes

Upon completion of the course the student should be able to:
CO1: analyze structures using finite element software

CO2: develop programs for finite element analysis of structural components.

ANALYSIS - DISCRETISATION 15 Hours

Matrix methods of Structural Analysis - programs for semi automatic techniques for flexibility and stiffness approaches - Direct Stiffness approach.

STRUCTURAL ANALYSIS 15 Hours

Modeling – loads and load combinations – calculation of deflections – stress resultants.

USE OF GENERAL PURPOSE PACKAGES 15 Hours

Analysis and design of R.C and Steel structures using software like ETABS, STAAD.Pro. Programming in ANSYS, MATLAB and MS-EXCEL.

Total: 45 Hrs

References:

1. ETABS - Integrated Building Design Software, CSI, Berkeley, California.
2. SAP 2000 - Linear and Nonlinear Static and Dynamic Analysis and Design, CSI, Berkeley, California.
3. ANSYS Structural Analysis Guide, ANSYS, Inc.,Canonsburg, PA, USA.
4. MATLAB - Beginners Guide to MATLAB,MathWorks, Inc.,Clarkson University, New York.

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P15SET201 **FINITE ELEMENT ANALYSIS**

L	T	P	C
3	2	0	4

Course Outcomes

Upon completion of the course the student should be able to:
CO1:explain various aspects of finite element method for structural analysis

CO2:formulate shape functions for various elements

CO3:apply finite element method for structural analysis

Pre-requisite:

1. Matrix Methods of Structural Analysis

INTRODUCTION AND BASIC EQUATIONS 9 Hours

Background - General description of the method - Analysis Procedure. Node numbering – Mesh generation - Linear constitutive equations - Plane stress, Plane strain and axisymmetric cases of elasticity - Energy principles - Variational methods – Raleigh Ritz method – Galerkin Method – Concept of piecewise approximation.

CONCEPTS OF FINITE ELEMENT METHOD 9 Hours

Concept of an element - various element shapes - Approximating displacements by Polynomials - Convergence requirements - shape functions from Lagrange and serendipity family - Isoparametric elements - Element strains and stresses - Direct and variational formulation of element stiffness and loads - Consistent and lumped loads - Plane Elements with interior nodes. Condensation of internal degrees of freedom - Degrading Technique.

FORMULATION OF ELEMENT PROPERTIES 9 Hours

Displacement formulation for axial element, beam bending element, constant and Linear strain triangle elements, Linear isoparametric quadrilateral and hexahedral elements, plate bending element and Axisymmetric element

OVERALL PROBLEMS 9 Hours

Discretization of a body or structure - Minimization of band width - Selection of a proper interpolation or Displacement model – Derivation of element stiffness matrices and load vectors – Assemblage of element equation to obtain the overall equilibrium equation- Solution for unknown nodal displacements – Computation of element strains and stresses (Overall problem pertains to displacement model only).

APPLICATIONS 9 Hours

Plane truss analysis – solution for beam problems – rigid plane frames - Free vibration analysis – Buckling problems – Fluid flow problems Computer Programs: Use of computer packages.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total: 60 Hrs**

References:

1. ChandrakantS.Desai and John F.Abel 'Introduction to the Finite Element Method', Affiliated East-West Press Private Limited.
2. Singiresu.S.Rao, "The Finite Element Method in Engineering", Butterworth-Heinemann, India Edition, 2001. Zienkiewicz, O.C 'The Finite Element Method in Engineering Science', McGraw Hill.
3. Cook, R.D., 'Concepts and Applications of Finite Element Analysis', John Wiley.
4. Cheung,Y.K., 'Finite Strip Method of Structural Analysis', Pergaman Press, 1976.
5. Rajasekaran,S., 'Finite Element Analysis', SChand,2003.
6. SS. Bhavikkatti, 'Introduction to Finite Element Analysis', New Age International Pvt. Ltd., New Delhi – 2005.

P15SET202 **DESIGN OF SUBSTRUCTURES**

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:
CO1: assess the nature of soil condition and suggest suitable foundation

CO2: design deep foundations like pile and well foundations.

CO3: design foundation for miscellaneous structures

CO4: design machine foundations.

Pre-requisite:

1.Design of Reinforced Concrete Elements

SHALLOW FOUNDATIONS 9 Hours

Types of foundations and their specific applications – depth of foundation – bearing capacity and settlement estimates – structural design of isolated footings, strip, rectangular and trapezoidal combined footings – strap – balanced footings – raft foundation – Approximate flexible method of raft design - Compensated foundations.

DEEP FOUNDATIONS 9 Hours

Types of Piles and their applications - Load capacity – Settlement of piles – Negative skin friction - Group action - Design of piles and pile caps – Lateral load capacity of piles and pile groups – Design of Piles and Pile cap - Sheet pile structures - cantilever sheet pile walls in granular soils and cohesive soils

WELL FOUNDATIONS 9 Hours

Types of wells or caissons - components - Shapes of wells - Forces acting - Construction and sinking - Design of drilled caissons.

FOUNDATIONS FOR MISCELLANEOUS STRUCTURES 9 Hours

Foundations for towers, Chimneys, Silos – Structural Design of supports for foundation excavations - Case studies – Design of Anchors - Foundation in Expansive Soils - Introduction - Identification of expansive soils Indian expansive soils – Swell potential and swelling pressure - Methods of foundation in expansive soils - Under reamed pile Foundation

MACHINE FOUNDATIONS 9 Hours

Types of machine foundation - General requirements and design criteria - General analysis of machine foundations - Dynamic properties of soil - soil system - Stiffness and damping parameters - Tests for design parameters - Reinforcement and construction details – Vibration isolation.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Swami Saran, 'Analysis and Design of Substructures', Oxford & IBH Publishing Company Private Limited, 2009.
2. Bowels J. E, 'Foundation Analysis and Design', McGraw-Hill International Book Co, 2007.
3. Thomlinson, M.J. and Boorman. R., 'Foundation Design and Construction', ELBS Longman VI edition, 2005.
4. Nayak, N.V., 'Foundation Design manual for Practicing Engineers', Dhanpat Rai and Sons, 2009.
5. Winterkorn H.F., and Fang H.Y., 'Foundation Engineering Hand Book', Van Nostrard - Reinhold - 2004.
6. Braja M. Das, 'Principles of Foundations Engineering', Thomson Asia (P) Ltd- 2009.
7. IRC-78: Standard Specifications and code of practice for Road Bridges.

P15SET203 ADVANCED STEEL STUCTURES

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: analyze and design various types of steel structural components for industrial buildings.

CO2: design connections for steel structural elements.

CO3: analyze and design cold-formed steel structural components.

CO4: analyze and design steel towers.

ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS 9 Hours

Review of loads on structures-Dead, Live, Wind and Seismic loads as per National standard-Analysis and Design of industrial buildings and bents-Sway and non-sway frames- Design of purlins, louver rails, gable column and gable wind girder-Analysis and design of gable frames - Concepts of Plastic design.

BEHAVIOUR AND DESIGN OF CONNECTIONS 9 Hours

Connection behaviour -Design requirements of bolted and welded connections- unstiffened and stiffened seat connections –framed connections- Connections for force and moment transmission-tee stub and end plate connections- Column stiffeners and other reinforcement-principles of semi-rigid connections

ANALYSIS AND DESIGN OF COLD-FORMED STEEL STRUCTURES 9 Hours

Types of cross sections-concepts of local buckling, and effective width-Design of compression and tension members,- concepts of lateral buckling –Design of Beams, deflections of beams and design of beam webs - Combined stresses and connections-Empirical design of Z-purlins with lips and wall studs.

ANALYSIS AND DESIGN OF STEEL TOWERS 9 Hours

Transmission line towers - Micro Wave Towers - Loads on towers - Shape, Sag and Tension in Uniformly loaded conductors - Analysis of towers - Design of member in towers - Design of tower foundations. Design and Analysis of Steel Towers using Software packages.

ANALYSIS AND DESIGN OF SPECIAL STRUCTURES 9 Hours

Design of self supporting chimney and guyed steel chimney – Stress due to wind and earthquake forces – Gust factor method – Design concept of bunkers and silos.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. P.Dayaratnam, ‘Design of Steel Structures’, S. Chand & Company Ltd., (2010)
2. S.Ramchandra and VirendraGehlot, ‘Design of Steel Structures’, Vol.-II, Scienific Publication, New Delhi, 2010.
3. INSDAG, ‘Teaching Resource for Structural Steel Design’, Kolkotta, Version-II
4. J.Rhodes, ‘Design of Cold-Formed Steel Members’, Elsevier Science Publishers (1991)
5. Horne, M.R., and Morris, L.J., Plastic, ‘Design of Low rise frames’, Cambridge University Press., 1985.
6. Salmon, C, G., and Johnson, J.E., ‘Steel Structures-Design and Behaviour’, Harper and Row, 1980.
7. Robert Englekirk, ‘Steel Structures – Controlling Behaviour through Design’, John Wiley & Sons
8. Kuzamanovic, B.O.andWilliems, N, ‘Steel Design for Structural Engineers”, Prentice Hall, (1983)
9. Subramanian.N, “Design of Steel Structures”, Oxford University press, 2008
10. IS 800 -2007, Indian Standard Code of practice for General Construction in Steel.
11. IS: 6533: Part 1- 1989 Code of Practice for Design and Construction of steel chimney.
12. SP 6: Part 1 : 1964 Handbook for structural engineers - Structural steel sections.
13. IS 802 : Part 1 : Sec 1 : 1995 Code of practice for use of structural steel in overhead transmission line towers, Part 1 Materials and Loads and permissible stresses Section 1 Materials and Loads
14. IS 6533: Part 2-1989 Code of practice for design and construction of steel chimneys Part 2 Structural aspects.

P15SET204 ASEISMIC DESIGN OF STRUCTURES

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1:explain behavior of structures subjected to earthquake

CO2:utilize various IS codal provisions for seismic design

CO3:design RC shear walls frame system

CO4: perform Retrofitting and Rehabilitation for existing damaged buildings

CO5: design buildings for seismic forces using various software packages

Pre-requisite:

1.Design of Reinforced Concrete Structures

INTRODUCTION **9 Hours**

Basic Seismology – General features of Tectonics of Seismic Regions- Earthquake Terminology - Definitions -Earthquake History – Behaviour of Buildings, Dams and Bridges in Earthquakes – Seismographs – Accelerographs – Theory of Vibrations – Damped and undamped system – free and forced vibrations – SDOF and MDOF systems

EARTHQUAKE RESPONSE **9 Hours**

Earthquake Response to Elastic and Inelastic Buildings – Application to Response Spectrum Theory – base exited motion - ground motion parameters – Modal response contribution – modal participation factor – response history – spectral analysis – multiple support excitation – earthquake response to continuous systems on rigid base

IS CODE PROVISIONS & SEISMIC DESIGN **9 Hours**

Design Criteria Strength, Deflection, Ductility and Energy Absorption – Cyclic Behaviour of PCC,RCC, Steel and PSC Elements- Codal Provisions of Design of Buildings As Per IS 1893 And IS 4326. Ductile Detailing of Structures As Per IS 13920. Behaviour and Design of Masonry Structures as Per IS 13827 and IS13828. Methods of Seismic Analysis: Equivalent static analysis – RS method – Time history method – Pushover Analysis – Mathematical modeling of multistoried RC building.

BEHAVIOUR OF RC STRUCTURES **9 Hours**

Analysis and Design of Frames for Lateral Loads – Capacity Design – Strong column weak Beam concept- Beam column joints– Shear Wall Frame System – Coupled Shear Wall – Design of Rectangular and Flanged Shear Walls – Ductile Detailing of Frames for Earthquake Forces - Strengthening of Existing Buildings – Retrofitting and Rehabilitation.- Liquefaction of soil

MODERN TOPICS **9 Hours**

Modern Concepts – Base Isolation, Passive Control and Active Control Systems – Computer Analysis and Design of Buildings for Earthquake Loads using Software Packages like ANSYS, SAP2000, STRAP AND STUDS.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Pankaj Agarwal, 'Earthquake Resistant Design of Structures', Prentice – Hall of India pvt.ltd., New Delhi,2002.
2. Anil K. Chopra, 'Dynamics of Structures – Theory and applications to Earthquake Engineering', Prentice – Hall of India pvt.ltd., New Delhi,2002.
3. Ambrose &Vergun, ' Simplified Building Design for wind and Earthquake Forces', John Wiley, 1985
4. Berg, 'Seismic, Design Codes and Procedures, Earthquake Engineering Research Institute, Oakland, California, USA.
5. Newmark&Rosenbluenth, 'Fundamentals of Earthquake Engineering', Prentice Hall, 1971.
6. Rosenblueth (Ed.), 'Design of Earthquake Resistance Structures', Prentech Press, London, 1980.
7. Arya,A.S., et.al., 'Earthquake Engineering' SaritaPrakasham, Meerut.

P15SEP201	STRUCTURAL ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

Course Outcomes

Upon completion of the course the student should be able to:
CO1: design a concrete mix using IS and ACI codes

CO2: perform non destructive and durability tests and predict the strength of concrete

CO3: explain the behavior of beams and columns under flexure and shear.

CO4: Identify rebar in the concrete structures

Course Content

1. Concrete Mix Design by IS:10262-2009 Procedure
2. Concrete Mix Design by ACI:211 Procedure
3. Testing of Simply Supported Reinforced Concrete beams for flexure and shear
4. Testing of Simply Supported Steel beams for flexure and shear
5. Testing of Reinforced Concrete columns
6. Accelerated Corrosion Test on concrete.
7. Rapid Chloride Penetration Test
8. Rebound hammer Test
9. Ultrasonic Pulse Velocity Test
10. Rebar locator Test

Total Hours:36

REFERENCES:

1. LS Srinath, ‘Experimental Stress Analysis’, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1992.

2. Dally J W, and Riley W F, ‘Experimental Stress Analysis’, McGraw-Hill, Inc. New York, 1991
3. IS:10262-2009 Guidelines for concrete mix design proportioning
4. ACI:211Standard Practice for selecting Proportions for Normal , Heavy weight and Mass concrete
5. Shetty.M.S, “Concrete Technology”, S.Chand and Company, New Delhi, 2010

P15SET301 **STABILITY OF STRUCTURES**

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:
CO1: perform stability analysis on columns

CO2: perform stability analysis on beam-columns

CO3: demonstrate buckling behavior of thin plates

STABILITY OF COLUMNS **9 Hours**

Concepts of Elastic Structural stability- Analytical approaches to stability - characteristics of stability analysis- Elastic Buckling of columns- Equilibrium; Energy and Imperfection approaches – Non-prismatic columns- Built up columns- orthogonality of buckling modes- Effect of shear on buckling load - Large deflection theory -Analysis for various boundary conditions - using Equilibrium, Energy - Timoshenko's Imperfect and kinetic methods.

METHODS OF ANALYSIS AND IN ELASTIC BUCKLING **9 Hours**

Approximate methods – Rayleigh and Galerkin methods – numerical methods – Finite difference and finite Element - analysis of columns – Experimental study of column behaviour – South well plot - Column curves - Derivation of Column design formula - Effective length of Columns - Inelastic behaviour- Tangent modulus and Double modulus Theory

BEAM COLUMNS AND FRAMES **9 Hours**

Beam column behaviour- standard cases- Continuous columns and beam columns – Column on elastic foundation – Buckling of frames – Single storey portal frames with and without side sway – Classical and stiffness methods – Approximate evaluation of critical loads in multistoried frames – Use of Wood's charts.

BUCKLING OF BEAMS **9 Hours**

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

BUCKLING OF THIN PLATES AND THIN WALLED OPEN SECTIONS **9 Hours**

Isotropic rectangular plates - Governing Differential equations - Simply Supported on all edges

– Use of Energy methods – Plates with stiffeners – Numerical Techniques- Torsional, flexural and local buckling of thin walled open sections.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Ashwinikumar, “Stability of Structures”, Allied Publishers Ltd, (1998), New Delhi.
2. NGR Iyengar, “Structural Stability of Columns and Plates” Affiliated East- West Press Pvt. Ltd (1986)
3. Stephen P. Timoshenko and Gere “Theory of Elastic stability”, McGraw-Hill Company (1963)
4. Allen, H.G and Bulson, P.S., ‘Background to Buckling’ McGraw-Hill Book Company, 1980
5. Smitses, ‘Elastic Stability of Structures’, Prentice Hall, 1973
6. Brush and Almorth, ‘Buckling of Bars, plates and shells’, McGraw-Hill Book Company, 1975.
7. Chajes, A. ‘Principles of Structures Stability Theory’, Prentice Hall 1974.

P15SETE11 **CAAD FOR STRUCTURES**

L	T	P	C
2	0	1	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: model engineering components.

CO2: use software to analyze, design and detail RC and steel structural elements

CO3:program for optimization

COMPUTER GRAPHICS **9 Hours**

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

STRUCTURAL ANALYSIS **9 Hours**

Computer methods of structural analysis - Finite Element programming - Analysis through application packages.

STRUCTURAL DESIGN **9 Hours**

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

OPTIMIZATION **9 Hours**

Linear programming - Simplex algorithm - Post-optimality analysis - Project scheduling - CPM and PERT applications - Genetic algorithm and applications.

ARTIFICIAL INTELLIGENCE **9 Hours**

Introduction - Heuristic search - knowledge based expert systems - Architecture and applications of KBES - Expert system shells - Principles of neural network.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. C.S. Krishnamoorthy and S.Rajeev, 'Computer Aided Design', Narosa Publishing

House, New Delhi, 1992.

2. H.B. Harrison, ‘Structural Analysis and Design’ Vol. I & II, Pergamon Press, 1991.
3. Billy E.Gillet, ‘Introduction to Operations Research, A computer oriented algorithmic approach’, Tata McGraw-Hill 1982.
4. Richard Forsyth (Ed.), ‘Expert System Principles and Case studies’ - Chapman & Hall.
5. E.Hinton and D.R.J.Owen, ‘Finite Element Programming’, Academic Press 1977.

P15SETE12 ADVANCED CONCRETE TECHNOLOGY

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: demonstrate various concrete ingredients
CO2: design concrete mix
CO3: demonstrate the properties and types of concrete.

CONCRETE INGREDIENTS **15 Hours**

Composition of OPC – Manufacture – Modified Portland Cements – Hydration Process of Portland Cements – Structure of Hydrated Cement Paste.

Mineral Admixtures – Hydration of Admixtures - Slags – Pozzolanas and Fillers – Chemical Admixtures – Solutes – Retarders – Air Entraining Agents – Water Proofing Compounds – Plasticizers and Super Plasticizers – Compatibility issues with Chemical Admixtures.

Aggregates – Properties and testing of fine and course aggregates – combining of aggregates – Substitute material for aggregates – recent advancements.

CONCRETE MIX DESIGN **10 Hours**

Mix Proportioning – Mixes incorporating Fly ash, Silica fume, GGBS – Mixes for High Performance Concrete – High strength concrete – Variations in concrete strength.

MECHANICAL PROPERTIES OF CONCRETE **7 Hours**

Interfacial Transition Zone – Fracture Strength – Compressive strength – Tensile strength - Impact strength - Bond strength - creep – Shrinkage.

DURABILITY OF CONCRETE **8 Hours**

Factors affecting durability – Chemical Attack – Permeability – chloride penetration – water absorption

SPECIAL CONCRETES **5 Hours**

Fibre Reinforced Concrete – High performance concrete - Self Compacting Concrete – Polymer Concrete - Sulphur concrete, Geo polymer

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Santhakumar.A.R, “Concrete Technology”, Oxford University press, New Delhi 2007

2. Gambhir.M.L, “Concrete Technology”, Tata McGraw Hill Book Co. Ltd., Delhi, 2004.

3. Neville.A.M, “Properties of Concrete”, Longman, 1995.

4. Metha.P.K and Montreio.P.J.M, “Concrete Structure Properties and Materials”, Prentice Hall, 1998.

5. Gupta.B.L and Amit Gupta, “Concrete Technology”, Standard Publishers and Distributers, New Delhi, 2004.

6. Shetty.M.S, “Concrete Technology”, S.Chand and Company, New Delhi, 2010

7. IS 456-2000 : Plain and Reinforced Concrete – Code of Practice.

8. IS 10262 : 2009 Recommended guidelines for concrete mix design.

P15SETE13 **WIND AND CYCLONE EFFECTS ON STRUCTURES**

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: demonstrate the fundamentals of wind effect

CO2:understand wind tunnel studies

CO3: design structures for wind and cyclone effects

INTRODUCTION **9 Hours**

Introduction, Spectral studies, Gust factor, Wind velocity, Methods of measurements, variation of speed with height, shape factor, aspect ratio, drag effects. Provisions in IS:875 Part-3.

WIND TUNNEL STUDIES **9 Hours**

Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.

WIND EFFECT **9 Hours**

Wind on structures, Rigid structures, Flexible structures, Static and Dynamic effects, Tall buildings, chimneys.

DESIGN PRINCIPLES **9 Hours**

Application to design, IS 875 code method, Buildings, Chimneys, Roofs, Shelters

CYCLONE AND DESIGN **9 Hours**

Cyclone effect on structures, cladding design, window glass design.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Cook.N.J., ‘The Designer's Guide to Wind Loading of Building Structures’,

Butterworths, 1989.

2. Kolousek., et.al., ‘Wind Effects on Civil Engineering Structures’, Elsevier Publications, 1984.

3. Peter Sachs, ‘Wind Forces in Engineering’, Pergamon Press, New York, 1972.

4. Lawson T.V., ‘Wind Effects on Building’ Vol. I and II, Applied Science Publishers, London, 1980.

P15SETE14 OPTIMIZATION IN STRUCTURAL DESIGN

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: apply knowledge on the recent advances in optimization

CO2: create cost effective designs by linear and non-linear programming

CO3: write algorithm for geometric and dynamic programming.

BASIC PRINCIPLES 5 Hours

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.

CLASSICAL OPTIMIZATION TECHNIQUES 4 Hours

Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

LINEAR PROGRAMMING 9 Hours

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. Computer Algorithm for Linear Programming

NON-LINEAR PROGRAMMING 9 Hours

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

(Multivariables): Unconstrained multivariable functions - Univariate method - Cauchy's steepest descent method - Conjugate gradient method (Fletcher Reeves) - Variable metric methods - (Davidon - Fletcher Powell).
Constrained optimization techniques: Direct and indirect methods - Cutting plane method - Methods of feasible direction - Interior penalty function - Exterior penalty function method.

Computer Algorithm for Non-Linear Programming

GEOMETRIC PROGRAMMING 9 Hours

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. Computer Algorithm for Geometric Programming

DYNAMIC PROGRAMMING 4 Hours

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

STRUCTURAL APPLICATIONS 5 Hours

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, bridges, shell roofs. Use of Software packages for optimization

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Rao,S.S.' Optimization theory and applications', Wiley eastern (P) Ltd., (1984)
2. SPUNT, 'Optimization in Structural Deisgn, Prentice Hall, New Delhi – 1992.
3. STARK and NICHOLLS,' Mathematical Foundations for Design', McGraw Hill Book, Co., (1972)

P15SETE15 PRESTRESSED CONCRETE

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1:design prestressed concrete structures for flexure and shear

CO2: analyze and design of anchorage zone.

CO3: analyze indeterminate prestressed concrete structures

Pre-requisite:

1.Design in reinforced concrete elements

PRINCIPLES AND ANALYSIS FOR FLEXURE **9 Hours**

Principles of Prestressing – Types of prestressing systems – Materials – Systems and devices – Analysis and design for flexure- Behaviour of prestressed concrete elements – General concept of prestress – Force transmitted by pretensioned and post-tensioned systems - losses in prestress – analysis for Ultimate strength – Comparison of codal provisions - at service load and Magnel's approach .

DESIGN FOR FLEXURE **9 Hours**

Concept of Limit State design – Limit state of Collapse and serviceability – Design using allowable stresses – Stress range approach - Lin's approach – Magnel's approach.

DESIGN FOR SHEAR, TORSION AND ANCHORAGE ZONE **9 Hours**

Shear resistance in beams – Design for shear in rectangular and flanged beams – Behaviour under torsion –Modes of failure - Design for torsion, shear and bending Anchorage Zone – analysis and design of pretensioned and post tensioned end blocks - IS code provisions – Comparison of other codes.

STATICALLY INDETERMINATE STRUCTURES **9 Hours**

Analysis of indeterminate structures – Continuous beams – Concept of concordance and linear transformations – Single storied rigid frames – Choice of cable profiles.

PSC SPECIAL STRUCTURES **9 Hours**

Concept of circular prestressing – Design of prestressed concrete pipes and cylindrical water tanks - Composite construction- types, behaviour, flexural stresses, longitudinal shear transfer, transverse shear – Compression members – Design of poles and piles - Partial pre stressing – Principles, analysis and design concepts

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. N.Rajagobalan, 'Prestressed Concrete', Norosa Publishing House (2005)
2. N.Krishnaraju, 'Prestressed Concrete', Tata McGraw-Hill Publishing Company 4th Ed (2008)
3. T.Y.Lin&Nedbhurns, 'Design of Prestressed Concrete Structures', 3rd edition (1982), John Wiley & Sons
4. N.C.Sinha&S.K.Roy, 'Fundamentals of Prestressed Concrete' S.Chand& Co, New Delhi (1985)

P15SETE16 SOIL STRUCTURE INTERACTION

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1:demonstrate soil and foundation behavior
CO2: analyze various types of piles
CO3: analyze laterally loaded piles

SOIL-FOUNDATION INTERACTION **9 Hours**

Introduction to soil-foundation interaction problems – Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, Soil response models, Winkler, Elastic continuum, two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.

BEAM ON ELASTIC FOUNDATION- SOIL MODELS **9 Hours**

Infinite beam, two parameters, Isotropic elastic half-space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

PLATE ON ELASTIC MEDIUM **9 Hours**

Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, Simple solutions.

ELASTIC ANALYSIS OF PILE **9 Hours**

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

LATERALLY LOADED PILE **9 Hours**

Load deflection prediction for laterally loaded piles, Sub-grade reaction and elastic analysis, Interaction analysis, Pile raft system, Solutions through influence charts

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Selvadurai, A.P.S., ‘Elastic Analysis of Soil Foundation Interaction’, Elsevier, 1979
2. Poulos, H.G., and Davis, E.H., ‘Pile Foundation Analysis and Design’, John Wiley, 1980
3. Scott, R.F., ‘Foundation Analysis’, Prentice Hall, 1981
4. ‘Structure-Soil Interaction - State of Art Report’, Institution of Structural Engineers, 1978.
5. ACI 336, ‘Suggested Analysis and Design Procedures for combined footings and Mats’, American Concrete Institute, Delhi, 1988

P15SETE71 DESIGN OF PLATES, SHELLS AND SPATIAL STRUCTURES

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: analyze various shapes of plates using various methods

CO2: analyze and design circular and cylindrical shells

CO3: analyze and design space frames

SYMMETRICAL BENDING OF PLATES 9 Hours

Equation of equilibrium and deformation of plates – Bending of rectangular plates and circular plates.

NUMERICAL METHODS 9 Hours

Energy method, finite difference and finite element methods for solution of plate bending problems. Principles of design of folded plates

SHELLS 9 Hours

Geometry of shells – Classification of Shells – membrane theory of circular and cylindrical shells – Detailed Analysis and design of cylindrical shells – Detailing of Reinforcement in shells, edge beams and transfer beam

INTRODUCTION TO SPACE FRAMES 9 Hours

Space frames – configuration – types of nodes – general principles of design Philosophy – Behaviour.

ANALYSIS OF SPACE FRAMES 9 Hours

Analysis of space frames – Formex Algebra, FORMIAN – detailed design of space frames.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Ramasamy, G.S. 'Design and Construction of Concrete shells roofs', CBS Publishers, 1986

2. Timoshenko, S. 'Theory of plates and Shells', McGraw-Hill, 1990

3. Principles of space structures by Dr.N. Subramanian – 1999, Wheeler Publishing Co.

4. Proceedings of International Conference on Space structures, Anna University,

November 1997.

5. Szllard, R. Theory of Analysis of Plates, Prentice Hall Inc.

P15SETE18 **DESIGN OF BRIDGES**

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: calculate loads for different types of Bridges.

CO2: design short span and long span bridges.

CO2: design bearings and substructure for bridges.

INTRODUCTION **9 Hours**

Classification, investigations and planning, choice of type, I.R.C.specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations.

SHORT SPAN BRIDGES **9 Hours**

Load distribution theories, analysis and design of slab bridge, box culverts and tee beam bridges

LONG SPAN GIRDER BRIDGES **9 Hours**

Design principles of balanced cantilever bridges – Design of articulation - continuous bridges - box girder bridges

DESIGN OF PRESTRESSED CONCRETE BRIDGES **9 Hours**

Design of prestressed concrete bridges - Preliminary dimensions - - Design of girder section - Maximum and minimum prestressing forces - Eccentricity - Live load and dead load shear forces - cable zone in girder -Short term and long term deflections.

BEARINGS, SUBSTRUCTURES AND FOOTINGS FOR BRIDGES **9 Hours**

Design of bearings – Foundation for bridges – Well and caisson foundation – Design of pier cap - Design of pier

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Krishnaraju, N., ‘Design of Bridges’, Oxford and IBH Publishing Co., Bombay, Calcutta, New Delhi, 2010

2. Ponnuswamy, S., ‘Bridge Engineering’, Tata McGraw-Hill, 2007

3. N. Rajagopalan, ‘Bridge Superstructure’, Alpha Science Intl Ltd, 2006

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.

6. Derrick Beckett, ‘An introduction to Structural Design of Concrete Bridges’, Surrey University Press, Henley Thomes, Oxford Shire, 1973.

7. Taylor, F.W., Thomson, S.E., and Smulski E., ‘Reinforced Concrete Bridges’, John Wiley and Sons, New York, 1955.

8. Edwin H.Gaylord Jr., Charles N.Gaylord, James, E., Stallmeyer ‘Design of Steel Structures’ McGraw-Hill International Editions, 1992.

P15SETE19	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES	L	T	P	C
		3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: explain about steel-concrete composites

CO2: design composite structural members

CO3: design composite members for fire

Pre-requisite:

1. Design of steel structures
2. Design of reinforced concrete strucutres

INTRODUCTION **9 Hours**

Introduction to steel - Concrete composite construction - Theory of composite structures - Introduction to steel - Concrete - Steel sandwich construction.

DESIGN OF COMPOSITE BEAMS **9 Hours**

Behaviour of composite beams - Design of composite beams - Shear Connectors, Connections for shear and uplift – Continuous members.

DESIGN OF SLABS **9 Hours**

Types of profile members – Design for flexture – Design for continuity

DESIGN FOR COLUMNS **9 Hours**

Encased columns – filled columns – Design for axial load – Design for Uniaxial & Biaxial bending.

DESIGN OF COMPOSITE MEMBERS FOR FIRE **9 Hours**

Concepts – Need – design under temperature gradient

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Johnson R.P., ‘Composite Structures of steel and concrete’, Blackwell Scientific Publications (Second Edition), UK, 1994.

2. Owens, G.W. and Knowels. P. Steel Designers manual (Fifth edition), Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.

3. Proceedings of “Workshop on Steel Concrete Composite Structures”, conducted at Anna University, 2000.

P15SETE20 DESIGN OF TALL BUILDINGS

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: demonstrate behavior of various structural systems.
CO2: calculate various types of loads for a tall building.
CO3: perform stability analysis of tall structures.

DESIGN CRITERIA **9 Hours**

Design Philosophy, Materials – Modern concepts – High Performance Concrete, Fibre Reinforced Concrete, Light weight concrete, Self Compacting Concrete.

LOADING **9 Hours**

Gravity Loading – Dead load, Live load, Impact load, Construction load, Sequential loading.

Wind Loading – Static and Dynamic Approach, Analytical method, Wind Tunnel Experimental methods.

Earthquake Loading – Equivalent lateral load analysis, Response Spectrum Method, Combination of loads.

BEHAVIOUR OF STRUCTURAL SYSTEMS **9 Hours**

Factors affecting the growth, height and structural form, Behaviour of braced frames, Rigid frames, Infilled frames, Shear walls, Coupled shear walls, Wall – Frames, Tubular, Outrigger braced, Hybrid systems.

ANALYSIS AND DESIGN **9 Hours**

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of structures as an integral unit, Analysis for member forces, drift and twist. Computerized 3D analysis.

Design for differential movement, Creep and Shrinkage effects, Temperature Effects and Fire Resistance.

STABILITY ANALYSIS **9 Hours**

Overall buckling analysis of frames, wall – frames, Approximate methods, Second order effect of gravity loading, P – Delta Effects, Simultaneous first order and P-Delta analysis, Translational instability, Torsional Instability, Out of plumb effects, Effect of stiffness of members and foundation rotation in stability of structures.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Bryan Stafford Smith and Alex Coull, ‘Tall Building Structures’, Analysis and Design, John Wiley and Sons, Inc., 1991.
2. Taranath B.S, ‘Structural Analysis and Design of Tall Buildings’, McGraw-Hill, 2011
3. COULL, A. and SMITH, STAFFORD, B. ‘Tall Buildings’, Pergamon Press, London, 1997.
4. LinT.Y. and Burry D.Stotes, ‘Structural Concepts and Systems for Architects and Engineers’, John Wiley, 1994.
5. Lynn S.Beedle, ‘Advances in Tall Buildings’, CBS Publishers and Distributors, Delhi, 1996.

P15SETE21 EXPERIMENTAL METHODS AND MODEL ANALYSIS

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1:demonstrate the various force and strain measuring equipments.
CO2:choose various data indicating and recording instruments.
CO3:perform model analysis.

Pre-requisite: Nil

FORCE AND STRAIN MEASUREMENTS **9 Hours**

Basic Concept in Measurements – Types of strain gauges – Hydraulic jacks – pressure gauges – proving rings – electronic load cells – Calibration of Testing Machines

DATA RECORDING **9 Hours**

Strain gauge circuits – Potentiometer and Wheatstone bridge – use of lead wires switches etc., - Use of electrical resistance strain gauges in transducer applications – LVDT - Indicating and recording devices - Static and dynamic data recording –Data (Digital and Analogue) acquisition and processing systems.

VIBRATION MEASUREMENT **9 Hours**

Strain analysis methods – Rosette analysis. Static and dynamic testing techniques. - Equipment for loading - Moire's techniques - Transducers for velocity and acceleration measurements - vibration meter - Seismographs - vibration analyzer - Cathode Ray Oscilloscope.

NDT **9 Hours**

Non-destructive testing techniques - Load testing of structures, Buildings, bridges and towers -Acoustic emission - holography - use of laser for structural testing.

MODEL ANALYSIS **9 Hours**

Laws of similitude - model materials – model testing – testing large scale structures – holographic techniques – Photoelasticity – optics of photoelasticity – Polariscope – Isoclinics and Isochromatics - methods of stress separation – wind tunnel and its use in structural analysis

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Dally J W and Riley W.F, ‘Experimental stress Analysis’, McGraw-Hill Inc. New York, 1991.

2. Sadhu Singh, ‘Experimental Stress Analysis’, Khanna Publishers, New Delhi, 1996.

3. Rangan C S et al., ‘Instrumentation – Devices and Systems’, Tata McGraw-Hill Publishing Co., Ltd., New Delhi, 1983.

4. Srinath L S et al, ‘Experimental Stress Analysis’, Tata McGraw-Hill Publishing Co., Ltd., New Delhi,1984.

5. D.E.Bray and R.K.Stanley, “Non-Destructive Evaluation”, McGraw Hill Publishing Co., New York, 1989.

P15SETE22	DESIGN OF STRUCTURES FOR DYNAMIC LOADS	L	T	P	C
		3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: explain the behavior of structures under dynamic loads
CO2: design structures for earthquake, blast and impact loads
CO3: perform ductile detailing

Pre-requisite:

1.Seismic resistant design of structures

INTRODUCTION **9 Hours**

Factors affecting design against dynamic loads - Behaviour of concrete, steel, masonry and soil under impact and cyclic loads - Recap of Structural dynamics with reference to SDOF, MDOF and continuum systems - Ductility and its importance.

DESIGN AGAINST EARTHQUAKES **9 Hours**

Earthquake characterisation - Response spectra - seismic coefficient and response spectra methods of estimating loads - Response of framed, braced frames and shear wall buildings - Design as per BIS codes of practice - Ductility based design.

DESIGN AGAINST BLAST AND IMPACT **9 Hours**

Characteristics of internal and external blast - Impact and impulse loads - Pressure distribution on buildings above ground due to external blast - underground explosion - Design of buildings for blast and impact as per BIS codes of practice.

DESIGN AGAINST WIND **9 Hours**

Characteristics of wind - Basic and Design wind speeds - Effect of permeability of the structure – pressure coefficient - Aeroelastic and Aerodynamic effects - Design as per BIS code of practice including Gust Factor approach - tall buildings, stacks and chimneys.

SPECIAL CONSIDERATIONS **9 Hours**

Energy absorption capacity – Ductility of the material and the structure – Detailing for ductility – Passive and active control of vibrations – New and favourable materials.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Bela Goschy, ‘Design of Building to withstand abnormal loading’, Butterworths, 1990.

2. Paulay, T. and Priestly, M.N.J., ‘A seismic Design of Reinforced Concrete and Masonry building’, John Wiley and Sons, 1992.

   Dowling, C.H., ‘Blast vibration - Monitoring and Control’, Prentice Hall Inc., Englewood Cliffs, 1985.

3. Kolousek, .V. et al., ‘Wind effects on Civil Engineering Structures’, Elsevier, 1984.

4. Synthesis Report CEB, ‘Concrete Structures under Impact and Impulsive Loading’,

   Lousanne, Germany, 1988.

P15SETE23 DESIGN OF OFFSHORE STRUCTURES

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: apply the concept of wave theories.
CO2: model offshore structures.
CO3:design jacket towers and cables.

WIND EFFECTS **9 Hours**

Wind on Structures - Rigid Structures - Flexible Structures -Static and dynamic effects.

WAVEHYDRODYNAMICS **9 Hours**

Wave generation and propagation small and finite amplititudes wave theories - wave energy and pressure distribution.

WAVE LOADING **9 Hours**

Wave forces on structures - Environmental loadings - use of Morrison equation.

OFFSHORE STRUCTURE MODELLING **9 Hours**

Different types of structures, Foundation modelling, static methods of analysis, Dynamics of Offshore structures. Software applications.

DESIGN OF OFFSHORE STRUCTURES **9 Hours**

Loads, design of platforms, Derricks, Helipads, Design principles and examples of Jacket towers, Mooring cables.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Chakrabarti.S.K, "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, 1987.

2. Thomas M.Dawson, "Offshore Structural engineering", Prentice Hall Inc Englewood

Cliffs, N.J., 1983.

3. API, Recommended Practice for Planning, Designing and Construction, Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.

4. PeterSachs, “Wind forces in Engineering”, Pergomon press, New York, 1972.

5. Ippen.J, “Esterany and Coast line hydrodynamics”, McGraw Hill Book, Co., 1966.

P15SETE24 MAINTENANCE AND REHABILITATION OF STRUCTURES

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: Demonstrate the various types of distress in concrete structures.

CO2: Identify the effects due to climate, temperature, chemicals, wear and erosion on structures.

CO3: Analyze the failures in structure due to design and construction errors.

CO4: Recommend the best Materials and Techniques for Repair.

GENERAL **9 Hours**

Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking.

Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

MAINTENANCE AND REPAIR STRATEGIES **9 Hours**

Definitions : Maintenance, repair and rehabilitation, Facts of Maintenance - importance of Maintenance - Preventive measures on various aspects - Inspection, Assessment procedure for evaluating a damaged structure - causes of deterioration - testing techniques.

MATERIALS FOR REPAIR **9 Hours**

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete.

TECHNIQUES FOR REPAIR **9 Hours**

Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning.

EXAMPLES OF REPAIR TO STRUCTURES **9 Hours**

Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure.

Safety measures – Dismantling of structures – Safety in finishing works - Engineered demolition techniques for Dilapilated structures

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Denison Campbell, Allen and Harold Roper, ‘Concrete Structures, Materials, Maintenance and Repair’, Longman Scientific and Technical UK, 1991.
2. R.T.Allen and S.C.Edwards, ‘Repair of Concrete Structures’, Blakie and Sons, UK, 1987.
3. M.S.Shetty, ‘Concrete Technology - Theory and Practice’, S.Chand and Company, New Delhi, 2000.
4. Santhakumar, A.R., ‘Training Course notes on Damage Assessment and repair in Low Cost Housing’, “RHDC-NBO”, Anna University, July, 1992.
5. Raikar, R.N., ‘Learning from failures - Deficiencies in Design’, Construction and Service - R & D Centre (SDCPL), RaikarBhavan, Bombay, 1987.
6. N.Palaniappan, ‘Estate Management, Anna Institute of Management’, Chennai, 1992.
7. Lakshmipathy, Metal Lecture notes of Workshop on ‘Repairs and Rehabilitation of Structures’, 29 - 30th October 1999.

P15SETE25 RESEARCH METHODOLOGY

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: demonstrate various methods and techniques related to research process.

CO2: analyze the data from a research

CO3: write a research report.

RESEARCH CONCEPTS 9 Hours

Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental).
Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

MATHEMATICAL MODELING AND SIMULATION 9 Hours

Concepts of modeling, Classification of Mathematical Models, Modeling with Ordinary differential Equations, Difference Equations, Partial Differential equations, Graphs, Simulation, Process of formulation of Model based on Simulation.

EXPERIMENTAL MODELING 9 Hours

Definition of Experimental Design, Examples, Single factor Experiments, Guidelines for designing experiments. Process Optimization and Designed experiments, Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design.

ANALYSIS OF RESULTS 9 Hours

Parametric and Non-parametric, descriptive and Inferential data, types of data, collection of data (normal distribution, calculation of correlation coefficient), processing, analysis, error analysis, different methods, analysis of variance, significance of variance, analysis of covariance, multiple regression, testing linearity and non-linearity of model.

REPORT WRITING 9 Hours

Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, References:, tables, figures, conclusion, appendices.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Willktnsion K. L, Bhandarkar P. L, 'Formulation of Hypothesis', Himalaya Publication.

2. Schank Fr., 'Theories of Engineering Experiments', Tata Mc Graw Hill Publication.

3. Douglas Montgomary, 'Design of Experiments', Statistical Consulting Services, 1990.

4. Douglas H. W. Allan, 'Statistical Quality Control: An Introduction for Management', Reinhold Pub Corp, 1959.

5. Cochran and Cocks, 'Experimental Design', John Willy & Sons.

6. John W. Besr and James V. Kahn, 'Research in Education', PHI Publication.

7. Adler and Granovky, 'Optimization of Engineering Experiments', Meer Publication.

8. S. S. Rao, 'Optimization Theory and Application', Wiley Eastern Ltd., New Delhi, 1996.

P15SETE26 CONSTITUTIVE MODELS AND MODES OF FAILURE

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: apply elastic and plastic theories for various engineering problems
CO2:apply various mechanical models to real life events
CO3:prepare models for structural elements

ELASTICITY 9 Hours

Stress strain analysis – 2D problems – Cartesian and polar coordinates – generalized Hooke's law – 3D problems – energy relations

PLASTICITY 9 Hours

Yielding and yield surface – strain rates and failure theories – flow rule – elastic plastic and strain hardening models – beam and soil applications

MECHANICAL MODELS 9 Hours

Kelvin and Maxwell models – viscoelasticity – friction and Coloumb models – series, parallel and hybrid models – applications

ENERGY RELATIONS 9 Hours

Work and energy types – energy theorems and material models – formulations, Applications in beams and simple structures

APPLICATIONS 9 Hours

Engineering material models – steel and concrete – reinforced concrete- composites -one, two and three dimensional models – practical examples

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. Dowling, N.E., 'Mechanical Behaviour of Materials: Engineering Methods of Deformation, Fracture and Fatigue', 2nd Edition, Prentice – Hall, 1999.
2. Bedford, A.M. and Liechti, K.M., 'Mechanics of Materials', Prentice Hall, 2001.
3. Popov, E "Mechanics of Materials", Prentice Hall Reprinted Pearson Education, 2003.

P15SETE27 DESIGN OF INDUSTRIAL STRUCTURES

L	T	P	C
3	0	0	3

Course Outcomes

Upon completion of the course the student should be able to:

CO1: explain various types of industrial structures and its design methodologies
CO2: design bunkers, silo.
CO3:design chimney and towers.
CO4: design various industrial floors

PLANNING AND FUNCTIONAL REQUIREMENTS

Classification of Industries and Industrial structures – planning for layout requirements regarding Lighting, Ventilation and Fire Safety – Protection against noise and vibration – Guidelines from Factories Act.

DESIGN FOR MATERIAL HANDLING **9 Hours**

Types of cranes - mono rails - under slung & overhead cranes - crane columns

DESIGN FOR MATERIAL STORAGE **9 Hours**

Stand pipes – Jessen& Rankine's theories – design of silos – design of bunkers

DESIGN FOR CHIMNEYS **9 Hours**

Self supporting chimney – guyed chimney – design for foundation – braced chimney

DESIGN FOR TOWERS & FRAMES **9 Hours**

Microvane Towers – Design for wind – Design of frames for wind & axial loads

DESIGN OF INDUSTRIAL FLOORS **9 Hours**

Ground floor – Pavement design – Mezzanine floors – Gratings – chequered plates – composite deck slabs

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES:

1. A.R. Santhakumar and S.S. Murthy, 'Transmision Line Structures', Tata McGraw-Hill 1992.

2. Dr. K. Rajagopalan, ‘Storage Structures’, Routledge,. 2004.

3. ‘Procs. of advanced course on Industrial Structures’, Structural Engineering Research Centre, 1982.
4. P.Srinivasulu and C.V. Vaidyanathan, ‘Handbook of Machine Foundations’, Tata McGraw-Hill 1976.

5. S.N. Manohar, Tall Chimneys, ‘Design and Construction’, Tata McGraw-Hill, 1985.

P15SEIN01 TRADITIONAL ARCHITECTURE

L	T	P	C
2	0	0	1

Course Outcomes

Upon completion of the course the student should be able to:

CO 1 :identify structural components of a traditional building.

CO 2 :choose the best construction materials and techniques for a traditional building.

CO 3 :suggest an effective preservation technique for traditional buildings.

ENGINEERING ASPECTS IN TRADITIONAL ARCHITECTURE **7 Hours**

Structural elements – Construction materials – Construction techniques

PRESERVATION OF TRADITIONAL BUILDINGS **8 Hours**

General principles – Techniques – Materials – Preservation of pillars, beams, arches, domes and vaults

Theory:15 Hrs **Total:15 Hrs**

REFERENCES

1. Ananda Kentish Coomaraswamy, "History of Indian Indonesian Art", dover Publications, 1927
2. Percy Brown, "Indian Architecture (Buddhist and Hindu Periods)",D.B.Taraporevala Sons & Co.,1956
3. James Fergusson, "History of Indian and Eastern Architecture", 1876
4. Ashish Nangia, "Architecture of India", http://www.boloji.com/architecture/index.html
5. E.B.Havell, "Indian Architecture", 1913
6. Prasanna Kumar Acharya, "Architecture of Manasara", Oxford University Press, 1933
7. Alice Boner, PanditSadasivaSarma and Dr.Bettina, "VastusutraUpanisad", MotilalBanarsidas Publishers Pvt. Ltd., 2000.
8. M.S. Mathews, "Conservation Engineering" 1998.

P15SEIN02 FORM-WORK AND SCAFFOLDING

L	T	P	C
2	0	0	1

Course Outcomes

Upon completion of the course the student should be able to:

CO 1 : deign formwork for various structures

CO 2 :choose suitable scaffolding system for construction works.

DESIGN OF FORMS AND SHORES — 7 Hours

Basic simplification - Beam formulae - Allowable stresses - Deflection, Bending - Lateral stability - Shear, Bearing - Design of Wall forms - Slab forms - Beam forms - Column forms - Examples in each. Simple wood stresses - Slenderness ratio - Allowable load vs length behaviour of wood shores - Form lining Design Tables for Wall formwork - Slab Formwork - Column Formwork - Slab props - Stacking Towers - Free standing and restrained - Rosett Shoring - Shoring Tower - Heavy Duty props.

FORMS FOR DOMES AND TUNNELS, SLIP FORMS AND SCAFFOLDS — 8 Hours

Hemispherical, Parabolic, Translational shells - Typical barrel vaults Folded plate roof details - Forms for Thin Shell roof slabs design considerations - Building the forms - Placing concrete - Form removed -Strength requirements -Tunnel forming components - Curb forms invert forms - Arch forms - Concrete placement methods - Cut and cover construction - Bulk head method - Pressures on tunnels - Continuous Advancing Slope method - Form construction - Shafts. Slip Forms - Principles -Types - advantages - Functions of various components - Planning - Desirable characteristics of concrete - Common problems faced - Safety in slip forms special structures built with slip form Technique - Types of scaffolds - Putlog and independent scaffold -Single pole scaffolds - Truss suspended - Gantry and system scaffolds.

Theory:15 Hrs **Total:15 Hrs**

REFERENCES

1. Austin, C.K., Formwork for Concrete, Cleaver -Hume Press Ltd., London, 1996.
2. Hurd, M.K., Formwork for Concrete, Special Publication No.4, American Concrete Institute, Detroit, 1996
3. Michael P. Hurst, Construction Press, London and New York, 2003.
4. Robert L. Peurifoy and Garold D. Oberlender, Formwork For Concrete Structures, McGraw -Hill , 1996.

P15SEIN03 **HEALTH MONITORING OF STRUCTURES**

L	T	P	C
2	0	0	1

Course Outcomes

Upon completion of the course the student should be able to:

CO 1: outline the health aspects of a structure.

CO 2: investigate the stability of a structure.

INTRODUCTION **7 Hours**

Structural Health, factors affecting health ofstructures, effect of leakage, age, creep, corrosion, fatigue on life of structure. Structural health monitoring. Various measures, regular maintenance, structural safety in alteration. Quality control & assurance of materials of structure, durability of concrete, Factors affecting durability of concrete, Corrosion in structures, Testing and prevention of corrosion, fire safety.

CASE STUDIES **8 Hours**

Structural Audit, Assessment of health of structure, study of structural drawings, nature of distress, visual observations, Collapse and investigation, limitations on investigator, tools for investigation, Various NDT Methods for assessing strength of distressed materials, investigation management, review of assimilated information, interviews and statements, evaluation and reporting, presentation of report, communication gap among client, architect, consulting engineer& contractor.

Theory:15 Hrs **Total:15 Hrs**

REFERENCES

1. R.N.Raikar, “Diagnosis and treatment of structures in Distress”, R&D Centre, (SDCPL), RaikarBhavan, Sector 17, Vashi, Navi Mumbai.
2. Krautkramer.J and Krautkramer.H, “Ultrsonic Testing of Materils”, Springer-Verlag, Berlin, 1969.
3. Mani.K and Srinavasan.P, An article “ Corrosion Damage and its evaluation by Testing” in Advanced Testing and Evaluation of Structures and Components, Allied Publishers, Chennai, 2002, pp 14.01-14.33
4. Ouyang, C., Landis, E., and Shah, S.P., An Article, ‘Damage Assessment in Concrete using Acoustic Emission,’ in Nondestructive Testing of Concrete Elements and Structures, ASCE, New York, 1992, pp 13-24.
5. Popovics S, and Popovics J.S., An Article, ‘ACritique of the Ultrasonic Pulse Velocity Method for Testing Concrete’ in Nondestructive Testing of Concrete Elements and Structures, ASCE, New York, 1992, pp 94-103.
6. Sreenath H.G., An Article, ‘Safety Auditing of Concrete Structures. In Advanced Testing and Evaluation of Structures and Components, Allied Publishres, Chennai, 2002 pp 9.01 – 9.19.

7. Thandavamoorthy T.S., et al ‘Health Assessment of Concrete Structures by Ultrasonic pulse Velocity Technique an experimental Investigation’, in Building Materials, RRL Bhopal, February 26-27, 2004, pp. 284-89.

P15SEIN04 BUILDING ENERGY AUDIT

L	T	P	C
2	0	0	1

Course Outcomes

Upon completion of the course the student should be able to:

CO 1: suggest various energy conservation schemes

CO 2: explain various case studies on energy conservation.

INTRODUCTION **7 Hours**

Energy scenario-Role of Energy Managers-Energy Monitoring. Auditing & Targeting-Economics of various energy conservation schemes. Total Energy system.

CASE STUDIES **8 Hours**

Energy conservation in steam systems-Energy conservation in cooling towers & spray ponds-Energy efficiency in lighting.

Theory:15 Hrs **Total:15 Hrs**

REFERENCES

1. Eastop.T.D& Croft D.R, "Energy efficiency for engineers and technologists," Logman scientific & Technical, ISBN-0-582-03184,1990.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, Tata McGraw-Hill Co 2008.