KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE- 638 052
(Autonomous)

M.E. DEGREE IN STRUCTURAL ENGINEERING (FULL TIME)
CURRICULUM

(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14AMT12	Applied Mathematics for Structural Engineers	3	1	0	4	40	60	100
14SET11	Theory of Elasticity and Plasticity	3	1	0	4	40	60	100
14SET12	Computer Analysis of Structures	3	1	0	4	40	60	100
14SET13	Structural Dynamics	3	1	0	4	40	60	100
14SET14	Design of Concrete Structures	3	0	0	3	40	60	100
14SET15	Experimental Methods and Model Analysis	3	0	0	3	40	60	100
	PRACTICAL							
14SEL11	Advanced Structural Engineering Laboratory	0	0	3	1	100	0	100
				Total	**23**			

CA – Continuous Assessment, ESE – End Semester Examination

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M.E. DEGREE IN STRUCTURAL ENGINEERING (FULL TIME)
CURRICULUM
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SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14SET21	Finite Element Method of Structures	3	1	0	4	40	60	100
14SET22	Stability of Structures	3	1	0	4	40	60	100
14SET23	Advanced Design of Substructures	3	0	0	3	40	60	100
14SET24	Earthquake Analysis and Design of Structures	3	0	0	3	40	60	100
	Elective-I (Professional)	3	0	0	3	40	60	100
	Elective-II (Professional)	3	0	0	3	40	60	100
	PRACTICAL							
14SEL21	Advanced Structural Engineering Computational Laboratory	0	0	3	1	100	0	100
				Total	**21**			

CA – Continuous Assessment, ESE – End Semester Examination

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M.E. DEGREE IN STRUCTURAL ENGINEERING (FULL TIME)
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SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14SET31	Advanced Design of Steel Structures	3	0	0	3	40	60	100
	Elective-III (Professional)	3	0	0	3	40	60	100
	Elective-IV (Open)	3	0	0	3	40	60	100
	PRACTICAL							
14SEI31	Industrial Training	0	0	0	1	100	0	100
14SEP31	Project Work Phase-I	0	0	12	6	50	50	100
				Total	**16**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
14SEP41	Project Work Phase-II	0	0	24	12	100	100	200
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

Total Credits: 72

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M.E. DEGREE IN STRUCTURAL ENGINEERING (PART TIME)
CURRICULUM
(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14AMT12	Applied Mathematics for Structural Engineers	3	1	0	4	40	60	100
14SET11	Theory of Elasticity and Plasticity	3	1	0	4	40	60	100
14SET12	Computer Analysis of Structures	3	1	0	4	40	60	100
	PRACTICAL							
14SEL11	Advanced Structural Engineering Laboratory	0	0	3	1	100	0	100
				Total	**13**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14SET21	Finite Element Method of Structures	3	1	0	4	40	60	100
14SET22	Stability of Structures	3	1	0	4	40	60	100
14SET23	Advanced Design of Substructures	3	0	0	3	40	60	100
	PRACTICAL							
14SEL21	Advanced Structural Engineering Computational Laboratory	0	0	3	1	100	0	100
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE- 638 052
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M.E. DEGREE IN STRUCTURAL ENGINEERING (PART TIME)
CURRICULUM

(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14SET13	Structural Dynamics	3	1	0	4	40	60	100
14SET14	Design of Concrete Structures	3	0	0	3	40	60	100
14SET15	Experimental Methods and Model Analysis	3	0	0	3	40	60	100
				Total	**10**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
14SET24	Earthquake Analysis and Design of Structures	3	0	0	3	40	60	100
	Elective-I (Professional)	3	0	0	3	40	60	100
	Elective-II (Professional)	3	0	0	3	40	60	100
				Total	**9**			

CA – Continuous Assessment, ESE – End Semester Examination

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M.E. DEGREE IN STRUCTURAL ENGINEERING (PART TIME)
CURRICULUM
(For the candidates admitted from academic year 2014-15 onwards)

SEMESTER – V

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
14SET31	Advanced Design of Steel Structures	3	0	0	3	40	60	100
	Elective-III (Professional)	3	0	0	3	40	60	100
	Elective-IV (Open)	3	0	0	3	40	60	100
	PRACTICAL							
14SEI31	Industrial Training	0	0	0	1	100	0	100
14SEP31	Project Work Phase-I	0	0	12	6	50	50	100
				Total	**16**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – VI

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
14SEP41	Project Work Phase-II	0	0	24	12	100	100	200
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

Total Credits: 72

LIST OF ELECTIVES					
Course Code	**Course Title**	**Hours/Week**			**Credit**
		L	**T**	**P**	
14SEE01	Design of Industrial Structures *	3	0	0	3
14SEE02	Pre-stressed Concrete Structures *	3	0	0	3
14SEE03	Design of Bridges	3	0	0	3
14SEE04	Theory of Plates and Shells	3	0	0	3
14SEE05	Design of Tall Buildings	3	0	0	3
14SEE06	Mechanics of Composite Construction Materials	3	0	0	3
14SEE07	Off shore Structures	3	0	0	3
14SEE08	Optimization of Structures	3	0	0	3
14SEE09	Prefabricated Structures	3	0	0	3
14SEE10	Wind and Cyclone Effects on Structures	3	0	0	3
14SEE11	Design of Composite Structures	3	0	0	3
14CME11	Maintenance and Rehabilitation of Structures	3	0	0	3

*- Open Elective

14AMT12 APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERS

3 1 0 4

UNIT – I **9**

Random Variables: Discrete and continuous random variables – Probability function – Mathematical expectation – Cumulative distribution function – Properties – Moments - Moment generating function. Joint probability distributions, marginal and conditional density functions.

UNIT – II **9**

Calculus of Variations and Simulation: Concept of variation and its properties- Euler's equation-Functional dependant on first and higher order derivatives -Functional dependant on functions of several independent variables.

Simulation: Simulation study-Types of simulation-Limitations and areas of simulation.

UNIT – III **9**

Correlation and Regression: Simple linear correlation and regression, Multiple correlation – Partial correlation – Regression: Multiple regression analysis.

Time Series: Trend and seasonal variations (concept only)-Components of Time series –Measurement of trend- Linear and Second degree parabola- Method of Least squares.

UNIT – IV **9**

Testing of Hypothesis: Definition –Population and samples –Large sample tests- Tests for mean, proportions- Test of significance for small samples – t- test – F- test– Chi-square test of goodness of fit – Independent of attributes.

UNIT – V **9**

Design of Experiments: Basic definitions – Analysis of variance – One way classification – Completely Randomized design – Two way classification – Randomized Block design – Latin Square design.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS:

1. Fruend, J.E. and Miller, I, "Probability and Statistics for Engineers", Prentice Hall of India Ltd. 1994.
2. Richard Johnson, Irwin Miller and John Fruend, Miller and Fruend's "Probability and Statistics for Engineers", Cengage Learning, 2011.
3. Sheldon Ross, "Probability and Statistics for Engineers and Scientists", Academic Press, USA, Fourth edition, 2009.
4. Jay.L. Devore, "Probability and Statistics for Engineering and the Sciences", Thomson and Duxbury, Singapore, 8th edition, 2012.
5. Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2010.
6. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol "Discrete-Event System Simulation", Pearson Education, Inc, 4th Edition, 2005.

Course Outcomes:

On completion of the course the students will be able to

- utilize probabilistic concepts in engineering problems
- solve variational problems
- forecast a value of the variable using past data
- develop various tests of significance for attributes and variables
- adopt design of experiments techniques in construction fields

14SET11 THEORY OF ELASTICITY AND PLASTICITY

3 1 0 4

UNIT – I **9**

Introduction: Analysis of stress and strain, stress strain relationship- Generalized Hooke's law- Lame's constants - Plane stress and plane strain- Boundary value problems -Airy's stress function, Stress polynomials.

UNIT-II **9**

Two dimensional problems: Cartesian co-ordinates- Methods of formulation of elasticity problems - Equilibrium equations in terms of displacements -compatibility equations - solution of Bi harmonic equation - St. Venant principle.

UNIT-III **9**

Polar Coordinates Method: Methods of analysis – derivation of equilibrium equation in polar coordinates – stress function in polar coordinates- Axis symmetric problems – filament problems- tensile strength of brittle materials.

UNIT-IV **9**

Torsion and Energy Theory: Torsion of non-circular section - torsion of thin rectangular section and hollow thin walled sections-Membrane analogy - Energy methods - Principle of virtual work - Energy theorem - Rayleigh Ritz methods.

UNIT-V **9**

Plasticity: Introduction to plasticity-Physical assumption - criterion of yielding, yield surface, Flow rule (plastic stress strain relationship). Elastic & plastic problems of beams in bending - Plastic torsion

Lecture: 45, Tutorial: 15, TOTAL : 60

REFERENCE BOOKS:

1. Timoshenko, S. and Goodier T.N., "Theory of Elasticity", 2nd Edition, McGraw Hill Book Co., Newyork, 1988
2. Chwo P.C. and Pagano, N.J., "Elasticity Tensor, Dyadic and Engineering applications", D.Van, Nestrand Co., In Co., 1967
3. Chenn, W.P. and Henry D.J., "Plasticity for Structural Engineers", Springer Verlag Newyork 1988.
4. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
5. Slater.R.A.C, "Engineering Plasticity", John Wiley and Son, Newyork, 1977.
6. Hearn.E.J, "Mechanics of Materials", Vol.2, Pergamon Press, Oxford, 1985.
7. Irving H.Shames &James, M.Pittarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt.Ltd, New Delhi, 2002.

Course Outcomes:

On completion of the course the students will be able to

- determine the stress strain parameters
- solve stress strain problems
- solve the torsion and energy method problems
- analyse the problems related to plasticity

14SET12 COMPUTER ANALYSIS OF STRUCTURES

3 1 0 4

UNIT – I **9**

Fundamental Concepts: Introduction – Forces and Displacement measurements – Principle of superposition – Methods of structural analysis – Betti's law – Stiffness and Flexibility matrices of the elements - a review.

UNIT-II **9**

Transformation of Information: Indeterminate structures – Transformation of system force to element forces – Element flexibility to System flexibility – System displacement to Element displacement – Transformation of forces and displacement in general – Normal and orthogonal transformation.

UNIT-III **9**

Flexibility Method : Choice of redundant – ill and well conditioned equations – Automatic choice of redundant – Rank technique – Transformation of one set of redundant to another set – Thermal expansion – Lack of fit – Application to pin jointed plane truss – continuous beams - frames and grids- Static condensation Technique – Substructure technique

UNIT-IV **9**

Stiffness method: Development of stiffness method – analogy between flexibility and stiffness – Analysis due to thermal expansion, lack of fit – Application to pin-jointed plane and space trusses – Continuous beams – frames and grids – problem solving- Static condensation Technique – Substructure technique

UNIT-V **9**

Matrix Displacement Methods – Special Topics: - Transfer Matrix method – Symmetry & Anti symmetry of structures – Reanalysis technique

Direct Stiffness Method: Discrete system – Direct stiffness approach – Application to two and three dimensional pin-jointed trusses - plane frames – Grids – Three dimensional space frames

Lecture: 45, Tutorial: 15, TOTAL : 60

REFERENCE BOOKS:

1. Mcguire and Gallagher, R.H., "Matrix Structural Analysis", John Wiley, 2001
2. Rajasekaran.S & Sankarasubramanian.G. "Computational Structural Mechanics", Prentice Hall of India, New Delhi, 2001.
3. Holzer, S.M., "Computational Analysis of Structures", Elsevier Science Publishing Co., Inc, 1988
4. C.Natarajan, P.Revathi .,"Matrix Method of structural Analysis",Eastern Economy Edition, PHI

Course Outcomes:

On completion of the course the students will be able to

- analyse the structural elements using the flexibility and stiffness method
- analyse and apply solutions for Structural elements subjected to practical problems
- analyse three dimensional space frames advanced and modern concepts

14SET13 STRUCTURAL DYNAMICS

(IS 4326:1993,13920:1993, 1893 (Part 1):2002,13935:1995 codes are permitted.)

3 1 0 4

UNIT – I **9**

Single Degree of Freedom systems: Equations of motion by equilibrium and energy methods, free and forced vibration of single degree of freedom systems, Effect of damping, Transmissibility.

UNIT – II **9**

Two Degree of Freedom Systems: Equations of motion of two degree of freedom systems, normal modes of vibration, applications.

UNIT – III **9**

Dynamic Response of MDOF Systems: Multi degree of freedom systems, orthogonality of normal modes, approximate methods. Mode superposition technique, numerical integration procedure.

UNIT – IV **9**

Continuous Systems: Free and forced vibration of bars and beams (concepts only), Rayleigh – Ritz method – Formulation using Conservation of energy – Formulation using Virtual work.

UNIT – V **9**

Practical Applications: Idealization and formulation of mathematical models for wind, earthquake, blast and impact loading, aerodynamics, gust phenomenon.

Lecture: 45, Tutorial: 15, TOTAL : 60

REFERENCE BOOKS:

1. Mario Paz, "Structural Dynamics :Theory and Computation", Kluwer Academic Publication, 2004
2. Anil K.Chopra, "Dynamics of Structures", Pearson Education, 2001.
3. Madhujth Mukhopadhyay,"Dynamics Vibration and Systems", Ane Books Pvt.Ltd
4. Leonard Meirovitch, "Elements of Vibration Analysis", McGraw Hill, 1986.
5. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, "Wind Effects on Civil Engineering Structures", Elsevier Publications, 1984.
6. J.N.Reddy, "Structural Stability and Dynamics", World Scientific Publishing Co.Pvt.Ltd

Course Outcomes:

On completion of the course the students will be able to

- utilize the vibration concept in design of buildings and damper design
- use the formulation concept in design of disaster structures
- use the mathematical modelling technique in R&D laboratories etc.

14SET14 DESIGN OF CONCRETE STRUCTURES

(IS 456:2000 & IS 3370 Part II&IV,13920:1993 codes are permitted)

3 0 0 3

UNIT – I **9**

Design of Special RC Elements: Review of limit state design of beams, slabs and columns according to IS Codes. Calculation of deflection and crack width according to IS - Design of slender columns

UNIT – II **9**

Design of RC walls and Beams: Design of RC walls - ordinary and shear walls. Strut and tie method of analysis and design for corbels and deep beams.

UNIT – III **9**

Flat slabs: Design of flat slabs and flat plates according to IS methods - Design of shear reinforcement – Design of Spandrel beams

UNIT – IV **9**

Design of Grid floors & Yield Line Theory: Design of grid floors - methods of analysis and design- Yield line theory and Hillerborgs strip method of design of slabs for various Boundary Conditions.

UNIT – V **9**

Inelastic behaviour of Concrete Structures : Inelastic behaviour of concrete beams and frames, moment - rotation curves, moment redistribution. Baker's method of plastic design. Design of cast-in-situ joints in frames. Detailing for ductility - Fire resistance of structural members.

TOTAL: 45

REFERENCE BOOKS:

1. Unnikrishna Pillai and Devdas Menon, "Reinforced concrete Design", Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
2. N. Krishnaraju, "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, 2000.
3. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2005.
4. Gambhir.M.L, "Design Of Reinforced Concrete Structures", Easter Economy Edition, Prentice-Hall of India Pvt.Ltd, New Delhi, 2011.
5. Subramanian.N, "Design Of Reinforced Concrete Structures", Oxford University Press, 2014.

Course Outcomes:

On completion of the course the students will be able to

- calculate deflection and crack of concrete
- design of slender columns, corbels and deep beams
- design of flat slabs and flat plates, spandrel beams and grid floors
- design of cast-in-situ joints and detailing for ductility

14SET15 EXPERIMENTAL METHODS AND MODEL ANALYSIS

3 0 0 3

UNIT- I **9**

General: Basic concept in measurements, measurement in displacement, strain pressure, force torque etc, type of strain gauges (Mechanical, Electrical resistance, Acoustical etc.) –Load calibration of testing machines- I.S. Code provisions.

UNIT-II **9**

Measurement system: Mechanical, Optical and Acoustical extensometers –Strain measurement- Electrical resistance strain gauges- Principle, Types, Performance, Uses- Strain Rosettes- Wheatstone Bridge- Electronic load cells-Proving rings- X Y Plotter- Wind Tunnels.

UNIT-III **9**

Testing and analysis Method: indicating and recording- static and dynamic data recording-Data (Digital and Analogue) acquisition and processing systems. Strain analysis methods-Rosette analysis. Static and Dynamic testing techniques. Equipment for loading – Moire's techniques.

UNIT-IV **9**

Testing techniques: Non destructive testing techniques. Photo elasticity – optics of photo elasticity – Plolariscope – Isoclinics and Isochromatics – methods of stress separation- holographic techniques.

UNIT– V **9**

Model Analysis Model laws: Laws of similitude-Model materials-Model testing- Necessity for Model analysis-Advantages-Applications- Types of similitude- Scale effect in Models- Indirect model study-Direct model study-Limitations of model investigations- Structural problems that may demand model studies- Usage of influence lines in model studies.

TOTAL : 45

REFERENCE BOOKS:

1. Rangan C S, "Instrumentation – Devices and systems ", Tata McGraw–Hill Publishing Co Ltd., New Delhi., 1983.
2. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996.
3. Dally J W and Riley W.F, "Experimental Analysis", Mc Graw Hill Inc., New York, 1991.
4. Srinath L S et al, "Experimental Stress Analysis", Tata McGraw-Hill Publishing Co., Ltd., New Dell 1984.
5. Ganesan.T.P, "Model Analysis of Structures", Universities Press, New Delhi, 2005

Course Outcomes:

On completion of the course the students will be able to

- use the basic concepts of smart materials in concrete structures
- utilize the testing and analytical methodology in R&D and in the field
- use the optical testing methodology in R&D areas

14SEL11 ADVANCED STRUCTURAL ENGINEERING LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
2. Testing of simply supported steel beam for strength and deflection behaviour.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
4. Dynamic testing of cantilever steel beam

a. To determine the damping coefficients from free vibrations.

b. To evaluate the mode shapes.

5. Static cyclic testing of single bay two storied steel frames to evaluate

a. Drift of the frame.

b. Stiffness of the frame.

c. Energy dissipation capacity of the frame.

6. Determination of in-situ strength and quality of concrete using i) rebound hammer and ii)Ultrasonic Pulse Velocity Tester
7. Rapid Chloride Penetration Test
8. Acceleration Corrosion Test

TOTAL : 45

REFERENCE BOOKS:

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

Course Outcomes:

On completion of the course the students will able to

- determine the static and dynamic properties of concrete structural elements

14SET21 FINITE ELEMENT METHOD OF STRUCTURES

3 1 0 4

UNIT – I **9**

One Dimensional Elements : History of development - Advantages-Disadvantages-Concept of Finite Element Analysis - Basic Equation of Elasticity -Strain Displacement Relationship - Stress Strain Relationship - General steps in Finite Element Analysis - Principles of virtual work - Approximate Methods - Rayleigh-Ritz and Galerkin formulations - Finite Difference Method - Shape functions - General and Natural Coordinates - Direct Stiffness method - Generation of Stiffness Matrix and Boundary conditions - Load Vector and Assembly of Elements - Element Stresses - One dimensional Problems

UNIT - II **9**

Two Dimensional Elements: Two Dimensional problems - Plane stress, Plane strain Analysis - Analysis of simple truss - Finite Element Analysis of Continuous beam - CST and LST Elements- Rectangular Elements - isoparametric formulation -Lagrange and Serendipity Elements - Axisymmetric solid Elements - Tetrahedran Element- Numerical Integration using Gaussian Quadrature - Weights and Gauss points

UNIT- III **9**

Three Dimensional Elements: Selective and reduced integration. Axisymmetric stress analysis - Tetrahedron element family - parallelopiped element - HexahedranElement family - ZIB 8 and ZIB 20 elements-Plate bending and Shell elements - Brick elements - P and H methods of refinement - Discretisation errors -Auto and adaptive mesh generation techniques - Error evaluation.

UNIT-IV **9**

Vibration & Thermal analysis: Dynamic Analysis - Eigen value extraction - Application to thermal analysis problems - One dimension heat flow - Heat conduction through a thin Film- Application of Finite element method based on commercial software packages.

UNIT- V **9**

Non-Linear Analysis: Types of non-linearities - Stability analysis - Load deformation response - Solution techniques – NewtonRaphson method - Modified Newton Raphson method, Alpha constant method, Riks Wempner method -classical Eigen Value analysis - programming organisation of Finite Element Schemes - Input / output plotting

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS:

1. Bathe, K.J., “Finite Elements Procedures in Engineering analysis”, Prentice Hall Inc., 1995.
2. Zienkiewicz, O.C, and Taylor, R.L., “The Finite Elements Methods”, Mc Graw Hill, 1987.
3. Chandraputla, R.T. and Belegundu, A.D ., “Introduction to Finite Elements in Engineering”, 2nd Edition Prentice Hall of India, 1997
4. Moaveni.S. “Finite Element Analysis: Theory and Application with ANSYS”, Prentice Hall Inc., 1999.
5. Singiresu S.Rao, “The Finite Element Method in Engineering”, Fourth Edition, Oxford Publication, 2005.

Course Outcomes:

On completion of the course the students will be able to

- execute finite element analysis concept in one dimensional element problems
- two dimensional element problems
- three dimensional, vibration and thermal analysis problems

14SET22 STABILITY OF STRUCTURES

3 1 0 4

UNIT- I **9**

Buckling of Columns: Introduction – States of equilibrium – Classification of buckling problems – South well plot – Concept of equilibrium, energy, imperfection and vibration approaches to stability analysis – Eigen value problem – Governing equation for columns – Analysis for various boundary conditions – using Equilibrium, Energy methods –Newmans Method-Finite Difference Method.

UNIT - II **9**

Buckling of Beam-Columns: Non- prismatic columns, Built-up columns – Rayleigh Ritz, Galerkins approach –Effect of shear on buckling. Theory of beam-column – Stability analysis of beam column with single and several concentrated loads, distributed load and end couples.

UNIT - III **9**

Buckling of Frames and Plates: Stability of frames – Stability functions – Analysis of rigid jointed frames with and without sway – Moment distribution – Governing differential equation – Buckling of thin plates, various edge conditions – Analysis by equilibrium and energy approach – Buckling of rectangular plates of various end conditions – Finite difference method .

UNIT -IV **9**

Torsional and Lateral Buckling: Introduction – Torsional buckling – Torsional and flexural buckling – Local buckling – Buckling of open sections – Numerical solutions – Lateral buckling of beams, pure bending of simply supported I beams and cantilever

UNIT -V **9**

Inelastic Buckling: Double modulus theory – Tangent modulus theory – Shanley's model – Eccentrically loaded inelastic column – Inelastic buckling of plates.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS:

1. Chajes, A., "Principles of Structural Stability Theory", Prentice Hall, 1974.
2. Timoshenko, S., and Gere., "Theory of Elastic Stability", McGraw Hill Book Company, 1963.
3. Ashwini Kumar, "Stability Theory of Structures", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.
4. Iyenger, N.G.R., "Structural stability of columns and plates", Affiliated East West Press, 1986.
5. Gambhir.M.L, "Stability Analysis and Design of Structures", Springer, New York, 2004.

Course Outcomes:

On completion of the course the students will be able to

- analyze the behaviour of columns
- analyze the buckling of frames and plates
- identify the torsional , lateral and inelastic buckling of plates

14SET23 ADVANCED DESIGN OF SUBSTRUCTURES

(IS 6403-1981,IS 5121-1969,IS 2911 Part 2-1982, IS 2911 Part 3-1985, IS 2950 Part 1-1984, IS 12070-1987,IS 14593-1998,IS 2810-1979,IS 5249-1992 codes are permitted)

3 0 0 3

UNIT - I **9**

Criteria for foundation choice, Bearing capacity, total and differential settlement tolerance for various types of structures. Interpretation of soil profile for design parameters like modulus of compressibility, Modulus of sub grade reaction, Poisson's ratio, etc.

UNIT - II **9**

Beam on elastic foundation – Raft foundations for Building and tower structures – Different types of rafts. Soil Structure Interaction (SSI) analysis and design of combined, continuous and raft foundation.

UNIT- III **9**

Pile foundations – types, method of installation, Codal practices for permissible load under vertical and lateral loads.

UNIT-IV **9**

Analysis and design of pile caps for single and group pile system; Diaphragm wall design and construction.

UNIT - V **9**

Machine Foundations: Fundamentals of soil dynamics – Dynamic soil properties – Field and laboratory techniques – Dynamic stiffness of foundation – Analysis and design of block foundations for vibratory machines.

TOTAL: 45

REFERENCE BOOKS:

1. Cuduto "Foundation Design- Principles and Practices", 2001
2. Brules.J.E, "Foundation Analysis and Design", McGraw Hill, 1996.
3. Srinavasalu.P. & Vaidyanathan.S.V., "Hand Book of Machine Foundation", 1990
4. Swamy Saran, "Solid Dynamics and Machine Foundations", Galgotia Publications,1999

Course Outcomes:

On completion of the course the students will be able to

- analyze and design of sub-structures
- achieve competency in executing the soil structure interaction analysis
- design the effective foundation for various types of structures

14SET24 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

(IS 1893, IS13935:1995, IS 13920 :1993& IS 4326:1993 codes are permitted)

3 0 0 3

UNIT - I **9**

Earthquakes and Ground motion: Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake phenomenon), – Plate tectonics quantification of earthquakes, Strong motion instrumentation –Ground motion-PGA-Fourier spectra-predominant period.

UNIT – II **9**

Characteristics of earthquake : Estimation of earthquake parameters, Response spectra - Average response spectra - Design response spectra, Evaluation of earthquake forces as per codal provisions. Seismic hazard analysis-Determination of probabilistic approaches.

UNIT - III **9**

Earthquake Resistant design of Masonry structures: Effect of earthquake on different types of structures, lessons learnt from past earthquakes. Structural systems - Types of buildings, Causes of damage, Planning considerations, Philosophy and principle of earthquake Resistant design, Guidelines for earthquake resistant design, Earthquake resistant earthen buildings (basic design), Earthquake resistant masonry buildings - Design consideration – Guidelines.

UNIT - IV **9**

Earthquake Resistant design of RC structures: Earthquake resistant design of R.C.C. buildings(basic design) - Material properties - Lateral load analysis - Design and detailing – Rigid frames(basic design) – Shear wall – Coupled shear wall(basic design). Mathematical modeling of multistoried RC buildings – Capacity based design.

UNIT – V **9**

Vibration control : Tuned mass dampers – Principles and application, Basic concept of Seismic base isolation – various systems- Case studies.

TOTAL: 45

REFERENCE BOOKS:

1. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2006.
2. S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007
3. Roberto Villaverde., "Fundamentals of Concepts of Earthquake Engineering" CRC Press, 2009
4. Amarnath Chakrabarti, Devadoss Menon & Amlan Kumar Sengupta., "Handbook on seismic retrofit of buildings", Alpha Science International, 2008.
5. Paulay.T & Priestly.M.N.J., "Aseismic Design Of Reinforced Concrete and Masonry Buildings", John Wiley & Sons, 1991.
6. Bruce.A.Bolt, "Earthquakes", WH Freeman & Company, New York, 2004.
7. Bungale.S.Taranadh, "Structural Analysis and Design of Tall Buildings", McGraw Hill Book Company, New York,1999.

Course Outcomes:

On completion of the course the students will be able to

- use the computation concept in measurement of earthquake
- design of earthquake resistant buildings
- use the choice of dampers in various field application

14SEL21 ADVANCED STRUCTURAL ENGINEERING COMPUTATIONAL LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

Analysis, Design & Detailing of

1. A multi-bay multi-storied building
2. T-beam Slab bridge
3. Prestressed concrete bridge
4. Box Culvert Bridge
5. Analysis and Design of industrial structures
6. Analysis and Design of Towers
7. Storage structures
8. Geotechnical aspects in foundation design.
9. Special emphasis on earthquake resistant design.

TOTAL : 45

Course Outcomes:

On completion of the course the students will be able to

- develop computer programs for the analysis and design of structural components.
- design the bridges to withstand earthquake forces
- design the different types of steel structures

14SET31 ADVANCED DESIGN OF STEEL STRUCTURES

(IS-800-2007, SP-06, IS 875-1987 codes and steel tables are permitted**)**

3 0 0 3

UNIT - I **9**

Tension and Compression members: Introduction – net sectional area for concentrically and eccentrically loaded members – tension splices - bending of tension members – stress concentrations.– practical end conditions and effective length factors – elastic compression members – restrained compression members – torsional buckling - built up compression members with lacings and battens – column splices.

UNIT - II **9**

Flexural members: Introduction – Inplane bending of beams – elastic analysis of beams – bending stresses – shear stresses – strength design – serviceability design – lateral buckling of beams – restrained beams – cantilever& over hanging beams- braced and continuous beams – mono symmetric beams – non uniform beams.

UNIT - III **9**

Beam – Columns and Frames: Introduction – inplane behaviour of isolated beam-column – flexural torsional buckling – biaxial bending. triangulated frames – two dimensional frames – three dimensional frames- semi rigid frames- braced frames

UNIT - IV **9**

Connections and Torsion members: Introduction – Welded and bolted connections – framed connection – seated connection – moment resistant connection - uniform torsion – non uniform torsion – torsion design – torsion and bending – distorsion

UNIT - V **9**

Local buckling of Thin Plate elements: Introduction – plate elements in compression –shear – bending – bending and shear – bearing – design against local buckling

TOTAL: 45

REFERENCE BOOKS:

1. Trahair N S, Brandford M A, Nethercot D,m Gardner L, "The Behaviour and Design of Steel Structures EC3", Fourth Edition, Taylor& Francis, London & Newyork, 2008.
2. Subramanian N," Design of Steel Structures", Oxford University Press, NewDelhi 2008.
3. Englekirk R, "Steel Structures: Controlling Behaviour through Design", John-Wiley &Sons, Inc, 2003.

Course outcomes:

On completion of the course the students will be able to

- design members subjected to lateral loads and axial loads, self supporting and guyed stacks, design of framed beam connections
- design compression and tension members, partial and full shear connections
- design thin plate elements

14SEE01 DESIGN OF INDUSTRIAL STRUCTURES

(IS875,2726,3034:1993,3058:1990,3079:1990,3594:1991,3595:2002,3836:2000,4226:1988,4886:1991, 6329:2000,1361:1978,3103:1975,4998(Part 1):1992,6533(Part 1):1992, 6533(Part 1):1989, 6533(Part 2):1989,11504:1985,4091:1979,802(Part 1/Sec 1):1995,802(Part 2/Sec 2):1978, 802(Part 3/Sec 2):1978, 2210:1988 codes are permitted.)

3 0 0 3

UNIT - I **9**

General Planning Requirements: Classification of Industries and Industrial Structures – Specific requirements for Industries like Engineering, Textiles, Chemicals, etc. – Site layout and external facilities required – Natural and artificial lighting – Protection from the sun light

UNIT – II **9**

Functional Requirements: Services – Electrical wiring fixtures – Cable and pipe bridge – Electrical installations – Substations – Heating and Ventilation – Air conditioning – Fire safety – Fire alarm, extinguishers and hydrants- Guidelines from Factories Act.

UNIT - III **9**

Industrial Buildings: Design and detailing of R.C. cable frames – Folded Plates and North Light Shell Roofs – Bunkers, Silos and Gantry Girders – Design of Corbels and Nibs – Machine Foundations.

UNIT - IV **9**

Power plant Structures: Chimneys and Cooling Towers – High pressure boilers and piping design – Nuclear containment structures

UNIT – V **9**

Power Transmission Structures : Cables –Transmission line towers – Substation Structures – Tower foundations – Testing towers.

TOTAL: 45

REFERENCE BOOKS:

1. Manohar,S.N., "Tall Chimneys - Design and Construction", Tata Mc Graw Hill, 1985.
2. Santhakumar, A.R. and Murthy, S.S., "Transmission Line Structures", Tata Mc Graw Hill 1992.
3. Dayaratnam, P., “Design of Steel Structures”, A.H. Wheeler & Co., Ltd., Allahabad, 2008.
4. Proceedings of Advanced course on “Industrial Structures”, Structural Engineering Research Centre, Chennai, 1982.
5. Handbook on “Fundamental Requirements of Industrial Buildings (Lighting and Ventilation)”, BIS.
6. Jurgen Axel adam, Katharria Hausman, Frank Juttner, Klauss Daniel,”Industrial Buildings: A Design Manual”, Birkhauser publishers, 2004.

Course Outcomes:

On completion of the course the students will be able to

- plan suitable methodology for industrial building
- design various industrial elements
- utilize the design concept for various structures subjected to wind

14SEE02 PRESTRESSED CONCRETE STRUCTURES

(IS 1343-1980,IS 3370 part III & IV-1967,IS 784-2001 & IS 784-1959 code are to be permitted)

3 0 0 3

UNIT – I **9**

Introduction : Principles of prestressing – Advantages - Materials – High strength concrete and high strength steel - Methods of prestressing - Pretensioning and post tensioning – Analysis of sections for stresses by various concepts

UNIT – II **9**

Prestressing loss and Deflection : Losses of pre-stress - Factors influencing deflections – Short term deflections of uncracked members – Prediction of long term deflections due to creep and shrinkage – Check for serviceability limit state of deflection.

UNIT – III **9**

Design for Flexure and Shear : Basic assumptions for calculating flexural stresses – Permissible stresses in steel and concrete as per I.S.1343 Code – Design of sections of Type I and Type II post tensioned and pretensioned beams – Check for strength limit state based on I.S. 1343 Code – Layout of cables in post tensioned beams – Location of wires in pretensioned beams – Design for shear based on I.S.1343 Code

UNIT – IV **9**

Design of tension members: Design of column subjected to bending moment and axial compression for working and ultimate loads – Design of anchorage zone by guyon's method – concept of magnels's method – IS1343 recommendations

UNIT – V **9**

Statically Determinate Structures: Concept of concordant cable and linear transformations – sketching of pressure lines for continuous beams – design of shear connections – design of a circular tank

TOTAL: 45

REFERENCE BOOKS:

1. Krishnaraju, N., "Prestressed Concrete", Tata McGraw Hill Publishing Co. Ltd, 2007.
2. Shinha, N.C. and Roy S.K., "Fundamentals of prestressed concrete", S.Chand and Company Ltd.,

Course Outcomes :

On completion of the course the students will be able to

- select suitable prestressing techniques in precast plants and cast-in-situ
- design various structural elements under serviceability conditions
- utilize the design concept for storage and dispose element

14SEE03 DESIGN OF BRIDGES

(IS456:2000, IS 458-1971,IRC 5-1998,IRC 6-2001,IRC 18-2000,IRC 21-2000,IRC 22-1986, IRC 24-2001,IRC 78-2000,2002,IRC 83 Part 1-1989, IRC 83 Part 2-1987 codes are permitted.)

3 0 0 3

UNIT - I **9**

Introduction and Short Span Bridges: Classification, investigations and planning, choice of type, I.R.C.specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations. Load distribution theories, analysis and design of slab culverts. Design of Tee beam and slab bridges.

UNIT - II **9**

Long Span Bridges and Bearings: Design principles of continuous bridges, box girder bridges, and balanced cantilever bridges. Different types of bearings – Design of elastomeric pad bearings.

UNIT - III **9**

Plate Girder Bridges: Design of plate girder bridges for highway and railway loading.

UNIT - IV **9**

Prestressed Concrete Bridges: Introduction - Courbon's theory – Design of Bridge deck bridges and Tee beam bridges – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – End block.

UNIT - V 9

Substructures: Design of piers and abutments – Types of bridge foundations – Design principles of foundations.

TOTAL: 45

REFERENCE BOOKS:

1. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, New Delhi, 2008.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co., New Delhi, 1990
3. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd, 2004.
4. Raina V.K." Concrete Bridge Practice" Tata McGraw Hill Publishing Company, New Delhi, 1991.

Course Outcomes:

On completion of the course the students will be able to

- analyze and design different types of short span and long span bridges
- analyze and design the prestressed concrete bridges
- analyze and design the substructure

14SEE04 THEORY OF PLATES AND SHELLS

(IS 1730-1989,IS 5488-1987,IS 2210-1988,IS 6332-1984 codes are permitted.)

3 0 0 3

UNIT - I **9**

Introduction to Plates: Simple bending of Plates-Assumptions in thin plate theory-Different relationships – Different boundary conditions for plates.

UNIT - II **9**

Plates subjected to lateral loads: Navier's method for simply supported plates – Levy's method for general plates – Example problems with different types of loading

UNIT - III **9**

Introduction to Shells: Classification of shells – Membrane and bending theory for singly curved and doubly curved shells – Various approximations – Analysis of folded plates.

UNIT - IV **9**

Analysis of Folded plates: Analysis – Simpsom Method, Whimey's Method – Yitchak method

UNIT - V **9**

Numerical Methods: Numerical method applied to plates and shells – Finite Difference method and Finite Strip method.

TOTAL: 45

REFERENCE BOOKS:

1. Rudolph Szilard, "Theory and Analysis of Plates", Prentice Hall, New Jercy 1986.
2. Stephen.P. Timoshenko & Woinowsky Krieger, "Theory of Plates and Shells", Mc Graw Hill, 1984.
3. Billington.D.P, "Thin Shell Concrete Structures", McGraw Hill Publishing Co.Ltd, NewYork, 1982.
4. Bairagi, "Plate Analysis", Khanna Publishers, 1996
5. Ugural.A.C., "Stresses in Plates and Shells", WCB/McGraw Hill, 1999.

Course Outcomes:

On completion of the course the students will be able to

- design plates subjected to lateral loading
- design singly curved and doubly curved shells
- utilize the behaviour and design philosophy of space frames due to seismic forces

14SEE05 DESIGN OF TALL BUILDINGS

(IS 875 Part 3-1987,SP 64 (S&T)-2001,IS1893 Part 4-2005,IS 4326-1993, SP 16-1980 codes are permitted)

3 0 0 3

UNIT – I **9**

Introduction and Design philosophy: Design philosophy- materials- loading- Gravity loading- Wind loading- Earthquake loading-blast loading. Strength and stability- stiffness and drift limitations-human comfort criteria-creep, shrinkage and temperature effects-fire-foundations, settlement and soil-structure interaction.

UNIT – II **9**

Behaviour of various structural systems: Factors affecting growth, Height and Structural form. High rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger – braced and hybrid mega systems.

UNIT – III **9**

Analysis and design of Structural Elements: Modelling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, Multistoried general three dimensional analysis.

UNIT – IV **9**

Structural elements: Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

UNIT – V **9**

Stability of Tall buildings: Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

TOTAL : 45

REFERENCE BOOKS:

1. Bryan Stafford Smith and Alexcoull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 1991.
2. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGraw Hill, 1988.
3. Gupta.Y.P.,(Editor), "Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities", New Age International Limited, New Delhi,1995.
4. Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.
5. Taraknath,IIT Bombay (Etalk Software).
6. Wolfgang Schueller, "High Rise Building Structures", Wiley Publications, 1977.

Course Outcomes:

On completion of the course the students will be able to

- identify and incorporate design principles in various structural elements
- utilize the basic concepts of loading in framed structures
- analyze and design tall structures taking into account the effect of creep, shrinkage and p-delta effect

14SEE06 MECHANICS OF COMPOSITE CONSTRUCTION MATERIALS

3 0 0 3

UNIT – I **9**

Introduction to composite materials: Definitions, classifying composite materials, commonly used fiber and matrix constituents, Composite construction, properties of unidirectional Long Fiber composites, Short Fiber composites and processing of FRP Composites.

UNIT – II **9**

Stress strain relations: Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear elasticity for Anisotropic materials, rotations of stresses, strains, residual stresses, transformation of stress and strain and restriction on elastic constants.

UNIT – III **9**

Analysis of Laminated composite plates: Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Laminate stiffness, Shear deformation plate theory, Static, dynamic and stability analysis for simpler cases of composite plates. Inter laminar stresses.

UNIT – IV **9**

Failure and Fracture of composites: Netting analysis, failure criterion, maximum stress, maximum strain, fracture mechanics of composites, Sandwich Construction.

UNIT – V **9**

Applications: Metal and ceramic matrix composites, applications of composites, composite joints, design with composites, Review and environmental issues.

TOTAL : 45

REFERENCE BOOKS:

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
2. Jones R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
3. Agarwal.B.D. and Broutman.L.J., "Analysis and Performance of Fiber Composites", John-Wiley and Sons, 1980.
4. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", University Press, India, 2004.
5. Joseph.C.Conway, Richard Allen Queeney, "Mechanical behaviour of Engineering Materials", The Pennsylvania State University.

Course Outcomes:

On completion of the course the students will be able to

- develop composite materials and its applications
- solve mechanics of composite materials problems using classical methods
- analyze problems on bending, buckling, vibration and failure criterion of laminated plates and beams

14SEE07 OFFSHORE STRUCTURES

(IS 4561 Part 1-1974,IS 4561 Part 2-1989,IS 4561 Part 3-1974,IS 4561 Part 4-1989, IS 4561 Part 5-1980,IS 9527 Part 1-1981,IS 9527 Part 3-1983,IS 9527 Part 4-1981, IS 10020 Part 4-1981,IS 875 Part 3-1987,SP 64 (S&T)-2001 codes are permitted.)

3 0 0 3

UNIT – I **9**

Wave Theories and Forces of Offshore Structures: Wave generation process, small and finite amplitude wave theories. Wind trains and wave energy-Wind forces, wave forces on vertical, inclined cylinders, structures – current forces and use of Morison equation.

UNIT – II **9**

Offshore Soil and Structure Modelling: Structures in the offshore environment – Description of typical offshore structures, Response of offshore structures, Modelling of offshore structures – single and multi degree freedom systems – effect of foundations, foundation modeling, structural modeling.

UNIT – III **9**

Analysis of Offshore Structures: Static method of analysis, foundation analysis and dynamics of offshore structures. Frequency domain analysis- time domain analysis- Response analysis of jacket and complaint structures.

UNIT – IV **9**

Design of Offshore Structures: Materials and their behavior under static and dynamic loads. Design of platforms, helipads, Jacket tower , mooring cables and pipe lines and pipe laying methods.

UNIT – V 9

Corrosion: Corrosion mechanism-types of corrosion-offshore structure corrosion zones-biological corrosion-preventive measures of corrosion- principle of cathode production systems-corrosion fatigue.

TOTAL : 45

REFERENCE BOOKS:

1. Chakrabarti, S.K. “Hydrodynamics of Offshore Structures”, Computational Mechanics Publications, 1987.
2. Dawson.T.H., “Offshore Structural Engineering”, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
3. Brebia, C.A and Walker.S., “Dynamic Analysis of Offshore Structures”, New Butterworths, U.K. 1979.
4. API, “Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms”, American Petroleum Institute Publication, RP2A, Dalls, Tex,2000.
5. Reddy, D.V. and Arockiasamy, M., “Offshore Structures”, Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.

Course Outcomes:

On completion of the course the students will be able to

- utilize wave theories for the design of offshore structures
- design and analyze offshore structures and modeling of various structural elements
- select suitable corrosion preventive measures to offshore structures

14SEE08 OPTIMIZATION OF STRUCTURES

3 0 0 3

UNIT – I **9**

Basic principles and Classical optimization techniques : Definition - Objective function; Constraints - Equality and inequality – Linear and non-linear, Side, Non-negativity, Behaviour and other constraints – Design space - Feasible and infeasible – Convex and Concave - Active constraint - Local and global optima.

UNIT – II **9**

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

UNIT – III **9**

Linear programming: Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables – Canonical form – Basic feasible solution - simplex method – Two phase method – Penalty method - Duality theory – Primal – Dual algorithm.

UNIT –IV **9**

Non linear programming: One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search – Dichotomous search – Fibonacci method – Golden section method – Interpolation methods. Unconstrained optimization techniques.

Geometric and Dynamic Programming: Polynomial – degree of difficulty – reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty – Concept of solving problems with one degree of difficulty.

UNIT – V **9**

Bellman's principle of optimality: Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods. Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design of R.C. structures such as Multistory buildings, water tanks and bridges.

TOTAL: 45

REFERENCE BOOKS:

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

Course Outcomes:

On completion of the course the students will be able to

- solve the classical methods of optimization problems
- utilize LPP to structural problems which is essential for a civil engineer
- solve the nonlinear programming problems
- use the programming concepts

14SEE09 PREFABRICATED STRUCTURES

(SP 7 Part 4-2005,IS 14142-1994,IS 14143-1994 codes are permitted.)

3 0 0 3

UNIT – I **9**

General Principles of Fabrication: Comparison with monolithic construction – Types of prefabrication – site and plant prefabrication – Economy of prefabrication – Modular coordination – Standardization – Planning for Components of prefabricated structures – Disuniting of structures – Design of simple rectangular beams and I beams – Handling and erection stresses – Elimination of erection stresses – Beams, columns – Symmetrical frames.

UNIT – II **9**

Prefabricated Elements: Roof and floor panels, ribbed floor panels – wall panels – footings – Joints for different structural Connections – Effective sealing of joints for water proofing – Provisions for non-structural fastenings – Expansion joints in pre-cast construction. Designing and detailing of precast unit for factory structures – Purlins, Principal rafters, roof trusses, lattice girders, gable frames – Single span single storeyed frames – Single storeyed buildings –slabs, beams and columns.

UNIT – III **9**

Production and Hoisting Technology: Choice of production setup – Manufacturing methods – Stationary and mobile production – Planning of production setup – Storage of precast elements – Dimensional tolerances – Acceleration of concrete hardening. Equipments for hoisting and erection – Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads.

UNIT – IV **9**

Applications: Designing and detailing of precast unit for factory structures– Purlins, Principal rafters, roof trusses, lattice girders, gable frames – Single span single storeyed frames – Single storeyed buildings: slabs, beams and columns, Application of prestressed concrete in prefabrication.

UNIT – V **9**

Pre-Engineered Buildings: Introduction – Advantages – Pre Engineered Buildings Vs Conventional Steel Buildings –Design of Pre Engineered Buildings (PEB) – Applications.

TOTAL : 45

REFERENCE BOOKS:

1. B.Lewicki, "Building with Large Prefabricates", Elsevier Publishing Company, Amsterdam/ London,New York, 1966.
2. Koncz.T., "Manual of Precast Concrete Construction", Vol.I II and III, Bauverlag, GMBH, 1971.
3. "Structural Design Manual, Precast Concrete Connection Details", Society for the Studies in the use of Prefabricated Concrete, Netherland Betor Verlag, 1978.
4. Lasslo Mokk, "Prefabricated Concrete for Industrial and Public Sectors", Akademiai Kiado, Budapest, 1964.
5. Murashev.V., Singalov.E., & Bailov.V.,"Design of Reinforced Concrete Structures", Mir Publishers, 1968.
6. Gerostiza.C.Z., Hendrikson.C., & Rehat.D.R., "Knowledge Based Process Planning for Construction and Manufacturing", Academic Press, Inc., 1989.
7. Warszawski.A., "Industrialization and Robotics in Building-A Mangerial Approach", Harper & Row, 1990.

Course Outcomes:

On completion of the course the students will be able to

- use basic design principles in precast plants and cast-in-situ
- design various structural elements under serviceability conditions
- utilize the design concept for industrial element

14SEE10 WIND AND CYCLONE EFFECTS ON STRUCTURES

(IS 875 Part 1 to 5- 1987, IS 6533 Part 2-1989 codes are permitted.)

3 0 0 3

UNIT – I **9**

Introduction: Spectral studies, Gust factor, Wind velocity, Methods of measurement, variation of speed with height, shape factor, aspect ratio, drag effects.

UNIT – II **9**

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

UNIT – III **9**

Effect of wind on structures:: IS codes and special structures, wind on structures, rigid structures, Flexible structures, Static and Dynamic effects,

UNIT – IV **9**

Tall Structures: Tall buildings, Chimneys – application to design - IS875 code method, buildings, chimneys, roofs, shelters

UNIT – V **9**

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

TOTAL: 45

REFERENCE BOOKS:

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

Course Outcomes:

On completion of the course the students will be able to

- interpret the result of wind tunnel
- utilize the design concept in wind and cyclone effects
- design tall buildings and chimneys

14SEE11 DESIGN OF COMPOSITE STRUCTURES

(IS 801,807,811,875, 1024,3370,6533 part 2 codes are permitted)

3 0 0 3

UNIT – I **9**

Introduction: Design of members subjected to lateral loads and axial loads - Principles of analysis and design of Industrial buildings and bents - Crane gantry girders and crane columns – Analysis and design of steel towers - Design of industrial stacks - Self supporting and guyed stacks lined and unlined.

UNIT – II **9**

Types of connections:, Design of framed beam connections, Seated beam connection, Un-stiffened, Stiffened seat connections, Continuous beam - to - beam connections and continuous beam-to-column connection both welded and bolted.

UNIT - III **9**

Cold formed Steel sections: Types of cross sections - Local buckling and post buckling - Design of compression and tension members - Beams - Deflection of beams – Combined stresses and connections. Introduction to composite design.

UNIT – IV **9**

Shear connectors: Types of shear connectors - degrees of shear connections - partial and full shear connections - composite sections under positive bending - negative bending - propped conditions - un-propped conditions - deflection of composite beams.

UNIT - V **9**

Composite slabs and Columns: Introduction - Composite slabs - profiled sheeting - sheeting parallel to span – sheeting perpendicular to span - Types of composite columns - design of encased columns - design of in-filled columns - axial, uni-axial and bi-axially loaded columns. Composite shear wall - double skinned composite deck panels - composite trusses - composite frames – composite plate girders.

TOTAL: 45

REFERENCE BOOKS:

1. Horne M.R. and Morris L.J, “Plastic Design of Low-rise frames”, Granada Publishing Ltd., 1981.
2. Salmon, C.G., and Johnson, J.E., “Steel Structure -Design and Behavior”, Harper and Row,1980.
3. Dayarathnam, P., “Design of Steel Structure”, A.H.Wheeler, 1990.
4. Subramaniam.N, “Design of Steel Structures: Theory and Practice”, Oxford University Press, 2011.

Course Outcomes:

On completion of the course the students will be able to

- design members subjected to lateral loads and axial loads, self supporting and guyed stacks, design of framed beam connections
- design compression and tension members, partial and full shear connections
- design Composite slabs, design of encased columns, design of in-filled columns and composite plate girders

14CME11 MAINTENANCE AND REHABILITATION OF STRUCTURES

(Common to Construction Engineering Management & Structural Engineering)

3 0 0 3

UNIT – I **9**

Introduction: Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking. Effects due to climate, temperature, chemicals, wear and erosion.

UNIT – II **9**

Corrosion: Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection.

UNIT – III **9**

Maintenance and Repair strategies: Facets of maintenance, importance of Maintenance, Preventive measures on various aspects of Inspection, Assessment procedure for evaluating a damaged structure causes of deterioration - testing techniques.

UNIT – IV **9**

Materials and Techniques for repair: Special concretes and mortar, concrete chemicals, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete. Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning.

UNIT – V **9**

Demolition Techniques: Engineered demolition and other case studies**.**

TOTAL : 45

REFERENCE BOOKS:

1. Campbell-Allen, Denison and Roper, Harold., "Concrete Structures: Materials, Maintenance and Repair", Longman Scientific and Technical UK, 1991.
2. Allen, R.T and Edwards, S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987.
3. Shetty, M.S, "Concrete Technology - Theory and Practice", S.Chand and Company, New Delhi, 2008.

Course Outcomes:

On completion of the course the students will be able to

- test the quality of structures in the construction field
- plan repair and maintenance strategies for structures
- select suitable techniques for demolition of structures