M.E. CIVIL ENGINEERING

Instruction and Syllabi

Subjects for Specialization: Structural Engineering

With effect from the academic year 2014-2015

S.No.	Ref. No	SUBJECTS	Period per week		Dura-tion in Hrs.	Marks			Credits
						Main EXAM	Internal		
		CORE SUBJECTS	**L/P**	**D/P**			**Ses**	**Ass**	
1.	CE 5101	Theory of Elasticity	4		3	75	20	5	3
2.	CE 5102	Structural Analysis	4		3	75	20	5	3
3.	CE 5103	Finite Element Methods	4		3	75	20	5	3
4.	CE 5104	Theory of Plates	4		3	75	20	5	3
5.	CE 5105	Structural Design	4		3	75	20	5	3
6.	CE 5106	Structural Dynamics	4		3	75	20	5	3
		ELECTIVE SUBJECTS							
7.	CE 6101	Repairs and Retro fitting of Structures	4		3	75	20	5	3
8.	CE 6102	Theory of Shells&Folded Plates	4		3	75	20	5	3
9.	CE 6103	Neural,Fuzzy & Expert Systems	4		3	75	20	5	3
10.	CE 6104	Advanced Reinforced Concrete Design	4		3	75	20	5	3
11.	CE 6105	Tall Buildings	4		3	75	20	5	3
12.	CE 6106	Structural Optimization	4		3	75	20	5	3
13.	CE 6107	Advanced Steel Design	4		3	75	20	5	3
14.	CE 6108	Pre Stressed Concrete	4		3	75	20	5	3
15.	CE 6109	Advanced Concrete Technology & Construction Techniques	4		3	75	20	5	3
16.	CE 6110	Bridge Engineering	4		3	75	20	5	3
17.	CE 6111	Industrial Structures	4		3	75	20	5	3
18.	CE 6112	Advanced Foundation Engineering	4		3	75	20	5	3
19.	CE 5204	Earthquake Resistant Design of Structures	4		3	75	20	5	3
20.	CE 6208	Earthquake Resistant design of Masonry Structures	4		3	75	20	5	3
		DEPARTMENTAL REQUIREMENTS							
21.	CE 5107	Structural Engineering Lab-(I Sem)		3			50		2
22.	CE 5108	Computer Aided Analysis and Design of Structures Lab- (II Sem)		3			50		2
23.	CE 5109	Seminar – I (I Sem)		3			50		2
24.	CE 5110	Seminar – II (II Sem)		3			50		2
25.	CE 5111	Project Seminar (III Sem)		3			50		3
26.	CE 9101	Dissertation (III & IV Sem)		3	#		*		16

Dissertation viva voce * Grade

M.E. dissertation synopsis requires to be approved within four weeks of registration

Offering of electives shall be in general satisfying the pre requisite courses.

CES 5101 *With effect from the academic year 2014-2015*

THEORY OF ELASTICITY

No. of Credits	3 Credits
Instruction	4periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course objectives:

1. To make the students understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity.
2. To enhance the competency level and develop the self confidence through quality assignments in theory of Elasticity.
3. To inculcate the habit of researching and practicing in the field of elasticity.

Course Out Comes:

1. Able to solve the problems of 3-D elasticity with confidence.
2. Can independently work with the problems of 2-D elasticity in Cartesian/Polar Coordinates.
3. Familiarized with the use of airy's stress function in 2-D problems of elasticity in Cartesian/Polar Coordinates.
4. Equipped with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion.
5. Able to interpreted and apply the theory of elasticity to practical problems of Structural engineering.

Unit – I

Definition and notation of stress. Components of stress and stain. Generalized Hooke's law. Stress and strain in three dimensions. Stress components on an oblique plane. Transformation of stress components under change of co-ordinate system.
Principal stresses and principal planes. Stress invariants. Mean and deviator stress. Strain energy per unit volume. Octahedral shear stress. Strain of a line element. Principle strains. Volume strain.

Unit – II
Two dimensional problems in elasticity: Plane stress and plane strain situations. Equilibrium equations. Compatibility equations. St. Venant's principle. Uniqueness of solution. Stress components in terms of Airy's stress functions. Applications to cantilever. Simply supported and fixed beams with sample loading.

Unit – III
Solutions of problems in polar co-ordinates.
Equilibrium equations. Stress Strain Components. Compatibility equation. Applications using Airy's stress functions in polar co-ordinates for stress distributions symmetric about an axis. Effect of hole on stress distribution in a plate in tension. Stresses due to load at a point on a semi-infinite straight boundary. Stresses in a circular disc under diametrical loading

Unit -IV

Torsion – Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars. Prandtl's membrane analogy, Solution of torsion of rectangular bars by (i) Raleigh Ritz method and (ii) Finite difference method

UnitV

Introduction to problems in plasticity- Assumptions-Criterian of yielding - Rankines theory - St. Venant's theory - Flow curve -Plastic stress - strain relationship - Elastic Plastic problems of beams in bending

Suggested Reading:

1) S. Timoshenko & N. Goodier, 1951"**Theory of Elasticity**", Mc Graw Hill.
2) Valiappan,2010 "**Theory of Elasticity**", Mc. Graw Hill
3) Chakrabarty, J, 2006 " **Theory of Plasticity**", Elsevier, London,
4) Chen, W.F., and Han, D.J.1998, **Plasticity for Structural Engineers**, Springer Verlag,

STRUCTURAL ANALYSIS

No. Of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course Objectives :

- To equip the students with the knowledge of analyzing structures.
- To make students through in the subject by way standard assignments.
- To instill the aptitude for research and problem solving**.**

Course Outcomes :

1. Able to analyse of columns, beam-columns, beams on elastic foundations, structures with moving loads and perform analysis of structures using matrix approaches.
2. Capable to analyse and provide solutions to field problems.
3. Able to persue research in the area of structural Engg.

UNIT – I

Matrix Methods: Matrix formulations by force and displacement methods. Analysis of redundant pin-jointed frames, portal frames. gabled frames and single panel quadrangular closed frames with degree of redundancy not exceeding three.

UNIT - II

Direct element method: Formulation of stiffness matrices for multi-storeyed frames, grid frames and space frames Assemblage of global stiffness matrix - exposure to software packages - STAAD and NISA.

UNIT- III

Buckling of column bars: Review of fundamentals - Differential equation for critical loads - determination of critical loads by energy and by numerical methods. Buckling of bars under its own weight - Effect of' shearing force on the critical loads

Beam-Columns: Analysis of Beam columns with lateral point loads and uniformly distributed loads with hinged or built in ends. Effect of initial curvature on deflections.

UNIT - IV

Beams on elastic foundation: Introduction - Modulus of foundation and the basic equation. Beams of infinite length under concentrated and uniformly distributed loads. Analysis of semi-infinite beams making use of functions for infinite beams.

UNIT- V

Influence Lines for Indeterminate Structures: Introduction, influence lines for reactions, bending moment and shear force for redundant beams with degree of redundancy not exceeding two - influences lines for redundant lines for redundant frames and arches with degree of redundancy not exceeding two – Influence lines for truss members with degree of external redundancy not exceeding two.

Suggested Reading:

1. A.P. Boresi &O.M. by*"Advanced Mechanics of Materials",*Side bottom John Wiley 1985
2. G.S. Pandit & S.P.Gupta *by "Structural Analysis",* Tata Mc Graw Hill, 1992.
3. Arababi.*"Structural Analysis and Behavior",* by F, Mc Graw Hill, 1991
4. Timoshenko by *"Theory of Elastic Stability",* S, Mc Graw Hill, 1992.

CE 5103

FINITE ELEMENT METHODS

No. of Credits	3 Credits
Instruction	4 Periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course Objectives:

- To provide an overview and basic fundamentals of Finite Element Analysis.
- To introduce basic aspects of finite element theory, including domain discretization, interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
- To explain the underlying concepts behind variational methods and weighted residual methods in FEM.
- Formulate simple structural problems in to finite elements.
- Derivation of element stiffness matrix for 1-D, 2-D and 3-D problems.

Out comes:

- Analyse and build FEA models for various Engineering problems.
- Able to identify information requirements and sources for analysis , design and evaluation
- Use professional-level finite element software to solve engineering problems.
- Interpret results obtained from FEA software solutions, not only in terms of conclusions but also awareness of limitations.

UNIT-I

Introduction to FEM: Types of Problems – Types of Materials – Elastic / Inelastic situations – Types of forces: Body forces / Surface Traction / Point loads – Deformable bodies – Types of Deformations – Homogeneous / Non homogeneous Problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D / 3-D – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strain problems.

Virtual Work Formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

Finite Difference Method with Central Differences: Solving ODE's and PDE's with central differences. Application to beam and plate bending problems of simple geometry.

UNIT-II

Variational Formulation:

Finite Element Formulation - Stationary of Functional – Given the Functional or Differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix / stiffness matrix / Minimum Potential Energy Approach / Rayleigh-Ritz Method / introduction to natural coordinates / stiffness matrix of second order bar element / Axial bar subjected to point loads, body forces and surface traction forces / Problems with kinematic indeterminacy not exceeding two.

2-D Triangular Elements: Displacement models / criterion for convergence / geometric invariance / conforming and non conforming elements - 3-node triangular elements (CST) / determination of strain-displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceeding three.

2nd Order triangular elements: Shape functions – degradation technique / strain-displacement matrix / Expression for stiffness matrix / Load matrices due to body forces and surface traction.

UNIT-III

ISO-parametric elements: Quadrilateral elements: Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/ Expressions for stiffness matrix, load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2nd Order Quadrilateral elements: - Determination of shape functions for 2nd order quadrilateral elements and serendipity elements/ Strain-displacement matrices / Load matrices for body force and surface traction.

UNIT-IV

Method of Weighted Residuals:

Galerkin's Method of Weighted Residuals – Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

Galerkin's Finite Element Method – Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

Introduction to material and geometric nonlinearities. Conforming and nonconforming plate bending elements (brief outline only).

UNIT-V

Axi-symmetric Problems: Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elements only.

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, stiffness matrix, load matrices due to body force and surface traction/ introduction to Hexahedron (brick) elements.

Introduction to ANSYS: Illustration on different modules of ANSYS / Structural engineering applications of the package/Creation of a simple 1-D model, 2-D model and a 3-D model/ analysis and post processing of the results.

Suggested Reading:

1. Cook, R. D. (1981). "Concepts and Application of Finite Element Analysis", John Wiley and Sons.
2. Zienkiewicz, O. C. And Taylor, R. L, (1989). "The Finite Element Method", Vol.1, McGraw Hill Company Limited, London.
3. Reddy, J. N, (1993). "An Introduction to the Finite Element Method", McGraw Hill, New York.
4. Chandrupatla, T. R. And Belegundu, A. D, (2012). "Introduction to Finite Elements in Engineering", Prentice Hall of India, New Delhi.
5. Seshu. P, (2003). "Finite Element Analysis", Prentice Hall of India Private Limited, New Delhi.
6. David V. Hutton, (2005). "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Bathe, K. J, (2006). "Finite Element Procedures", Prentice Hall of India, New Delhi.

CE 5104 *With effect from the academic year 2014-2015*

THEORY OF PLATES

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course Objectives

1. To enable the students comprehend the concepts of analysis of plates.
2. To build the confidence in students to solve plate problems through qualitative assignments.
3. To give insight to practice and research.

Course Outcomes

1. Ability to analyse rectangular plates (both isotropic and orthotropic) and circular plate problems.
2. Capability to perform buckling analysis of plates.
3. Familiarity with problems of plates on elastic foundations and different approximate methods of plate analysis..
4. Confidence to analyse field problems and persue research in the domain of theory of plates..

UNIT-I

Cylindrical Bending:
Derivation of differential equation for Cylindrical Bending of long rectangular plates – Analysis of uniformly loaded rectangular plates with simply supported and fixed edges subjected to uniform load.

Pure Bending of Plates: Pure; Relations between slope and curvature of slightly bent plates Moment-curvature relations in pure bending. Strain energy in pure bending – Solution using Finite Difference Methods.

UNIT-II
Small Deflections of Laterally Loaded Plates: Differential equation of equilibrium: Boundary conditions. Solution of simply supported rectangular plates under various loading conditions Viz unormaly distributed load (full or partial) concentrated load by Navier's approach. . Levy type solution for rectangular plates under U.D.L . With all four edges simply supported or two opposite edges simply supported and other two fixed.

UNIT-III
Symmetrical Bending of Circular Plates: Differential equation of equilibrium. Uniformly loaded plates at center. Circular plates with circular holes at the center

Bending of Orthotropic Plates:. Differential equation of the bent plate. Application of the theory to simply supported rectangular (i) Laminates (ii) RC slabs (iii) grids.

UNTI –IV
Buckling of plates: Calculation of critical loads - Buckling of simply supported rectangular plates - uniformly compressed in one and two directions with different edge conditions. Web Buckling. Solution using Finite Difference method.

Plates on Elastic Foundations : Governing differential equation – Deflection of uniformly loaded simply supported rectangular plate – Buckling of rectangular plates – Navier and levy type solutions – Large plate loaded at equidistant points by concentrated force.

UNIT -V
Approximate Methods for Rectangular Plates: Stain energy approaches, Rayleigh-Ritz method. Finite difference method for simply supported or fixed rectangular plates carrying UDL (full or partial) or central point load.

Suggested Reading:

1. S. Timoshenko and W. Krieger., Me Graw Hill by *"Theory of plates and shells"*.
2. P.Szilard, Prentice Hall by Theory and Analysis of Plates.
3. Chadrasekhara by Theory of plates, University press.
4. N.K. Bairagi, Khanna by Plate Analysis, Publishers, New Delhi.

CE 5105

STRUCTURAL DESIGN

No. of Credits	3 Credits
Instruction	4 Periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course objectives:

1. To brush up the fundamental of design of Reinforced Concrete and steel structures by limit state design and to review the usage of relevant codes.
2. To make the students competent and tailor made, by covering contemporary engineering. Patrice's in the Structural design.
3. To develop mixed qualities like independently handling the design problems and working in a group as team works (through assignments).

Course Out Comes:

1. Students thoroughly understand the concepts of design of flat slabs, circular slabs, &waffle slabs, complexity in the design of slabs with openings.
2. Students are able to design continuous beams independently and can carry out confident the design of portal frames for gravity as well as lateral loads.
3. Attain confidence in Reinforcement detailing of Rein forced Concrete and detailing of steel structures. (interpretation drawings)
4. Able to do the problems independently on the analysis and design of indeterminate beams and frames by plastic theory.
5. Students can adopt the latest systems in the design like composite constructions.

UNIT I

Flat slabs: Introduction, components, IS code recommendations, design methods, design for flexure and shear - openings in flats slabs - Moment transfer and its effect on punching shear .
Design of continuous reinforced concrete beams.

UNIT II

Reinforced Concrete Portal Frames: Introduction, analysis and design of rectangular portal frames for vertical loading - design of hinges. Multi-Storied Building Frames: Design for vertical loads using substitute frame method and design for lateral loads.

UNIT III

Circular Slabs: Introduction, Analysis and Design of Circular Slabs Ribbed and Waffle Slabs.

UNIT IV

Plastic Design of Steel Structures: Plastic analysis and design of indeterminate beams and portal frames of upto single bay two storied and two bay single storied- minimum weight design.

UNIT V

Composite construction: Introduction, design principles, shear connectors and their types -IS codal provisions - design of slab-beam type composite construction systems.

Suggested Reading:

1. Pumia by*"R.C.C. Design"*, B.C., Laxmi Pub. 1998
2. H.J. Shah *by"Reinforced Concrete"* V oI-II, Charotar Pub. 2000.
3. Ramamrutham S. by*"Steel Structurd'* by, Dhanpat Rai Pub. 2001
4. S.A. Raj *by "Design of Steel Structures* " , New Age Pub. 2002.
5. Macleod, I.A, Shear Wall Frame Interaction. A design aid with commentary Portland Cement Association
6. Park, R and Paulay T, Reinforced Concrete Sttuctures, John Wiley & Sons, Newyork

CE 5106

Structural Dynamics

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course Objectives:

- To study the various types and characteristics of loading.
- Formulation of equations of motion.
- To study the response of undamped and damped SDOF and MDOF systems under various loadings.
- Use of approximate and iterative methods.
- Learn to model continuous vibratory systems.
- Use of seismic codes in analysis and design of civil engineering structures.
- Dynamic response by Numerical methods

Outcome:

- Understanding of the fundamental theory of dynamic equation of motions.
- Understanding of the fundamental analysis methods for dynamic systems.
- Understanding of modeling approach of dynamic response in civil engineering applications.

- Create simple computer models for engineering structures using knowledge of structural dynamics.
- Evaluate dynamic response analysis results and understand the possible error sources.
- Interpret dynamic analysis results for design, analysis and research purposes.
- Apply structural dynamics theory to earthquake analysis, response, and design of structures.

UNIT-I

Objectives of dynamic analysis – Types of prescribed dynamic loading – Characteristics of a dynamic problem – Methods of dicretization: Lumped mass Procedure / Consistent mass procedure/generalised displacements – Single Degree Freedom Systems – Formulation of Equation of Motion: d'Alemberts's Principle / Method of Virtual Work / Hamilton's Principle – Influence of Gravity Forces and Ground Motion on equation of motion – Generalised SDOF systems: Rigid Body Assemblage/Distributed Flexibility.

UNIT-II

Response of Un-damped/Damped free vibrations of SDOF systems – Un-damped/Damped vibrations of SDOF systems subjected to Harmonic loading: Dynamic equilibrium /Accelero Meters / Displacement Meters / Resonant Response / Vibration Isolation – Un-damped / Damped vibrations of SDOF systems subjected Periodic loading – Response of SDOF systems subjected Impulse loads: Half-sine pulse/Rectangular pulse/Triangular Pulse/ Shock spectra / Approximate method of impulse load analysis – Un-damped / Damped vibrations of SDOF systems subjected General dynamic loading / Duhamel Integral.

UNIT-III

Multi Degree Freedom Systems: Formulation of Equations of Motion / Evaluation of Lumped Mass Matrix / Evaluation of Stiffness Matrix Un-damped Free Vibrations: Analysis of Frequency matrix and mode shape matrices using detrimental equation/Flexibility Formulation/Ortogonality Conditions/ Normalizing Mode shapes/Analysis of Dynamic Response/Normal Coordinates/ Uncoupled Equations of Motion for un-damped systems/Conditions for damping Ortogonality – Mode super position procedure for damped forced vibrations – Time History Analysis.

UNIT-IV

Practical Vibration Analysis: Stodola Method, Holtzer Method – Fundamental mode only, Reduction of degrees of freedom, basic concepts in matrix iteration.

Variational Formulation of Equations of Motion: Generalised coordinates, Lagrange's Equations of Motion, Application to simple un-damped problems of 2-DOF systems. Vibration of continuous systems.

UNIT-V

Distributed Parameter Systems: Partial Differential Equation of Motion – Beam Flexure (Elementary case) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates.

Numerical Evaluation of Dynamic Response of linear (SDOF/MDOF) systems. Time stepping methods, Central difference method and Newmarks method.

Construction of response spectrum from a design spectrum.

Suggested Reading:

1. Walter C. Hurty & Moshe F. Rubinstein, (1964). "Dynamics of Structures", Prentice Hall India.
2. Clough, Ray. W, and Penzien, Joseph (1982). "Dynamics of Structures", McGraw Hill Company Limited, New Delhi.
3. Mario Paz, (1987). "Structural Dynamics", CBS Publishers.
4. Chopra, A. K, (1996). "Dynamics of Structures", Prentice Hall India.
5. Manish shrikhande and Pankaj Agarwal,(2006), "Earthquake Resistant Design of Structures", Prentice Hall India.

Forensic Engineering and Rehabilitation of Structures

Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

UNIT – I (8 hours)
Failure of structures: Review of the construction theory – performance problems – Responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading

UNIT – II (8 hours)
Diagnosis and Assessment of Distress: Visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack detection techniques – case studies – single and multistorey buildings – Fibreoptic method for prediction of structural weakness

UNIT – III (8 hours)
Environmental Problems and Natural Hazards: Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326

UNIT – IV (8 hours)
Modern Techniques of Retrofitting: Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.

UNIT – V (8 hours)
Rehabilitation of special structures Rehabilitation of Bridges, retaining walls, water retaining structures – case studies.

Suggested Reading:

1. Dovkaminetzky, Design and Construction Failures, Galgotia Publication, New Delhi,2001
2. Jacob Feld and Kenneth L Carper, Structural Failures, Wiley Europe.

CE 6101

REPAIRS AND RETROFITTING OF STRUCTURES

No. of Credits	3 Credits
Instruction	4 Periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

OBJECTIVES: 1**.** To enable the student assess the condition of various types of structures
2. To enable the student identify a strategy for repair of a structure
3. To enable the student comprehend the repair techniques for structures
4. To bring awareness among students of various materials and techniques

UNIT I - MAINTENANCE AND REPAIR STRATEGIES **8**

Maintenance, Facets of Maintenance, importance of Maintenance, various aspects of Inspection, Condition Assessment of a structure, Various methods of Condition assessment , NDT and NDE ,Repair Strategies , Repairs-Rehabilitation-Retrofitting-Strengthening-Upgradation of a Structure, Selection of Materials and Techniques for Repair

UNIT II - REPAIRS TO MASONRY AND CONCRETE STRUCTURES **8**

Methods of crack repair in masonry and concrete structures, routing and sealing of cracks, removal and surface preparation in masonry and concrete structures, cleaning of reinforcement steel, reinforcement repair, anchorage, bonding repair materials to existing concrete, material placement methods; Shot-creting and guniting, Grouting- Portland cement grouting, chemical grouting, Dry packing, polymer impregnation, Strengthening of structures: Techniques, design consideration, flexural strengthening, Shear Strengthening, strengthening of columns-jacketing of Columns, strengthening by interior and external reinforcing, External Pre-stressing, Fiber wrapping, Corrosion Protection: surface treatment, joint sealants, cathodic protection, removal and replacement techniques of Structural members.

UNIT III - REPAIRS TO TIMBER AND STEEL STRUCTURES **8**

Testing of Timber Structures for rots , marine borers , Creosote retention , mico biological activity and moisture content –Planning for repairs in Timber Structures- Repairs to Timber Structures Testing of structural steel, lamination, Dynamic Loading and Fatigue, welding technology, weldability, Cleaning and surface Preparation of Corroded Structural Steel, replacement and addition of new members,different Types of Steel and Composite Joints,

UNIT IV - REPAIRS TO SPECIAL STRUCTURES AND SPECIAL REPAIRING TECHNIQUES **8**

Repairs to Concrete Structures under water , Repairs to Bridges , Repairs to Water Tanks , Repairs to Tunnels , Repairs to Dams – At least one case study for each of these structures – Strengthening using FRP -Strengthening and stabilization techniques for repair , Engineered demolition techniques for structures – Implosion -case studies

UNIT V - SEISMIC RETROFITTING OF STRUCTURES **8**

Condition Assessment of Buildings - Repair and Retrofit of Non-engineered Buildings - Retrofit of Masonry Buildings - Retrofit of Historical and Heritage Structures -Structural Analysis for

Seismic Retrofit - Retrofit of Reinforced Concrete Buildings - Retrofit of Steel Buildings - Mitigation of Geotechnical Seismic Hazards - Retrofit of Foundations - Retrofit using Fibre Reinforced Polymer Composites - Base Isolation and Energy Dissipation - Quality Assurance and Control - Retrofit Case Studies

TOTAL: 40 PERIODS

REFERENCES:

1. Den Campbell, Allen and Harold Roper, "Concrete Structures Materials, Maintenance and Repair", Longman Scientific and Technical, UK, 1991.
2. Allen R.T and Edwards S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987
3. Philip H. Perkins"Repair , Protection and Waterproofing of Concrete Structures",Elsevier Applied Science Publisher, London,Newyark, 1986
4.P.C. Guha " Maintenance and Repairs of Buildings " , New Central Book Agency , Kolkata , 2006
5.H.W.Kwon " Maintenance and Repair of Concrete under water" , 11th International Conference Proceedings ,Conclinic Co. Ltd., 2013
6.CPWD " Handbook on Repair and Rehabilitation of RC buildings " , Director General of CPWD , New Delhi,2002
7.IITM & CPWD " Hand book on Seismic Retrofit of buildings " , Narosa Publishing House
8.American Wood Council " National Design Specification " , 2005

CE6102 *With effect from the academic year 2014-2015*

THEORY OF SHELLS AND FOLDED PLATES

No. of credits	3 Credits
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

UNIT – I

Introduction: Definition and Classification of shells.
Cylindrical Shells: Membrane Theory - Equilibrium equations for a differential shell element - Calculation of stresses and displacements due to dead loads and snow loads for circular cylindrical shell.

UNIT-II

Bending Theory- Necessicity of bending theory (i) D.K.J. theory Assumption -Equilibrium equations for a differential element-stress strain relations -Moment curvature relations - Derivation of D.K.J. Differential and characteristics equations - Roots of the Characteristics equation - Expression for defection (ii) Schorer theory , Assumptions - Equilibrium equations for a differential shell element – Stress strain relations Moment curvature relations - Derivation of Schorer differential and characteristic equations -Roots of the characteristic equation, Expression of defection.

UNIT-III

Beam Theory - Assumptions and range of their validity - Outline of the beam arch analysis - Advantages of beams theory over other theories

UNIT-IV

Shells of Doubles Curvature: Membrane theory of shells of revolution - Equilibrium equations for a differential shell element - Calculation of Stresses in a spherical dome due to uniform load over the surface and due to concentrated load around a skylight opening. Shells of translation equilibrium equations for a differential shell element. Puncher's stress function, derivation of a differential equation from equations of equilibrium using purchaser's stress function calculation of tresses in hyperbolic parabolids with straight edges under uniform load over the surface.

UNIT-V

Folded Plates: Assumptions - structural behaviour - Resolutions of ridge loads- Edge sheers - Stress distribution - PIate deflections and rotations Effect of joint moments - Analysis of V sshped folded plates using (i) Simpson and (ii) Whitney methods.

Suggested Reading:

1. S. Thimoshenko& W. Krieger, by "*Theory of Plates, & Shells*", Mc . Graw Hill, 1959.
2. G. S. Rama Swamy ,by "*Design and Construction of Concrete shell roofs*", CBS Pub. 1986
3. J. Ramchandran, by "*Thin Shells Theory and Problems*", Universities Press 1993.

NEURAL, FUZZY AND EXPERT SYSTEMS

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

UNIT – I

Introduction: Brief introduction to the study of artificial intelligence:" An insight to the concept of natural intelligence followed by the development of artificial neural networks, fuzzy logic systems and expert systems tools. Demonstration of the importance of artificial neural networks, fuzzy logic, and expert systems with the help of at least two practical examples of Civil Engineering for each study. Importance of nuero-fuzzy systems

UNIT – II

Neural Networks: Components of artificial neural networks -neurons, inputs, outputs, error, error propagation, hidden layers threshold logic, weights: bias, noise, momentum, rate of learning, training and testing-Hebb's rule, Delta rule - Supervised learning – Generalized delta rule-unsupervised learning - Types of Neural Networks - Perceptions - feed forward back propagation networks - Hop field networks.

UNIT – III

Fuzzy sets: Crispness vagueness, uncertainty, and fuzzy sets. Basic Definitions and operations of Fuzzy sets, approximate reasoning, and membership function.

Fuzzy Relations: Fuzzy relation and fuzzy composition, fuzzy aggregation procedures, Dominance Matrix, Weight ages, applications of Fuzzy sets to civil engineering problems, and pattern recognition.

UNIT-IV

Expert systems: Structure of expert systems, Knowledge of acquisition, Knowledge organization, methods of representing knowledge, types of inference engines, reasoning under uncertainty, various types of expert system tools, heuristics, search mechanism, expert system Development and hybrid expert systems.

UNIT-V

Exposure to Software Packages:Neural networks (Matlab tool kit)–fuzzy logic - expert systems (L5 object) - Applications of Artificial Neural Networks, Fuzzy logic and expert systems in Civil Engineering- Case studies with atIeast one problem on each aspect of ANN, FL and Expert systems

Suggested Reading:

1. Zimmerman. H.J., "*Fuzzy Sets, Decision Making, and Expert Systems*", KIuwer Academic Publications, Boston, 1987.
2. Elaine Rich, Juda Pearl, Heuristics, "*Artificial Intelligence and Expert System*",
3. Adeli H., Chapman, 1988, "*Expert Systems in Construction and Structural Engineering*".
4. Freeman, J.A., and Skapura, D.M. Addition-Wesley, Reading MA, 1991, "*Neural Networks Algorithms, Applications and Programming*".

CE 6104 *With effect from the academic year 2014-2015*

ADVANCED REINFORCED CONCRETE DESIGN

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessionals	25 Marks

Course objectives:

4. To review the fundamental of Limit State Design of Reinforced Concrete Sections as per IS: 456-2000.
5. To make the students to understand the Analysis and Design and Detailing of Curved and Deep Beams.
6. To enable the students understand internal stresses developed in Domes – Analysis and Design.
7. To introduce the students various theories and design principles of Bunkers and Silos - Analysis and Design.
8. To make the students to understand the structural behaviour and design principles of Raft, Pile and Machine foundations.

Course Out Comes:

Upon the completion of this course, the student should

- be able to Analyse and Design suitable curved and deep beam as per the field requirements.
- be able to find the stresses in domes for various loads and design them.
- justify the various theories of analyzing Bunkers and Silos and their design.
- be able to predict structural behaviour of Raft, Pile and Machine foundations and design them.

UNIT – I

Beams curved in plan: Introduction – Design Principles – Structural Design of beams curved in plan of circular and rectangular types.

Deep Beams. Introduction – flexural and shear stresses in deep beams. – I.S. Code provisions – design of Deep beams.

UNIT - II

Domes: introduction - Stresses and forces in domes - design of spherical and conical domes.
Bunkers and Silos: Introduction - Design principles and theories - IS Code provision - design of square and circular bunkers - design of cylindrical soils.

UNIT – III

Building Frames: Substitute frame method of analysis for building frames-design of rectangular portal frames for vertical loading including hinges at the base- Detailing of frames.

Flat slabs: Introduction, Components- I.S. Code Provisions – Design methods, Design for flexure and shear – Openings in Flat slabs

UNIT – IV

Pile foundations – Structural design of piles and pile caps

Raft Foundations: Definitions, Types – Structural analysis and design of Raft foundation for buildings with column grids up to three by two

UNIT-V

Analysis, Design and Detailing of Shear Walls considering shear wall-frame interaction in a tall RC structure subjected to wind loading.

Suggested Reading:

1. N.Krishna Raju by Advanced Reinforced Concrete Design, CBS Publishers
2. H.J. Shah, Reinforced Concrete, Charoatr Publishers
3. P.C.Varghese, Advanced Reinforced Concrte Design, PHI, 2001
4. Dr. B.C.Punmia, et al, Comprehensive R.C.C. Designs, Laxmi Pub. 1998.

CE6105 *With effect from the academic year 2014-2015*

TALL BUILDINGS

Number of Credits	3 Credits
Instruction	4 periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks

Course Objectives:

I. To make the student learn**:**

1. the differences between the regular buildings and tall buildings
2. various structural systems usually considered for the functional design of the tall buildings
3. various methods of calculation lateral forces (both wind forces and seismic/ earth quake forces) on the tall buildings
4. the provisions of relevant IS codes (IS:875 - Part-3, IS:1893 - Part-1) in calculating the lateral forces mentioned above, on tall buildings
5. the importance of shear wall in resisting the lateral forces on the tall buildings
6. the importance of ductility of various structural members in resisting the seismic loads on tall buildings and the relevant provisions of the IS code (IS: 13920) regarding the reinforcement detailing in achieving this ductility in RCC members.
7. the concept of capacity based design in resisting seismic forces on tall buildings

II. To mould the student as a specialist structural engineer in handling the design of tall buildings

III. To make the student as an illustrious alumni of the Institute by virtue of the success in the specialized field of tall building design.

IV. To develop interest in the student for pursuing higher education/research in the field of tall buildings.

Course Outcomes:

I. The students learnt:

1. the differences between the regular buildings and tall buildings
2. various structural systems usually considered for the functional design of the tall buildings
3. various methods of calculation lateral forces (both wind forces and seismic/ earth quake forces) on the tall buildings
4. the provisions of relevant IS codes (IS:875 - Part-3, IS:1893 - Part-1) in calculating the lateral forces mentioned above, on tall buildings
5. the importance of shear wall in resisting the lateral forces on the tall buildings
6. the importance of ductility of various structural members in resisting the seismic loads on tall buildings and the relevant provisions of the IS code (IS: 13920) regarding the reinforcement detailing in achieving this ductility in RCC members.
7. the concept of capacity based design in resisting seismic forces on tall buildings

II. The students are knowledgeble enough to handle the design of tall buildings

III. Given the knowledge levels of the students in general, in the subject of Tall Buildings are such that they would be successful in their professional careers.

This success would make each student as an illustrious alumni of the Institute.

IV. Some students wish to take up their M.Tech desertation (Project work) in the desighn of Tall Buildings using the prominenet softwares in the market like STAAD Pro, ETABS etc. Some students even expressed their inclination to pursue further learning in the field of Tall Buildings to keep them abreast with the latest trends in the design of Tall Buildings.

Course Syllabus:

UNIT-I

Introduction:

Design Principles for Lateral Load resistance, ductility considerations in earthquake resistant design of concrete buildings, construction methods, choice of materials, cladding systems and their design principles, types of foundations for tall buildings.

UNIT-II

Wind Loads:

Introduction to wind, characteristics of wind, Computation of wind loads on buildings as per IS code methods, Wind Tunnel testing, Introduction to Computational Fluid Dynamics.

UNIT-III

Seismic Loads:

Introduction to Earthquakes, Characteristics of Earthquake, Computation of seismic loads on tall buildings – Response Spectrum Method, , Vibration Control – active control & passive control, Liquefaction effects of earthquake, Introduction to Time history Analysis and Pushover analysis.

UNIT – IV

Structural systems:

Necessity of special structural systems for tall buildings, Structural Systems for **Steel Buildings -** Braced frames, Staggered Truss System, Eccentric Bracing System, Outtrigger & Belt truss system, Tube Systems**;** Structural Systems for **Concrete Buildings -** shear walls, frame tube structures, bundled tube structures**;** Design of shear wall as per IS code

UNIT- V

Special Topics:

Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor levelling problems, Panel zone effects, P-Delta analysis

Suggested Reading:

1. Taranath B. S., "*Structural Analysis and Design of Tall Buildings*", McGraw-Hill Book Company, 1988.
2. Simlu E, "*Wind Effect on Structures: An Introduction to Wind Engineering*",Wile & Sons, 1978.
3. Fintel, M, "*Hand Book of Concrete Engineering*", Von Nostrand, 1974.
4. Emilio Rosenblueth, "*Design of Earthquake Resistant Structures*", Pentech Press Ltd., 1990.
5. Schuellar, W, "*High Rise Building Structures*" , John Wiley & Sons Inc, 1977.
6. Bryan Stafford Smith & Alex Coull, "*Tall Building Structures: Analysis & Design*", Wiley India Pvt Ltd, 1991.
7. Lynn S. Beedle, "*Advances in Tall Buildings*", CBS Publishers and Distributors Delhi, 1996.

STRUCTURAL OPTIMIZATION

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

UNIT-I

Introduction: General Introduction: basic theory and elements of optimization - Terminology and definitions - Basic principles and 'procedure of optimization.

Classical Methods of Optimization: Trial and error method, Monte-Carlo method and Lagrangian Multiplier Method - illustrative examples. Linear Programming: Introduction, terminology, standard form of linear programming problem, geometrical interpretation, canonical form of equation graphical and algebraic methods of solving L.P. problems, illustrative examples.

UNIT- II

Linear Programming: Simplex, methods, Dual formulations illustrative examples.

Network analysis: Introduction to network theory, transportation and assignment models - formulation of mathematical models and solutions- applications to Civil Engineering problems.

UNIT - III

Non Linear programming: Unconstrained and constrained methods of optimization on- .Univariate search, Steepest Descent Methods, Kuhn- Tucker conditions – Penalty functions, slack variables and Lagrangian Multiplier methods - illustrative examples

Geometric and Dynamic Programming : illustrative Examples.

UNIT- IV

Structural Optimization: structural design of rectangular timber , and reinforced concrete beams - Optimization applied to concrete mix proportioning - procedure of optimization for reinforced concrete deep beams.

UNIT-V

Structural Optimization: Optimum structural design of reinforced concrete T and L beams - Optimization of planner trusses - Procedure of optimization for structural grid and slab - floor systems

Suggested Reading:

1. S.S. Rao, "*Engineering Optimization*", New Age Internationals (1999)
2. Paul, J.O., John Wiley & Sons "*Systems Analysis for Civil Engineers*" (1988).

CE 6107 *With effect from the academic year 2014-2015*

ADVANCED STEEL DESIGN

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Note: 1. IS Codes required: IS 800, Is 802, IS 805, IS 806, IS1161.
2. For all units design philosophy is working stress method

Course Objectives:

Structural steel is used extensively in the construction of Industrial buildings, bridges, roof trusses, water tanks & transmission line towers. The aim of introducing this course is to provide a student to have ability to perform analysis and design of steel structures with reference to relevant IS codes.

Course out comes:

1. Students will understand behaviour of structural steel, pressed steel and design philosophies of steel structures.
2. Students will be able to analyze and design of grillage foundation.
3. Students will able to analyze and design of overhead steel and pressed steel water tanks.
4. Students will be able to analyze and design of tubular trusses.
5. Students will be able to analyze and design of bunkers and silos.
6. Students will be able to analyze and design of foundations of Transmission line towers overall arrangements and design of members of Transmission line towers.
7. Students will be able to analyze and design of Beam –Columns subjected to uniaxial and bi-axial bending.

UNIT - I

Beam Columns: Introduction, Design for Uni-axial and Bi-axial bending.

Grillage Foundations: Introduction, necessity of grillage foundations, various types, Design of Grillage foundations for axial loads under single and double columns.

UNIT-II

Steel Tanks: Introduction, Types, loads, permissible stresses - detailed design of elevated rectangular mild steel and pressed steel tanks including staging.

UNIT-III

Tubular Structures: Introduction – Advantages - Permissible Stresses - Design of tubular trusses - Design of tension members, compression members and flexural members including welded joints.

UNIT-IV

Bunkers and Silos: introduction - general design principles- design theories - Janssen's Theory and Airy's Theory - Detailed design of bunkers and silos.

UNIT-V

Transmission Line Towers: Classification, economical spacing and design loads - IS code provisions - Calculation of wind loads and permissible stresses - Overall arrangement and design procedure - Detailed design including foundations

Suggested Reading:

1. B.C. Punmia by "*Design of Steel Structures*" Laxmi Pub. – 2001.
2. P. Dayaratnam by "*Design of Steel Structures*" Orient Longman, Pub.- 1987.
3. I.C. Syal and S. Singh, by "*Design of Steel Structures*", Standard Pub. -2000.
4. Ram Chandra, by "Design of Steel Structures:, Standard Pub.-2011.

CE 6108 *With effect from the academic year 2014-2015*

PRE STRESSED CONCRETE

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of End Examination	3 Hours
End Examination	75 Marks
Sessional	25 Marks

Course Objectives:

Pre stressed concrete is used extensively in the construction of Bridges, Fly over's, Multistoried building and many other important parts of today modern infrastructure. The aim of this course is to introduce students to the basic principles about structural behaviour, analysis and design of pre stressed concrete structures, with reference to IS 1343 code. This course provides students with an opportunity to enhance their skills in pre stressed concrete design and applications. The specific implication, to the serviceability and ultimate limit states are covered.

Course outcomes:

On successful completion of this course

1. Students will understand the general mechanics of behaviour of pre stressed concrete members, types of pre stressing, losses in pre stressing, short and long term deflections in P.S.C members.
2. Students should be able to evaluate the behaviour, analyze and design of pre stressed concrete structures, layout of tendon satisfying strength and serviceability limit states.
3. Student will be able to analyze and design for shear in P.S.C members.
4. Student will be able to analyze the stresses in anchorage zones and design of end anchorage
5. Student should be able to discuss and apprise the recent advances in pre stressed concrete technology.

UNIT-I

General Principles of Pre Stressed Concrete:

Introduction: Basic concepts – Materials - permissible stresses – Advantages – pre-tensing and post tensing – Pre Stressing by straight Concentric, Eccentric bent and Parabolic Tendons – Different methods of Pre stressing – Hoyer System – Freyssinet system – Magnel – Blaton system – Lee Mecal system – Use of IS 1343 code.

Losses of Prestress: Losses in P.S.C. members due to elastic shortening – Shrinkage – Creep in Concrete – Relaxation of Steel – Slip in anchorage – Frictional Loss – Computation of losses.

UNIT – II

Analysis **:** Analysis of sections for prestress and flexure.

Deflections of P.S.C members: Importance of deflections - factors influencing deflections, short term and long term deflections – IS code requirements for Maximum deflections – Computation of deflection due to prestressing force – Dead and live loads – Different cases of loading.

UNIT – III

Design of Section for Flexure: Allowable stresses – Elastic Design and Limit state method of Design of Rectangular – I Section beams for Flexure – Kern of section – Pressure Line – Cable Profile – IS 1343 Codal Provisions – Check for ultimate flexural strength.

Design of Section for Shear and Torsion: Shear and principal stresses – Cracked and uncracked sections – Codal provisions – Ultimate shear resistance – Design of shear reinforcement in beams – Design of torsional reinforcement in beams.

UNIT -IV

Anchorage Zone stress in post tensioned members: Stress distribution in End block – A analysis by Magnel and Guyon' s methods – IS 1343 code provisions – Bursting Tensile force – Design of anchorage zone reinforcement.

UNIT – V

Continuous beams : Advantage and Disadvantages – Primary and Secondary moment – P and C lines – Liner transformation concordant and Non concordant cable profile - Analysis and Design of Continuous beams.

Floor slabs: Analysis and design of one way slab and two way slab.

Suggested reading:

1. N. Krishna Raju *by "Prestressed Concrete"* , Tata Mc Graw-HIl.
2. G.S. Pandit and S.P. Gupta *by "Prestressed Concrete"* , CBS Pub.
3. Arthur H. Nilson, John Wiley *by "Design of Prestressed Concrete*".
4. *T.Y Lin and Burn by Design of prestressed Concrete.*

CE 6109 *With effect from the academic year 2014-2015*

ADVANCED CONCRETE TECHNOLOLGY & CONSTRUCTION TECHNIQUES

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course Objectives:

1. To prepare the graduates as best civil engineers with an excellent comprehension of fundamentals of concrete structure at micro and macro levels and applications of different types of cement and concretes, besides keeping them abreast with latest developments in concrete technology at the National and International levels.
2. To make the graduates best fit in the concrete construction industry by providing knowledge in advanced topics like application of SEM, non-destructive testing methods etc.
3. To give them all inputs required to help them attain professional expertise and establish themselves as renowned concrete technologists.
4. To enable them develop interest in concrete technology area and pursue academic / research assignments by providing information regarding innovative developments on special concretes, eco-friendly and smart concretes, sustainable development and bacterial concretes in concrete technology.

Course Outcomes:

1. Students have learned the fundamentals concrete and how the properties of concrete are affected by the properties of the ingredients of concrete.
2. Students were trained to get selected in reputed companies and for pursuing higher education.
3. 72% pass percentage was achieved in the subject.
4. Students expressed keen interest in doing research in the area of concrete specially SCC, eco-friendly and smart concretes & bacterial concrete.

UNIT – I

Structure of Concrete : Introduction, significance, complexities, structural levels, structure of concrete in Nanometer scale C-S-H-structure, Transition zone in concrete. Transition Zone improvement, scanning Electron Microscopy, Effect of polymers in microstructural Engineering.

UNIT – II

Admixtures and Mix Design: Classification of admixtures, various mineral and chemical admixtures, Influence of admixtures on properties of concrete and field applications.

Mix Design: Basic considerations, mix design process, factors in choice of mix design and their influence. Comparison of mix design – using I.S.Code, ACI & DOE methods. Statistical quality control of concrete.

UNIT – III

Durability of Concrete and Concrete Fracture Mechanics:

Durability of Concrete : Durability and impermeability , Factors governing durability of concrete, cracking, carbonation, Alkali-silica reaction, chemical attack and physical Aggression.

Fracture Mechanics: Introduction, Linear elastic fracture Mechanics, the crack tip plastic zone, crack tip opening displacement, Fracture process in Concrete.

UNIT – IV

Advanced concretes: Fibre reinforced cementations composites: Introduction, factors influencing properties, fibre - cements properties and Mechanical Properties - Hybrid fiber reinforced concrete SIFCON,SIMCON

Ultra high strength concrete-composition, Micro structure, Brittleness and application.

Self compacting concrete (SCC) – Materials for SCC, Requirements of SCC, production and placing, Mix Design, tests in fresh state of SCC (as per EFNARC specification) complexity in making SCC, New generation super plasticizers and viscosity modifiers for SCC, Economy of SCC & applications. Introduction to other special concretes such as Bacterial concrete, Bendable concrete, pervious concrete and translucent concrete.

UNIT – V

Form work and Scaffolding : Form work: Materials, forces on form work, structural requirements, connection, form work system, special forms such as slip forms & permanent forms, specification, design, shores, removal of forms and shores, reshoring, construction loads, failure of form work, economy.

Scaffoldings: Importance – Types of scaffoldings and their safety requirements.

Suggested Readings:

1. A.M.Neville, "*Properties of Concrete*",English Language Book Society/Longman Pub, 1988
2. P.K.Mehta and J.M.M.Paulo, "*Concrete – Microstructure – Properties and Material*", ICI, Indian First Edition, Reprint 1999.
3. Zongjin Li, "Advanced Concrete Technology, John Wiley & Sons, INC, Newjersy, 2011".
4. M.S. Shetty, "Concrete Technlogy", S. Chand & Company Ltd., New Delhi, 2013.
5. A.R. Santhakumar, "Concrete Technolgy", Oxford University press, New Delhi, 2009.
6. N.Krishna Raju, "*Design of Concrete Mix*", CBS Pub., 1985.

BRIDGE ENGINEERING

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course objectives:

1. To introduce the students various types of bridges, History, Materials of construction, Planning and other Engineering Considerations, Codes of practice and various Loading Standards for the construction of new bridges.
2. To make the students understand the Analysis and Design of Solid Slab, Slab – Beam systems and Box Girder system – various methods.
3. To enable the students understand the Analysis and Design of Steel – Concrete Composite Bridges, Truss Bridges.
4. To enable the students understand the Analysis and Design of the components of the Sub Structure. And also the Bridge Appurtenances.
5. To introduce the students the design principles of Long Span Bridges, Continuous Box Girders , Curved and Skew Bridges, Seismic Resistant Design and various construction Techniques.
6. To introduce the students the different ways of Inspection,Maintenance,Rehabilitation,Current Design and Construction Practices, and also the usage of Design Aids, Computer Software and Expert Systems.

Course Out Comes:

Upon the completion of this course, the student should

- be able to Prepare a Detailed Project Report for the proposed bridge.
- justify the various methods/techniques used in the analysis , design , construction and maintenance of different types of bridges.
- expertise the usage of Design Aids, Computer Software and Expert Systems.

UNIT – I

Introduction:

Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), loading standards, (IRC, RDSO, AASHTO), Planning and layout of bridges Railings, drainage system, lighting, Hydraulic design, geological and geo-technical considerations, inspection and maintenance.

UNIT – II

Concrete Bridges :

Bridge deck and approach slabs, design of bridge deck systems, transverse load distribution by Guyon – Maasonet and Hendry Jaeger Methods

UNIT – III

Pre Stressed Concrete and Composite Bridges:

Pre Stressed Concrete Bridges **–** General aspects = Design of Post Tensioned slab deck – Design of post tensioned T Beam and Slab Bridge deck – end block reinforcement – Check for ultimate strength and shear.

Composite Bridges – Advantages – Design principles – complete design of steel – Concrete Composite Bridge deck.

UNIT – IV

Long Span Bridges:

Box girder bridges – Structural action and analysis, Skew box girder bridges

Design principles of Cable stayed and suspension bridges

UNIT – V

Sub structure & Bridge Appurtenances:

Analysis and Design of Piers and abutments

Expansion joints, Design of joints

Types and functions of bearings, design of elastometer bearings,

Construction techniques -cast in–situ, prefabricated, incremental launching, free cantilever construction , inspection, maintenance and rehabilitation

Suggested Reading:

1. Wai-Fah Chen Lian Duan **,** ***"****Bridge Engineering Handbook****",***, CRC Press, USA, 2000
2. Barker, R.M. and Puckett, J.A., John Wiley & Sons, ***"****Design of Highway Bridges*", New York, 1997
3. Xanthakos, P.P., John Wiley & Sons, ***"****Theory and Design of Bridges*", New York, 1994
4. Raja Gopalan, "*Bridge Superstructure" – Narosa Publishing – 2010.*
5. N. Krishnam Raju, "*Design of Bridges"* Oxford and IBH Publishing – 2010.

CE 6112 *With effect from the academic year 2014-2015*

Advanced Foundation Engineering

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of Main Examination	3 Hours
Main Examination	75 Marks
Sessional	25 Marks

Course objectives:

7. The course “Advanced foundation Engineering” will cover various aspects of foundation engineering including soil exploration, details of shallow and deep foundations, retaining walls.
8. The soil-foundation interaction will also be discussed along with the numerical solution techniques of beams and plates resting on elastic foundation bed.
9. The behavior and design methods of foundation on reinforced earth will be discussed.
10. The advanced theories and design of various foundation components will be discussed in logical way.
11. The earth pressure theories for designing the retaining walls will be discussed.
12. The codal provisions of the design of various types of foundation will also be discussed.
13. The number of chosen problems will be solved in this course.

UNIT - I

Introduction, soil exploration, analysis and interpretation of soil exploration data, estimation of soil parameters for foundation design.

Shallow Foundations: Methods for bearing capacity estimation, toal and differential settlements of footing and raft, code provisions - Design of individual footings, strip footing, combined footing, rigid and flexible mat, buoyancy raft, basement raft, underpinning.

UNIT - II

Pile Foundations: Estimation load carrying capacity of single and pile group under various loading conditions.- Pile load testing (static, dynamic methods and data interpretation), settlement of pile foundation, code provisions, design of single pile and pile groups and pile caps.

UNIT – III

Well foundations: Types, components, construction methods, design methods (Terzaghi, IS and IRC approaches, check for stability, base pressure, side pressure and deflection.

Retaining Walls **:**Types (types of flexible and rigid earth retention systems: counter fort, gravity, diaphragm walls, sheet pile walls, soldier piles and lagging) - Support systems for flexible retaining walls (struts, anchoring), construction methods, stability calculations, design of flexible and rigid retaining walls, design of cantilever and anchored sheet pile walls.

UNIT – IV

Soil-Foundation Interaction**:** Idealized soil, foundation and interface behavior- Elastic models of soil behavior; Elastic-plastic and time dependent behavior of soil - Beams and plates on elastic foundation; numerical analysis of beams and plates resting on elastic foundation.

UNIT – V Reinforced Earth **:** Geotechnical properties of reinforced soil, shallow foundation on soil with reinforcement, retaining walls with reinforcements, design considerations.

Suggested Reading:.

1. A.P.S. Selvadurai, "Elastic Analysis of Soil-Foundation Interaction", Elsevier Scientific Publishing Company.
2. Braja M. Das, "Principles of Foundation Engineering", PWS Publishing Company.
3. Joseph Bowles, "Foundation Analysis and Design", McGraw-Hill Book Company.
4. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors.

CE 5204 *With effect from the academic year 2014-2015*

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks

UNIT – I

Basic Concepts: Seismic performance of structures and structural components during earthquakes; Ground motion parameters; Response spectrum, design spectrum.

UNIT – II

Seismic Design Philosophy: Concept of strength, overstrength and ductility, Concept of equal displacement and equal energy principles, capacity design; seismic design consideration in buildings with irregularities.

UNIT – III

Seismic Analysis of Buildings: Equivalent static analysis, response spectrum analysis, mode superposition method; Time history analysis; Modelling concept of reinforced concrete building.

UNIT – IV

Seismic Design of Building Components: Seismic resistant properties of reinforced concrete; Seismic behaviour and design of linear reinforced concrete elements; Seismic behavior of planar reinforced concrete elements, codal provisions.

UNIT – V

Seismic Provisions for Structural Steel Buildings: Materials, connections, joints and fasters; Columns, ordinary, intermediate and special moment resisting frame; Concentrically and eccentrically braced frames.

Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/Reprint
1.	Pauley, T. and Priestley, M.J.N "Seismic Design of Reinforced Concrete and Masonry Buildings", John-Wiley & Sons.	1992
2.	Drysdale, R.G. Hamid, A. H. and Baker, L.R "Masonry Structure: Behaviour and Design", Prentice Hall, Englewood Cliffs.	1994
3.	Schneider, R.R. and Dickey, W.L. "Reinforced Masonry Design", 3nd Ed., Prentice Hall.	1994
4.	Edmund Booth, "Concrete Structure in earthquake regions – Design & Analysis" Longman Scientific & Technical.	1994
5.	"Seismic Evaluation and retrofit of concrete building – Vol. I & II", Applied Technology Council, California, ATC 40.	1996
6.	Penelis, George G., and Kappos, Andreas J., E & F. N., Spon, "Earthquake Resistant Concrete Structures",.	1997
7.	"Building Seismic Safety Council", Federal Emergency Management Agency, Washington, D.C, FEMA 356, 2000, FEMA 440 / ATC 55, 2005, FEMA 310	1998
8.	Amrhein, J. E. "Reinforced Masonry Engineering Handbook", Masonry Institute of America, CRC Press.	1998
9.	Allan Willians, "Seismic Design of Building & Bridges", Oxford University Press.	2003
10.	Robert E. Englekirk "Seismic Design of Reinforced and Precast Concrete Buildings", John-Wiley & Sons.	2003
11.	Steven L. Krammer "Geotechnical Earthquake Engineering", Low Priced Edition, First Indian Reprint, Prentice-Hall International Series in Civil Engineering and Engineering Mechanics, Pearson Education.	2003
12.	Edmund Booth and David Key, Tomas Telford, "Earthquake Design Practice for Buildings",.	2006

EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES

No. of Credits	3 Credits
Instruction	4 periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks

UNIT-I

Behavior of Masonry Structures During Past Earthquakes: Common modes of failure, effect of unit shapes and mortar type, effect of roof and floor systems; Common deficiencies.

Material Properties: Masonry units – stones, brick and concrete blocks, hollow and solid units; Manufacturing process; Mortar, grout and reinforcement; various tests and standards.

UNIT-II

Masonry under Compression: Prism strength, Failure mechanism, types of construction and bonds; Eccentric loading; Slenderness – effective length and effective height, effect of openings; Code provisions.

UNIT -III

Masonry Under Lateral Loads: In-plane and out-of-plane loads, bending parallel and perpendicular top bed joints; shear and flexure behavior of piers; Test and stands; Analysis of perforated shear walls, lateral force distribution for flexible and rigid diaphragms; Arching action; Combined axial and bending actions.

UNIT-IV

Earthquake Resistant Measures: Analysis for earthquake forces, role of floor and roof diaphragm; Concept and design of bands, bandages, splints and ties; Reinforced masonry; Vertical reinforcement at corners and jambs; Measures in random-rubble masonry; Confined masonry; Code provisions.

Masonry Infill's : Effect of Masonry infill's on seismic behavior of framed buildings; Failure modes; Simulation of infill's – FEM and equivalent strut; Safety of infill's in in-plane action- shear, compression and buckling; Out-of-plane action, arching; Code provisions.

UNIT-V

Retrofitting of Masonry Building: Techniques of repair and retrofitting of masonry buildings; IS: 13935-1993 provision for retrofitting.

Advance Concepts: Strength and ductility; Nonlinear pushover analysis ; performance based design; Vulnerability and fragility analysis.

Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/Reprint
1.	Drysdale, R. G., Hamid, A. H. and Baker, L. R., "Masonry Structure: Behaviour and Design", Prentice Hall, Englewood Cliffs.	1994
2.	Schneider, R.R. and Dickey, W. L., "Reinforced Masonry Design", 3rd Ed, Prentice Hall.	1994
3.	Paulay, T. and Priestley, M. J. N., "Seismic Design of Reinforced Concrete and masonry Buildings", John Wiley & Sons.	1995
4.	Amrhein, J. E., "Reinforced Masonry Engineering Handbook," Masonry Institute of America, CRC Press.	1998
5.	Hendry, A. W., "Structural Masonry", Macmillan Press Ltd.	1998
6.	"Prestandard and Commentry For The Seismic Rehabilitation of Buildings," FEMA 356, Federal Emergency Management Agency, Washington, D.C.	2000
7.	Tomazevic, M., "Earthquake Resistant Design of Masonry Buildings", Imperial Colleges Press.	2000
8.	Donald Anderson and Svetlana Brzev, "Seismic Design Guide for Masonry Buildings," Canadian Concrete Masonry Producers Association.	2009

STRUCTURAL ENGINEERING LABORATORY - I

Instruction	3 periods per week
Sessional	50 Marks

1. Evaluation of properties Cement, Fine aggregates, and coarse aggregates
2. Evaluation of properties of Reinforcing Steel. Timbers, Building blocks and Tiles
3. Variation of workability with time for different grades of concrete – Experimental observations
4. Experimental observations on influence of following parameters on strength characteristics of concrete (some of these parameters may be considered depending upon the time).

   i) Size, Shape and grade of coarse aggregate
   ii) Grading of fine aggregate
   iii) Hand mixing / machine mixing
   iv) Aggregate – cement ratio
   v) Coarse aggregate – Fine Aggregate ratio
   vi) Size and shape of test specimen
   vii) Admixtures

CE 5108 *With effect from the academic year 2014-2015*

CAD LAB (proposed in the place of SE Lab – II)

Instruction	3 periods per week
Sessional	50 Marks

1. Spread sheet for design of beams. Using Excel.
2. Spread sheet for design of slabs. Using Excel.
3. Spread sheet for design of column. Using Excel.
4. Spread sheet for design of footing. Using Excel.
5. Analysis of Steel roof truss for gravity loads using software.
6. Analysis of Tall Building for gravity loads using software.
7. Program for concrete mix design (C program).
8. Analysis of beams by Stiffness method (C Program).

SEMINAR – I (I Sem)

Instruction 3 periods per week
Sessional 50 Marks

CE 5110

SEMINAR – II (II Sem)

Instruction 3 periods per week
Sessional 50 Marks

CE 5111

PROJECT SEMINAR

Instruction 3 periods per week
Sessional 50 Marks

Each student will be attached to a faculty member, (guide) for Project Seminar during the Third Semester. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design / Analysis /Experimental related to his / her Specialization: The work will be monitored regularly by the guide. At the end of the Semester, student will write the report on the work done and submit to the guide. Student has to present his / her work before two faculty members (one guide and other to be appointed by Chairman BOS) on a fixed day during last week of the semester in which project seminar is offered. The sessional marks will be awarded jointly by these two examiners based on the report, the presentation and vica voce.

CE 9101

DISSERTATION (III & IV Sem)

Instruction 6 periods per week
University Examination Viva Voce
Sessionals Grade*

***Excellent / Very Good / Good / Satisfactory / Unsatisfactory**