DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF INSTRUCTION AND SYLLABI OF

M.E.

(Civil Engineering)

Specialization:

Structural Engineering

w.e.f 2016-17 (CBCS)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(Autonomous)
Affiliated to Osmania University
Hyderabad – 500 075, Telangana, INDIA

CHAITANYA BHARATHI INSTIUTE OF TECHNOLOGY

(AUTONOMOUS)-CBCS

Gandipet, Hyderabad – 500 075

INSTITUTE

Vision

To be a Centre of Excellence in Technical Education and Research

Mission

To address the Emerging Needs through Quality Technical Education and Advanced Research

DEPARTMENT

Vision

To become and stay as a centre of excellence in the field of Civil Engineering and contribute for the building up of better living environment, infrastructural facilities and protection of natural resources

Mission

To establish and maintain qualitative staff and infrastructure**,** monitor the quality of process such as teaching - learning, consultancy and research**,** maintain strong relationships with reputed Industry, academic and research organizations**,** produce qualitative civil engineers and thus contribute for the betterment of the society.

CHAITANYA BHARATHI INSTIUTE OF TECHNOLOGY

(AUTONOMOUS)

Gandipet, Hyderabad – 500 075

CIVIL ENGINEERING

Programme: M.E (Structural Engineering)

Programme Educational Objectives:

1. To train the graduates as best Structural Engineers with good comprehension of fundamentals and applications of Structural Engineering, besides keeping them abreast with the latest developments at the national and International levels.
2. To produce the graduates with sound technical background and make them industry ready.
3. To prepare the graduates competent to face the State/National and International competitive examinations/evaluation processes.
4. To provide them all requisite inputs that help them attain professional expertise and establish themselves as Structural Engineers.
5. To help them develop interest in Structural Engineering area and pursue academic/ Research assignments

Scheme of Instruction & Examination With effect from the academic year 2016- 2017

M.E. (Structural Engineering) – Civil Engineering - 4 Semesters (Full Time) (CBCS)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective	3	--	3	30	70	100	3
5.	Elective	3	--	3	30	70	100	3
6.	Elective	3	--	3	30	70	100	3
7.	Laboratory-I	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	2	--	--	--	--	--
	Total	**18**	**11**		**340**	**360**	**700**	**25**

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1		30	70	100	4
2.	Core	3	1		30	70	100	4
3.	Core	3	1		30	70	100	4
4.	Elective	3	--		30	70	100	3
5.	Elective	3	--		30	70	100	3
6.	Elective	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	**18**	**11**		**390**	**360**	**750**	**26**

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i)Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	**100**	**--**	**100**	**6**
	Total	**100**		**100**	**6**

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	**100**	**100**	**200**	**12**

Note: Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars,Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and 50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69

M.E. CIVIL ENGINEERING

Instruction and Syllabi

Subjects for Specialization: Structural Engineering

With effect from the academic year 2016-2017

S.No.	Ref. No	SUBJECTS	Period per week		Dura-tion in Hrs.	Marks			Credits
		CORE SUBJECTS	L	T/P		Main Exam	Internal Ses	Internal Ass	
1.	16CEC101	Theory of Elasticity	3	1	3	70	20	10	4
2.	16CEC102	Structural Analysis	3	1	3	70	20	10	4
3.	16CEC103	Finite Element Methods	3	1	3	70	20	10	4
4.	16CEC104	Theory of Plates	3	1	3	70	20	10	4
5.	16CEC105	Structural Design	3	1	3	70	20	10	4
6.	16CEC106	Structural Dynamics	3	1	3	70	20	10	4
		ELECTIVE SUBJECTS							
7.	16CEE101	Repairs and Retro fitting of Structures	3		3	70	20	10	3
8.	16CEE102	Theory of Shells & Folded Plates	3		3	70	20	10	3
9.	16CEE103	Neural, Fuzzy & Expert Systems	3		3	70	20	10	3
10	16CEE104	Advanced Reinforced Concrete Design	3		3	70	20	10	3
11	16CEE105	Tall Buildings	3		3	70	20	10	3
12	16CEE106	Structural Optimization	3		3	70	20	10	3
13	16CEE107	Advanced Steel Design	3		3	70	20	10	3
14	16CEE108	Pre Stressed Concrete	3		3	70	20	10	3
15	16CEE109	Advanced Concrete Technology & Construction Techniques	3		3	70	20	10	3
16	16CEE110	Bridge Engineering	3		3	70	20	10	3
17	16CEE111	Industrial Structures	3		3	70	20	10	3
18	16CEE112	Advanced Foundation Engineering	3		3	70	20	10	3
19	16CEE113	Earthquake Resistant Design of Structures	3		3	70	20	10	3
20	16CEE208	Earthquake Resistant design of Masonry Structures	3		3	70	20	10	3
		DEPARTMENTAL REQUIREMENTS							
21	16CEC107	Structural Engineering Lab-(I Sem)		3			50		2
22	16CEC108	Computer Aided Analysis and Design of Structures Lab- (II Sem)		3			50		2
23	16CEC109	Seminar – I (I Sem)		3			50		2
24	16CEC110	Seminar – II (II Sem)		3			50		2
25	16EG104	Soft Skills Lab		2	Satisfactory/ unsatisfactory				
26	16CEC111	Mini Project		2			50		1
27	16CEC112	Project Seminar (III Sem)		3			100		6
28	16CEC113	Dissertation (III & IV Sem)			#		*		12

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.

16CEC101 **THEORY OF ELASTICITY**

No. of Credits	4
Instruction	3(L) + 1(T)
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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. Stres and stain in three dimensions. Stress components on an oblique plane. Transformation of stress components under change of co-ordinate system.

Unit – II

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 – III

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-IV

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-V

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

Text Book:

1. "**Theory of Elasticity**", S. Timoshenko & N. Goodier, Mc Graw Hill
2. "**Theory of Elasticity**", Valiappan, Mc. Graw Hill

Suggested Reading:

1. R.J Aatkin, N.Fox "An Introduction to Theory of Elasticity", Dover Publications
2.C.T.Wang, "Äpplied Elasticity", McGraw Hill Company

16CEC102

STRUCTURAL ANALYSIS

No. Of Credits	4
Instruction	3(L) + 1(T)
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 Marks

Course Objectives:

1. To enable the students understand the importance of matrix methods and acquire the ability to analyse beams, frames and trusses including grids and gable frames.
2. Make them market ready and comfortably fit into the design offices with good knowledge in matrix methods, and fair knowledge of STTAD
3. Make them understand the importance of buckling phenomena, influence line concepts, and beams on elastic foundations and their field applications.
4. To make them passionate about structural analysis and encourage them take up higher studies and research in this field.

Course Outcomes:

1. Ability to analyse structures with the thorough conceptual knowledge acquired in matrix methods
2. Ability to carry out structural analysis of field problems by making the necessary assumptions and making appropriate assignments like geometry and support conditions etc.
3. Ability to compute critical buckling loads for some simple shapes understanding its implications.
4. Ability to solve problems on beams on elastic foundations for various field conditions.
5. Generate Influence line diagrams for various indeterminate structures and find the internal forces Using ILDs

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.

Text Books:

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.

Suggested Reading:

1. Arababi."*Structural Analysis and Behavior*", by F, Mc Graw Hill, 1991
2. Timoshenko by "*Theory of Elastic Stability*", S, Mc Graw Hill, 1992.

16CEC103 **FINITE ELEMENT METHODS**

No. Of Credits	4
Instruction	3(L) + 1(T)
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 Marks

Course Objectives:

1. To provide the fundamental concepts of the theory of the finite element method.
2. To enable the students to formulate the design problems into FEA.
3. To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
4. To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code
5. To provide the concepts to Solve different domain problems in structural engineering.

Course Outcomes:

1. To obtain an understanding of the fundamental theory of the FEA method;
2. To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
3. To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements
4. To demonstrate the ability to create models for trusses, frames, plate structures, machine parts, and components using ANSYS general-purpose software.
5. To demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes;
6. To develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use

Unit-I:- Introduction to FEM:

Types of problems–types of materials–Elastic -in-Elastic 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 nonconforming elements-3-node triangular are elements (CST), determination of strain-displacement matrix, area coordinates-shape functions, determination of 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 Shape functions–degradation 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.

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 FEA Software's :

Illustration on different modules of FEA Software, Structural engineering applications of the package, Pre-Processing, Analysis and post Processing of the results.

Text Books:

1. Chandrupatla, T. R. And Belegundu, A. D, (2012). "Introduction to Finite Elements in Engineering", Prentice Hall of India, New Delhi.
2. Seshu. P, (2003). "Finite Element Analysis", Prentice Hall of India Private Limited, New Delhi.

Suggested Reading:

1 David V. Hutton, (2005). "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi.

16CEC104

THEORY OF PLATES

No. of Credits	4
Instruction	3(L) + 1(T)
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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
4. Ability to analyse plates using different approximate methods.
5. Aptitude and confidence to analyse field problems and persue research in the area 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.

UNIT –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.

Text Books:

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.

Suggested Reading:

1. Chadrasekhara by Theory of plates, University press.
2. N.K. Bairagi, Khanna by Plate Analysis, Publishers, New Delhi.

16CEC105

STRUCTURAL DESIGN

No. of Credits	4
Instruction	3(L) + 1(T)
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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:

After the completion of the course, the students will

1. Have thorough understanding of the concepts of yield line theory and be able to design slabs of complex shapes and complex supports.
2. Be able to design and detail circular and waffle slabs.
3. Have a deep insight into the non linear behavior of concrete and the concepts of inelastic analysis of concrete structures.
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:

Introduction to Yield line analysis and application for slabs – virtual work method, Application to Rectangular, Trapezoidal, Triangular and circular slabs for various edge conditions with uniformly distributed loads

UNIT II:

Inelastic analysis of reinforced concrete beams and frames-moment curvature relations, concept of plastic hinges, effect of shear on rotation capacity, Bakers method for plastic analysis of beams and frames.

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.

Text Books:

1. P.C. Varghese, "Advanced Reinforced Concrete Design", , Pentice Hall, India Pub.2002
2. Ramachandra, "*Design of steel Structures* VoI-II", Standard Book House.

Suggested Reading:

1. Teaching Resource for Structural Steel Design, Volume 2, IIT Madras and INSDAG
2. N. Krishnam Raju, Advanced Concrete Design", CBS Publishers
3. P.Purushothaman, "Reinforced Concrete Elements", Tata Mcgraw Hill,

16CEC106

STRUCTURAL DYNAMICS

No. of Credits	4
Instruction	3(L) + 1(T)
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 Marks

Course Objectives:

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

Course Outcome:

1. 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.
2. Create simple computer models for engineering structures using knowledge of structural dynamics.
3. Evaluate dynamic response analysis results and understand the possible error sources.
4. Understand modal analysis and its influence on the dynamic response of structures
5. 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.

Text Books:

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.

Suggested Reading:

1. Mario Paz, (1987). "Structural Dynamics", CBS Publishers.
2. Chopra, A. K, (1996). "Dynamics of Structures", Prentice Hall India.
3. Manish shrikhande and Pankaj Agarwal,(2006), "Earthquake Resistant Design of Structures", Prentice Hall India.

16CEE101 **REPAIR AND RETROFITTING OF STRUCTURES**

No. of credits	3
Instructions	3 periods per week
Duration of Main Examination	3 hours
Main examination	70 marks
Sessional	30 marks

Course Objective:

To enable the students

1) Learn the causes of distress and failures in Structural members and also the methods of diagnosis and assessment of distress.
2) Know about the materials and methods for repairing masonry and concrete structures.
3) Grasp the design considerations and repair techniques of composite structures
4) Gain knowledge of testing procedures and repairing techniques of steel structures
5) Become aware of the condition assessment and seismic retrofitting of masonry, reinforced concrete and steel buildings.

Course outcomes :

At the end of the course the stands would be able to

1) Diagonise and assess the destress in structural members through visual inspection and application of various non-destructive techniques.
2) Suggest suitable repairing materials and techniques for masonry and concrete structures.
3) Apply the design considerations and repairing techniques for composite structures.
4) Test the structural steel and suggest suitable replacement and repair techniques for steel structures
5) Assess the condition and suggest suitable seismic retrofitting measures for masonry, reinforced concrete and steel buildings.

UNIT – I :-

Distress, Failures and Diagnosis

Causes of distress and failures in structural members – design and material deficiencies – Extreme loading, Principles of Forensic engineering – Diagnosis and assessment of distress : Visual inspection – non destructive test – ultrasonic pulse velocity method – rebound hammer techniques – pullout tests – Bremor test – Windsor probe test – crack detection techniques.

UNIT – II

REPAIRS TO MASONRY AND CONCRETE STRUCTURES

Method of crack repair in masonry and concrete structures grouting and sealing of cracks, 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,

UNIT – III

REPAIR OF COMPOSITE STRUCTURE

Design consideration, flexural strengthening, shear strengthening, strengthening of columns – jacketing of columns, strengthening by interior and external reinforcing , External prestressing , fiber wrapping, corrosion protection: surface treatment, joint sealants, cathodic protection, removal and replacement techniques of structural members.

UNIT – IV –

REPAIRS TO STEEL STRUCTURES

Testing of structural steel, lamination, dynamic loading and fatigue , welding technology, weld ability, replacement and addition of new members , different types of steel and concrete joints

UNIT – V –
SEISMIC RETROFITTING OF STRUCTURES
Condition assessment of buildings – Repair and retrofit of non-engineered buildings – retrofit of masonry buildings – retrofit of reinforced concrete buildings - retrofit of steel buildings

Text Books:
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", Blackie and sons, UK, 1987.

Suggested Reading:
1. Philip H.Perkins"Repair, Protection and waterproofing of Concrete Structures", Elsevier Applied Science Publisher, London, Newyark, 1986.
2. P.C. Guha "Maintenance and Repair of Buildings", New Central Book Agency, Kolkata, 2006.
3. CPWD"Handbook on Repair and Rehabilitation of RC Buildings", Director General of CPWD, New Delhi, 2002.
4. IITM & CPWD "Handbook on Seismic Retrofit of Buildings", Narosa Publishing House.
5. American Wood Council "National Design Specification", 2005.

16CEE102 **THEORY OF SHELLS AND FOLDED PLATES**

No. of credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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.

Text Books:

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

Suggested Reading:

1. J. Ramchandran, by "*Thin Shells Theory and Problems*", Universities Press 1993.

16CEE103 **NEURAL, FUZZY AND EXPERT SYSTEMS**

No. of Credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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

Text Books:

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*",

Suggested Reading:

1. Adeli H., Chapman, 1988, "*Expert Systems in Construction and Structural Engineering*".
2. Freeman, J.A., and Skapura, D.M. Addition-Wesley, Reading MA, 1991, "*Neural Networks Algorithms, Applications and Programming*".

16CEE104 ADVANCED REINFORCED CONCRETE DESIGN

No. of Credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessionals	30 Marks

Course objectives:

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

Course Out Comes:

1. Upon the completion of this course, the student should
2. Be able to Analyse and Design suitable curved and deep beam as per the field requirements.
3. Be able to find the stresses in domes for various loads and design them.
4. Justify the various theories of analyzing Bunkers and Silos and their design.
5. 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.

Text Books:

1. N.Krishna Raju by Advanced Reinforced Concrete Design, CBS Publishers
2. H.J. Shah, Reinforced Concrete, Charoatr Publishers

Suggested Reading:

1. P.C.Varghese, Advanced Reinforced Concrte Design, PHI, 2001
2 Dr. B.C.Punmia, et al, Comprehensive R.C.C. Designs, Laxmi Pub. 1998.

16CEE105 **TALL BUILDINGS**

Number of Credits	3
Instruction	3 periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 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. the provisions of relevant IS codes (IS:875 - Part-3, IS:1893 - Part-1) in calculating the lateral forces mentioned above, on tall buildings
4. the importance of shear wall in resisting the lateral forces on the tall buildings
5. 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.

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

Text Books:

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.

Suggested Reading:

1. Fintel, M, "*Hand Book of Concrete Engineering*", Von Nostrand, 1974.
2. Emilio Rosenblueth, "*Design of Earthquake Resistant Structures*", Pentech Press Ltd., 1990.
3. Schuellar, W, "*High Rise Building Structures*" , John Wiley & Sons Inc, 1977.
4. Bryan Stafford Smith & Alex Coull, "*Tall Building Structures: Analysis & Design*", Wiley India Pvt Ltd, 1991.
5. Lynn S. Beedle, "*Advances in Tall Buildings*", CBS Publishers and Distributors Delhi, 1996.

16CEE106 STRUCTURAL OPTIMIZATION

No. of Credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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

Text Books:

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

16CEE107 **ADVANCED STEEL DESIGN**

No. of Credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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 be able to analyze and design of grillage foundation and beam columns .
2. Students will able to analyze and design of overhead steel and pressed steel water tanks.
3. Students will be able to analyze and design of tubular trusses.
4. Students will be able to analyze and design of bunkers and silos.
5. Students will be able to analyze and design of foundations of Transmission line towers overall arrangements and design of members of Transmission line towers.

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

Text Books:

1. B.C. Punmia by "*Design of Steel Structures*" Laxmi Pub. – 2001.
2. P. Dayaratnam by "*Design of Steel Structures*" Orient Longman, Pub.- 1987.

Suggested Reading:

1. I.C. Syal and S. Singh, by "*Design of Steel Structures*", Standard Pub. -2000.
2. Ram Chandra, by "Design of Steel Structures:, Standard Pub.-2011.

16CEE108 **PRE STRESSED CONCRETE**

No. of Credits	3
Instruction	3 periods per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessional	30 Marks

Course Objectives:

1. The aim of this course is to introduce students to the basic principles about structural behaviour, of pre stressed concrete structures, with reference to IS 1343 code

2. The objective is to equip the students with a thorough understanding of the behaviour and analysis ,design of prestressed concrete beam, slab and column.

3. Various time dependent factors, such as cracking, creep and shrinkage of concrete, and prestress losses, are discussed thoroughly.

4. Background to design equations and relevant modern research will also be discussed to provide the students with solid understanding of the topics covered.
.
5. To provide 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 mechanism 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 will be able to evaluate the behavior of pre stressed concrete structures,
3. Students will be able to analyze and design of pre stressed concrete structures using serviceability limit states.
4. Student will be able to analyze and design for shear in P.S.C members.
5. Student will be able to analyze the stresses in anchorage zones and design the end anchorages
6. Student will 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 Pre stress: 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 pre stress 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 pre stressing 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.

Text Books:

1. N. Krishna Raju *by "Prestressed Concrete" ,* Tata Mc Graw-HIl.
2. G.S. Pandit and S.P. Gupta *by "Prestressed Concrete" ,* CBS Pub.

Suggested Reading:

1. Arthur H. Nilson, John Wiley *by "Design of Prestressed Concrete*".
2. *T.Y Lin and Burn by Design of prestressed Concrete.*

16CEE109 ADVANCED CONCRETE TECHNOLOGY & CONSTRUCTION TECHNIQUES

No. of Credits	3
Instruction	3periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 Marks

Course Objectives:

1. To enable the students comprehend fundamentals of structure of concrete at nano, micro and macro levels and gain knowledge of SEM and it's applications.
2. Attain detailed knowledge of various types of Admixtures used for concrete , their properties , functions and applications and also learn the fundamentals of IS code , ACI and DoE methods of mix designs.
3. Learn the concepts of durability of concrete and fundamentals of Fracture mechanics of concrete .
4. Gain exposure to various types of Advanced concretes, their making, properties and applications.
5. Know about the form work and scaffolding for concrete, their design principles and safety requirements.

Course Outcomes:

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

1. Study the micro-structure of concrete in a given context and situation and suggest suitable measures for improving its transition zone and other properties.
2. Use or suggest suitable admixtures for concrete in a given situation and context.
3. Identify the processes and mechanisms that disturb the durability of concrete and suggest suitable remedial measures; also, apply the fundamentals of fracture mechanics of concrete wherever necessary.
4. Apply or suggest suitable advanced concretes for a given special situation.
5. Design or suggest suitable form work and scaffolding for concrete in a given situation and also check their safety aspects.

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.

U**NIT – 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.

Text Books:

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.

Suggested Reading:

1. Zongjin Li, "Advanced Concrete Technology, John Wiley & Sons, INC, Newjersy, 2011".
2. M.S. Shetty, "Concrete Technlogy", S. Chand & Company Ltd., New Delhi, 2013.
3. A.R. Santhakumar, "Concrete Technolgy", Oxford University press, New Delhi, 2009.
4. N.Krishna Raju, "*Design of Concrete Mix*", CBS Pub., 1985.

16CEE110 **BRIDGE ENGINEERING**

No. of Credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 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

Text Books:

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

Suggested Reading:

1. Xanthakos, P.P., John Wiley & Sons, "*Theory and Design of Bridges*", New York, 1994
2. Raja Gopalan, "*Bridge Superstructure" – Narosa Publishing – 2010.*
3. N. Krishnam Raju, "*Design of Bridges"* Oxford and IBH Publishing – 2010.

16CEE112 **ADVANCED FOUNDATION ENGINEERING**

No. of Credits	3
Instruction	3 periods per week
Duration of Main Examination	3 Hours
Main Examination	70 Marks
Sessional	30 Marks

Course objectives:

1. The course "Advanced foundation Engineering" will cover various aspects of foundation engineering including soil exploration, details of shallow and deep foundations, retaining walls.
2. The soil-foundation interaction will also be discussed along with the numerical solution techniques of beams and plates resting on elastic foundation bed.
3. The behavior and design methods of foundation on reinforced earth will be discussed.
4. The advanced theories and design of various foundation components will be discussed in logical way.
5. The earth pressure theories for designing the retaining walls will be discussed.
6. The codal provisions of the design of various types of foundation will also be discussed.
7. 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.

Text Books:.

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.

Suggested Reading:

1. Joseph Bowles, "Foundation Analysis and Design", McGraw-Hill Book Company.
2. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors.

16CEE113 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

No. of Credits	3
Instruction	3 periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 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.

Text 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

16CEE208 EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES

No. of Credits	3
Instruction	3 periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 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.

Text 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

16CEC107 STRUCTURAL ENGINEERING LABORATORY

No. of Credits	3
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

16CEC108 COMPUTER AIDED ANALYSIS AND DESIGN OF STRUCTURES LAB

No. of Credits	3
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).

16CEC109 **SEMINAR – I (I Sem)**

No. of Credits	3
Instruction	3 periods per week
Sessional	50 Marks

16CEC110 **SEMINAR – II (II Sem)**

No. of Credits	3
Instruction	3 periods per week
Sessional	50 Marks

Code16 EG 104 **SOFT SKILLS LAB**

No. of Credits	Nil
Instruction	2 periods per week
Final Assessment	Satisfactory/unsatisfactory

Course Objectives: To help the students

1. Participate in group discussions and case studies with confidence and to make effective presentations. Also to learn the art of communication.
2. With- resume packaging, preparing and facing interviews.
3. Build an impressive personality through effective time management, leadership, self-confidence and assertiveness.
4. Understand what constitutes proper grooming and etiquette in a professional environment. Also to understand academic ethics and value systems.
5. To be competent in verbal aptitude.

Course Outcomes: The students will be able to

1. Be effective communicators and participate in group discussions and case studies with confidence. Also be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals. Also learn to mange time effectively and deal with stress.
4. Make the transition smoothly from campus to corporate. Also use media with etiquette and know what academic ethics are.
5. Correct and complete sentences, have a good vocabulary and comprehend passages confidently

Exercise 1

Group Discussion & Case studies – dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.
Elements of effective presentation – Structure of presentation – Presentation tools – Body language
Creating an effective PPT

Exercise 2

Interview Skills – Resume' writing – structure and presentation, planning, defining the career objective, projecting ones strengths and skill-sets
Interview Skills – concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews

Exercise 3

Personality Development – Effective Time Management, assertiveness, decision making and problem solving, stress management, team building and leadership.

Exercise 4

Corporate Culture – Grooming and etiquette, corporate communication etiquette.
Academic ethics and integrity

Exercise 5

Verbal Aptitude – Sentence correction, sentence completion, jumbled sentences and vocabulary.
Reading comprehension

Suggested Reading:

1. Leena Sen , "Communication Skills", Prentice-Hall of India, 2005
2. Dr. Shalini Verma, "Body Language- Your Success Mantra", S Chand, 2006
3. Edgar Thorpe and Showick Thorpe , "Objective English", 2nd edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010
5. Gulati and Sarvesh, " Corporate Soft Skills", New Delhi: Rupa and Co. , 2006
6. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004
7. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal
8. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989

16CEC 111 **MINI PROJECT**

No. of Credits	1
Instruction	2 Periods per week
Sessional	50 Marks

Outcomes:

Students are able to

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained and write the documentation in standard format

Objectives:

First year ME students will each do a 14-week mini project, each generally comprising about one week of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment (see assessment information below). Each student will be allotted to a Faculty supervisor for mentoring.

Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original. Mini projects should have inter disciplinary/ industry relevance. The students can select a mathematical modeling based/Experimental investigations or Numerical modeling. All the investigations are clearly stated and documented with the reasons/explanations. All the projects should contain A clear statement of the research objectives, background of work, Literature review, techniques used, prospective deliverables, benefit from this [line of] research, Detailed discussion on results, Conclusions and references.

Assessment:

1. 50 % of marks for a scientific report on the project.
   Regarding the formatting and structure, the report should be written as a journal article using the style file of a journal appropriate for the field of the research (which journal format is most appropriate should be agreed between student and supervisor).
   Regarding content, the report should be understandable by your fellow students, so the introduction and literature review could be a bit more detailed than in a research paper. The results and discussions are in elaborate form and at end conclusions and include references.

2. 50 % of marks for an oral presentation which will take place at the end of the semester and evaluation by a committee consist of Supervisor, one senior faculty and Head of the department or his nominee.

16CEC112 **PROJECT SEMINAR**

No. of Credits	6
Instruction	3 periods per week
Sessional	100 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.

16CEC113 **DISSERTATION (III & IV Sem)**

No. of Credits	12
University Examination	Viva Voce
Marks	100+100

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