Syllabus for Structural Engineering

1st SEMESTER				2nd SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
CEPC101	Theory of Elasticity and Plasticity	4-0-0	4	CEPC201	Elastic Stability and Behaviour of Metal Structures	4-0-0	4
CEPC102	Structural Dynamics	4-0-0	4	CEPC202	Advanced Reinforced Concrete Design	4-0-0	4
CEPC103	Matrix methods of Analysis of Structures	4-0-0	4		Professional Electives-III (Any One)	3-0-0	3
				CEPE201	a) Offshore Structures		
				CEPE202	b) Wind Engineering		
				CEPE203	c) Composite Structures		
					Professional Electives-IV (Any One)	3-0-0	3
				CEPE204	d) Structural Optimisation		
				CEPE205	e) Soil Dynamics and Geotechnical Earthquake Engineering		
				CEPE206	f) Infrastructure Engineering and Transportation Planning		
					Professional Electives-IV (Any One)	3-0-0	3
				CEPE207	g) Finite Element Analysis of Structures		
				CEPE208	h)Advanced Steel Structures		
				CEPE209	i) Industrial Structures		
	Professional Electives-I (Any One)	3-0-0	3				
CEPE101	a) Bridge Engineering	3-0-0	3				
CEPE103	b) Advance Numerical methods						
CEPE104	c) Theory of Plates and Shells						
	Professional Electives-II (Any One)						
CEPE102	d) Advance Construction Materials						
CEPE105	e) Earthquake Resistant Design of Structures						
CEPE106	f) Tall Structures						
	Credits (Theory)		18		Credits (Theory)		17
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
CEPR101	Structural Engineering Laboratory	0-0-3	2	PCPR201	Earthquake Resistant Design and Detailing of Structures	0-0-6	4
CMPR101	CAD Laboratory	0-0-3	2	CECV201	Comprehensive Viva	0-0-3	2
CEPT101	Technical Seminar	0-0-3	2	CECV202	Technical Seminar	0-0-3	2
	Credits (Practicals/Sessionals)		6		Credits (Practicals/Sessionals)		8
	TOTAL SEMESTER CREDITS		24		TOTAL SEMESTER CREDITS		25
	TOTAL CUMULATIVE CREDITS		24		TOTAL CUMULATIVE CREDITS		49

3rd SEMESTER				4th SEMESTER			
THEORY		*Contact Hours*		*THEORY*		*Contact Hours*	
Code	*Subject*	*L-T-P*	*Credits*	*Code*	*Subject*	*L-T-P*	*Credits*
OE	Open Electives a) Disaster Management and Mitigation b) Non Conventional Energy c) Project Planning and Construction Management	3-0-0	3				
		Credits (Theory)	03			Credits (Theory)	00
	PRACTICALS/SESSIONALS				*PRACTICALS/SESSIONALS*		
PC	Thesis Part-I	0-0-3	14	CEPT401	Thesis Part-II	0-0-6	20
				CECV401	Technical Seminar	0-0-3	2
				CECV402	Viva	0-0-3	2
		Credits (Practicals/Sessionals)	14			Credits (Practicals/Sessionals)	24
		TOTAL SEMESTER CREDITS	17			TOTAL SEMESTER CREDITS	24
		TOTAL CUMULATIVE CREDITS	66			TOTAL CUMULATIVE CREDITS	90

Theory of Elasticity & Plasticity

Module-1 :

Linear elasticity; stress, strain, constitutive relations, strain displacement relations, three dimensional stress and strain analysis, compatibility, stress and displacement functions.

Module 2:

Two dimensional problems in Cartesian and polar coordinates, description of an elasticity problem as a boundary value problem, bending of beams-cantilever and simply supported beam.

Module 3:

Torsion of rectangular bars including hollow sections, torsion of a circular and a rectangular section

Module-4: Elements of plasticity, failure & yield criterion, Equations of plasticity, plastic stress-strain relations, flow rule, velocity field, slip lines and plastic flow, incremental plasticity.

Books:

(1) S.P.Timoshenko & J.N.Goodier,"Theory of Elasticity", McGraw Hill-1970.
(2) M.Kachanov, "Theory of Plasticity", MIR Publication.
(3) C.R.Calladine, "Plasticity for Engineers", Ellis Horwood, Chichester,U.K.,1985

Structural Dynamics

Module 1:

Oscillatory motion; harmonic motion, periodic motion, vibration terminology,
Free vibration; equations of motion-natural frequency, energy method, principle of virtual work, viscously damped free vibration, Coulomb damping, Harmonically excited vibration; forced harmonic vibration, energy dissipated by damping, equivalent viscous damping, structural damping, vibration measuring instruments

Module 2:

Transient vibration; impulse excitation, arbitrary excitation, Laplace transform formulation, response spectrum,
Introduction to multi degree of freedom systems; normal mode vibration, forced harmonic vibration, vibration absorber, vibration damper.

Module 3:

Properties of vibrating systems, flexibility matrix, stiffness matrix, stiffness to beam elements, eigen values and eigen vectors, modal matrix, modal damping in forced vibration, normal mode summation, normal mode vibration of continuous beams, vibrating string, longitudinal vibration of rods, torsional vibration of rods, Euler equation for beam, effect of rotary inertia and shear deformation.

Module 4:

Random vibrations, random phenomena, time averaging and expected value, frequency response function.

Books:

(1) W.T.Thomson, "Theory of Vibration with Applications"
(2) R.W. Clough & J.Penzien, " Dynamics of Structures", McGraw Hill

Matrix Methods of Analysis of Structures

Module 1: Introduction, equilibrium, static and kinematic indeterminacy, kinematics, virtual work, concepts of stiffness and flexibility, analysis by displacement and force methods.

Module 2: Application of flexibility method to beams and plane trusses.

Module 3: Application of stiffness method to beams, plane frames and plane trusses.

Module 4: Application of stiffness method to space truss, space frames and grids, basic concepts associated with computer implementation of stiffness method.

Books:

(1) H.C.Martin," Introduction to Matrix Methods of Structural Analysis.
(2) M.B.Kanchi, "Matrix Methods of Structural Analysis", New Age International Publishers, New Delhi Kardestuncer ,
(3) "Elementary Matrix Analysis of Structures" Gere & Weaver,"Matrix Structural Analysis'

Professional Electives –I (Any One)

Bridge Engineering

Module 1: Introduction and selection of type of bridges, longitudinal arrangement and economical span, bridge components, Design preliminaries: Layout, types of loads including wind and seismic loads, standard specifications for road bridges, substructures, superstructures, IRC provisions on loads and stresses, specification for single/double multi lane railway and road bridges, Abutments, piers and their foundations .

Module 2: Design of reinforced concrete slab culvert, box culvert bridge.

Module 3: Tee beam and slab bridge deck, design of prestressed concrete bridge.

Module 4: Design of balanced cantilever bridge, design of continuous bridge, Introduction to long span bridges.

Books:

N.K.Raju, " Design of bridges", Oxford & IBH Publishing Co. pvt. ltd.
D.J.Victor," Essentials of bridge engineering", Oxford & IBH Publishing Co. pvt. ltd.
Indian Road Congress Codes No.5,6,18,21,24, Jamnagar House, Shah Jahan Road, New Delhi.

Advanced Numerical Methods

Module 1: Introduction to digital computers & Programming - an overview; Errors - polynomial approximations and interpolations - Numerical differentiation & Integration;

Module 2: Evaluation of single and multiple integrals, Newton's method, variational and weightened residual methods., Matrices – Linear equations, Eigenvalues and Eigenvectors - nonlinear equations,

Module 3: Harmonic and biharmonic equations - solutions, convergence, completeness & stability.

Module 4: Initial and boundary value problems of finite difference method, Implicit & Explicit scheme.

Theory of Plates & Shells

Module 1:
Plate equation and behaviour of thin plates in cartesian, polar coordinates; Isotropic and orthotropic plates, bending and twisting of plates.
Module 2:
Navier's solution and energy method, rectangular, circular plates with various end conditions.
Module 3:
Shell behaviour, shell surfaces and characteristics, classifications of shells, equilibrium equations in curvilinear coordinates, force displacement relations.
Module 4 : Membrane analysis and bending theory of shells of revolution, cylindrical shells under different loads, shallow shells, solutions of typical problems.

Texts/References

1. S.P. Timoshenko, S.W., Krieger, 'Theory of Plates and Shells, McGraw-Hill, 1959.
2. K. Chandrashekhara, "Theory of Plates,University Press, 2001
3. A.C.Urugal, "Stress in plates and shells"
4. N.K. Bairagi, Plate Analysis, Khanna Publishers, Delhi, 1986
5. N.K. Bairagi, Shell Analysis, Khanna Publishers, Delhi, 1990

Professional Electives –II (Any One)

Advanced Construction Materials

Module 1:
Fresh concrete and its rheology. Mechanical, deformational behavior and microstructure of hardened concrete. Creep and shrinkage. Testing of concrete. mix design and properties of concrete; High strength concrete; High density and lightweight concretes; admixtures

Module 2:
Industrial waste materials in concrete, their influence on physical and mechanical properties and durability of concrete, Concreting under extreme weather conditions, High strength concrete. Changes in concrete with time, Corrosion of concrete in various environments. Corrosion of reinforcing steel. Ferro-cement, material and properties.

Module 3:
Foams and light weight materials, fibrereinforced concrete. Types of fibres, workability, mechanical and physical properties of fibre reinforced concrete. Polymers in Civil Engineering, Polymers, fibres and composites,

Module 4:
Fibre reinforced plastic in sandwich panels, modeling. Architectural use and aesthetics of composties. Adhesives and sealants. Structural elastomeric bearings and resilient seating. Moisture barriers, Polymer foams and polymers in Building, Polymer concrete composites.

Books:
1. Neville A.M., 'Properties of concrete', 3rd ed., 1985, ELBS Lea F.M.,
2. 'Chemistry of cement and concrete', 3rd ed., 1970, Edward Arnold Proceedings of recent seminars etc. and journals.

Earthquake Resistant Design of Structures

Module 1:
Characteristics of earthquakes; Earthquake response of structures; Seismology, seismic risk and hazard, Soil dynamics and seismic inputs to structures, Characterization of ground motion; lateral load calculation, base shear

Module 2:
Earthquake intensity and magnitude; Recording instruments and base line correction; Predominant period and amplification through soil; Response spectrum, analysis, Spectral analysis,

Module 3:
Idealization of structural systems for low, medium and high rise buildings; Nonlinear and push over analysis, Dynamic soil-structure interaction. Earthquake design philosophy,

Module 4:
Concept of earthquake resistant design; Code provisions of design of buildings; Reinforcement detailing for members and joints, retrofitting and strengthening of structures, concept of base isolation design and structural control.

Text Book:

1. Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992
2. Earthquake Resistant Design: Shrikhandee & Agarwal-PHI Publ
3. Newmark N.M. and Rosenblueth E., 'Fundamentals of Earthquake Engg.', Prentice Hall, 1971.
4. David Key, 'Earthquake Design Practice for Buildings', Thomas Telford, London, 1988.
5. Wiegel R.L., 'Earthquake Engg.', Prentice Hall, 1970.
6. Blume J.A., Newmark N.M., Corning L.H., 'Design of Multi-storied Buildings for Earthquake ground motions', Portland Cement Association, Chicago, 1961.
7. Proc. World Conferences on Earthquake Engg., 1956-1992.
8. I.S. Codes No. 1893, 4326, 13920 etc.

(f) Tall Structures

Module 1:
Structural systems and concepts. Matrix and approximate methods, analysis of tall building frames, lateral load analysis, multi bay frames, gravity loads, settlement of foundation.

Module 2:
Foundation-superstructure interaction. Earthquake effects and design for ductility. Analysis of shear walls - plane shear walls, infilled frames, coupled frames, frames with shear walls.

Module 3:
Principle of three dimensional analysis of tall buildings; Perforated cores, pure torsion in thin tubes, bending and warping of perforated cores.

Module 4:
Analysis of floor system in tall buildings, Vierendal girders, diagrid floors, elastic stability of frames and shear walls. Analysis of thermal stresses.

Practicals/ Sessionals:

Structural Engineering Lab

Concrete : Concrete mix design and testing, non-destructive testing of concrete. Reinforced concrete : underreinforced and over-reinforced beams, columns under eccentric loading, twoway reinforced slabs. Tests on RC beam, Prestressed beam, RC column, Steel beam, Steel column; Application of acoustic emission instrument, ultrasonic test. Biaxial and multiaxial testing. Steel-concrete composite,

CAD Lab

Application pf STAAD PRO Software for various design problems

Second Semester

Elastic Stability & Behaviour of Metal Structures

Concept of stability, static, dynamic and energy criterion of stability; Beam-columns; differential equations for beam-columns, beam-columns subjected to transverse load, beam-columns subjected to end moments, application of Trigonometric series.

Elastic buckling of bars and frames; Euler column formula, buckling of frames, torsional buckling, pure torsion of thin-walled bars of open cross section, nonuniform torsion of thin-walled bars of open cross section, buckling by torsion and flexure, warping torsion.

Lateral buckling of beams; differential equations for lateral buckling, lateral buckling of beams in pure bending, lateral buckling of a cantilever beam and a simply supported I beam, , Torsional stability of beams
bending of thin plates; bending of plates by distributed lateral load.

Behaviour of Metal Structures

Structural steel, brittle fracture and fatigue, plastic behaviour of flexural member, plastic analysis of beams and rigid frames, upper and lower bound theorems, mechanism and equilibrium methods, plastic design of beams and frames, design of light weight gauge sections

Books:

- Timoshenko, S.P. and Gere, J.M., Theory of elastic stability, 1963, McGraw-Hill, London,
- D.O.Brush and B.O.Almorth, " buckling of bars, plates and shells".

Arya & Ajmani,"Design of Steel Structures"
B.G.Neal," Plastic Methods of Structural Analysis", Chopman & Hall
Galambus, T.V., " Structural Members and Frames", Prentice Hall INC.
Trahair, N.S., "The Behaviour and Design of Steel Structures", Chapman & Hall, London-1977.

Advanced Reinforced Concrete Design

Limit state design concepts in flexure, shear, torsion and combined stresses.
Slender column, safety and serviceability, control of cracks and deflections.
Yield line theory analysis of slabs, work and equilibrium methods.

Introduction to limit design of beams and frames., General principles and philosophies of design with special references to the codal provisions. Serviceability and stability requirements.

Books:
Park & Paunlay,"Reinforced Concrete Structures".
*Ramakrishna & Arthur,"*Ultimate strength design for structural concrete".
B.I.S. Codes

Professional Electives-III

Offshore Structures

Module 1:
Design of offshore platforms : Introduction, fixed and floating platforms. case studies and general features-elements of hydrodynamics and wave theory-fluid structure interaction, Steel, concrete and hybrid platforms.
Module 2:
Design criteria. Environmental loading. Wind, wave and current loads after installation. Stability during towing. Foundations : Site investigations. Piled foundation. Foundations for gravity structures.
Module 3:
Behaviour under dynamic loading. Static and dynamic analysis of platforms and components.
Module 4: Dynamic response in deterministic and indeterministic environment, codes of practice, analysis of fixed platform and semisubmersible related topics.

Wind Engineering

Module 1:
Causes and types of wind; atmospheric boundary layer and turbulence, wind velocity measurements and distribution,

Module 2:
Bluff-body aerodynamics, random vibrations and spectral analysis, Alongwind and acrosswind response of tall buildings, towers and slender structures,

Module 3:
Aeroelastic phenomena, vibration of cable supported bridges and power lines due to wind effects, wind pressure on cooling towers,

Module 4:
Design of cladding and wind damping devices, Wind tunnel simulations and tornado effects.

Composite Structures

Module 1:
Introduction: definition and characteristics, fibres, matrices, fibre reinforced composites, advantages and limitations, basic concepts and characteristics: isotropy, orthotropy, classification, limina and laminate, micromechanics and macromechanics, constituent materials and properties.

Module 2:
Elastic behaviour of unidirectional lamina: specially orthotropic and transversely isotropic material, relation between mathematical and engineering constants, stress strain relations for thin lamina, transformation of stress and strain, transformation of elastic parameters, transformation of stress-strain relations in terms of engineering constants.

Module 3:
Elastic behaviour of multidirectional laminates, symmetric and balanced laminates, design considerations, computational procedure for finding engineering elastic properties, stress and failure analysis of multidirectional laminates.

Module 4:
Bending of laminated composite plates, thin laminated plate theory, deflection of all edges simply supported rectangular symmetric cross-ply laminate, two opposite edges simply supported.

Books:

1. I.M. Daniel & O. Ishai,"Engineering Mechanics of Composite Materials", Oxford Press
2. S.W.Tsai & H.T.Hahn, "Introduction to Composite Materials:Technomic Pub. Co.INC,USA.
3. P.K.Sinha,"A short term course on Composite Materials and Structures"-1996

Professional Electives-IV

Structural Optimisation

Module 1:
Formulation of different types of structural optimization problems; Optimality criteria based structural optimizations;

Module 2:
Computation of derivatives of response quantities w.r.t. design variables; Classical optimization;

Module 3:
Lagrange multiplier technique and Kuhn-Tucker conditions;

Module 4:
Solution of NLP by direct methods and by series of unconstrained optimization problems and by series of linear programming problems.

Books:

- S.S. Rao, Optimization, Theory and Applications, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1991.
- J.S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company, New York, 1989.
- A.J. Morris (Editor), Foundations of Structural Optimization - A Unified Approach; John Wiley and Sons, Chichester, 1982.

Soil Dynamics & Geotechnical Earthquake Engineering

Module 1:
Engineering problems involving soil dynamics; Role of inertia; Theory of Vibrations: Single and two-degree freedom systems, vibration-measuring instruments, vibration isolation,

Module 2:
Wave propagation in elastic media. General nature of soil behaviour under cyclic/dynamic loading; Field and Laboratory tests for measurement of small strained and large strain, dynamic properties of soils.

Module 3:
Design criteria for machine foundations, elastic homogeneous half space solutions, lumped parameter solutions. Codal provisions. Strong Ground Motion: Measurement, characterization and estimation. Dynamic soil properties; Ground response analysis; Effect of local site conditions on ground motion;

Module 4:
Amplification theory and ground response analysis. Densification and liquefaction of granular soils, Liquefaction: evaluation of liquefaction hazards, effects of liquefaction; Case studies. Seismic slope stability analysis, Seismic bearing capacity and earth pressures. Codal provisions. Elastic theories of soil dynamics; Wave propagation; Dynamic soil properties; Vibration isolation; Pile dynamics.

Infrastructure Engineering & Transportation Planning

Module 1:
Quick response travel evaluation procedure, TSM actions: Traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions. Small area management: individual sites, residential neighbourhoods,

Module 2:
Introduction to transportation systems. Transportation innovations, social and economic impacts of transportation. Decision makers and their options, demand modeling and prediction. Stated and Revealed Preference approaches; Modeling transportation technologies.

Module 3:
Analysis of network flows. Transportation networks. Network Theory. planning for pedestrians, parking planning. Travel demand management and telematics in travel planning, Design and drawing of grade intersections, Rotaries, interchanges (cloverleaf, trumpet), multilevel intersections; Onstreet parking facilities; Off-street parking facilities (parking lots and garages);

Module 4:
Layout for buses and trucks; Bridges and Fly-overs; Guard rails; Culverts; Retaining Sides; Mix wells; Foot bridges; River Spans; Tunnels and Underpasses;

Professional Electives-V

Finite Element Analysis of Structures

Module 1:
Basic principles of structural mechanics, principle of virtual work, energy principles, element properties; relation between nodal degrees of freedom and generalized oordinates , convergence requirements, natural coordinate systems, shape functions, element stiffness matrix.
Module 2:
Isoparametric elements; computation of stiffness matrix for isoparametric elements, direct stiffness method of analysis and solution technique, assemblage of elements, direct stiffness method, boundary conditions and reaction, basic steps in finite element analysis.
Module 3:
Analysis of framed structures; 2 and 3 dimensional truss element, 2 dimensional beam element, stiffness matrix for a two dimensional beam element with 6 d.o.f., element load vector, transformation matrix, computation of stress resultants, shear deformation, plane stress and plane strain analysis, nodal load vector, rectangular elements, 8 noded rectangle, isoparametric elements, axisymmetric solid element.
Module 4:
Three dimensional stress analysis, 8 noded isoparametric solid element, analysis of plate bending, displacement functions, various types of plate bending elements, types of isoparametric elements, analysis of shells; bilinear degenerated shell element strain-displacement matrix, stress-displacement matrix, element stiffness matrix, 8 noded shell element, analysis using finite element computer codes.

Books:

1. C.S.Krishnamoorthy, " Finite element analysis, theory and programming", Tata McGraw Hill
2. Cook R.D., Malkus, D.S. and Plesha, M.E., Concepts and Applications of Finite Element Analysis, Third Edition, John Wiley, 1989.
3. O.C. Zienkiewicz, The Finite Element Method, Tata McGraw-Hill.

Advanced Steel Structure

Module 1:
Properties of steel: mechanical properties, hysteresis, ductility; Hot-Rolled Sections: compactness and non-compactness, slenderness, residual stresses; Design of steel structures:
Module 2:
Inelastic bending – curvature, plastic moments, design criteria - stability , strength, drift; Stability criteria: stability of beams - local buckling of compression flange & web, lateral-torsional buckling,
Module 3:
Stability of columns - slenderness ratio of columns, local buckling of flanges and web, bracing of column about weak axis, method of design - allowable stress design, plastic design, load and resistance factor design; Strength Criteria: beams – flexure, shear, torsion, columns - moment magnification factor, effective length, P-M interaction, bi-axial bending, joint panel zones; Drift criteria: P-Δ effect,
Module 4:
Deformation-based design; Connections: types – welded, bolted, location - beam-column, column-foundation, splices.

Industrial Structures

Module 1:
Planning of industrial structures. Design of single and multibay industrial structures in steel and concrete.

Module 2:
Bunkers and silos. Pressure vessels and chimneys.

Module 3:
Cooling towers. Large span roof structures.

Module 4:
Suspended roof structures. Structural aspects of machine foundations.

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