KONGU ENGINERING COLLEGE, PERUNDURAI, ERODE- 638 052
(Autonomous Institution affiliated to Anna University of Technology, Coimbatore)

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

CURRICULUM
(For the candidates admitted from academic year 2012-13 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11SE101	Applied Mathematics for Structural Engineers	3	1	0	4	50	50	100
11SE102	Theory of Elasticity and Plasticity	3	1	0	4	50	50	100
11SE103	Computer Analysis of Structures	3	1	0	4	50	50	100
11SE104	Structural Dynamics	3	1	0	4	50	50	100
11SE105	Advanced Design of Substructures	3	0	0	3	50	50	100
11CM103	Advanced Concrete Technology	3	0	0	3	50	50	100
	PRACTICAL							
11SE106	Advanced Structural Engineering Laboratory	0	0	3	1	100	0	100
				Total	**23**			

CA – Continuous Assessment, ESE – End Semester Examination

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CURRICULUM

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SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11SE201	Finite Element Analysis	3	1	0	4	50	50	100
11SE202	Stability of Structures	3	1	0	4	50	50	100
11SE203	Design of Concrete Structures	3	0	0	3	50	50	100
11SE204	Earthquake Analysis and Design of Structures	3	0	0	3	50	50	100
	Elective-I	3	0	0	3	50	50	100
	Elective-II	3	0	0	3	50	50	100
	PRACTICAL							
11SE205	Structural Engineering Design Studio	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)

CURRICULUM
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SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11SE301	Design of Steel and Steel Concrete Composite Structures	3	0	0	3	50	50	100
	Elective-III	3	0	0	3	50	50	100
	Elective-IV	3	0	0	3	50	50	100
	PRACTICAL							
11SE302	Industrial Training	0	0	0	1	50	50	100
11SE303	Project Work Phase-I	0	0	12	6	50	50	100
				Total	**16**			

CA – Continuous Assessment, ESE – End Semester Examination

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CURRICULUM
(For the candidates admitted from academic year 2012-13 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
11SE401	Project Work Phase-II	0	0	24	12	100	100	200
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

LIST OF ELECTIVES					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
11SE011	Design of Industrial Structures	3	0	0	3
11CM202	Maintenance and Rehabilitation of Structures	3	0	0	3
11SE012	Pre-stressed Concrete Structures	3	0	0	3
11SE013	Design of Bridges	3	0	0	3
11SE014	Theory of Plates, Shells and Space Frames	3	0	0	3
11SE015	Design of Tall Buildings	3	0	0	3
11SE016	Composite Materials Mechanism	3	0	0	3
11SE017	Offshore Structures	3	0	0	3
11SE018	Optimization of Structures	3	0	0	3
11SE019	Prefabricated Structures	3	0	0	3
11SE020	Wind and Cyclone Effects on Structures	3	0	0	3
11SE021	Experimental Methods and Model Analysis	3	0	0	3
11SE022	Corrosion and its Prevention	3	0	0	3

11SE101 APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERS

3 1 0 4

Objective:

On completion of the course the students are expected

- To understand the basic concepts and properties of probability and random variables.
- To understand partial and multiple correlation, regression.
- To understand analysis of time series and simulation.

MODULE - I **15**

Probability: Axiomatic approach to probability, addition and multiplication laws of probability, conditional probability, Baye's theorem.

Random variable: 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.

MODULE - II **15**

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

Time Series and Simulation: Trend and seasonal variations-components of Time series –Measurement of trend-Linear and Second degree parabola-Simulation study-Types of simulation-Limitations and areas of simulation.

MODULE - III **15**

Testing of Hypothesis: Definition – Population and samples – Test of significance for small samples – t- test – F- test– Chi-square test of goodness of fit – Independent of attributes.

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

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2010.
2. Kandasamy. P, Thilagavathi. K and Gunavathy. K, "Probability, Statistics and Queueing Theory", S.Chand & Company Ltd., Reprint 2010.
3. Veerarajan.T,, "Probability, Statistics and Random Process", Tata McGraw Hill Publication Company Ltd., 2010.
4. Fruend, J.E. and Miller, I, "Probability and Statistics for Engineers", Prentice Hall of India Ltd. 1994

11SE102 THEORY OF ELASTICITY AND PLASTICITY

3 1 0 4

Objective:

- To understand the concept of 2 Dimensional and 3 Dimensional stress-strain analysis and its applications to simple problems**.**

MODULE - I **15**

Analysis of stress and strain, stress strain relationship- Generalized Hooke's law- Plane stress and plane strain-Airy's stress function, Stress polynomials-Two dimensional problems in Cartesian co-ordinates.

MODULE - II **15**

Methods of analysis –derivation of equilibrium equation in polar coordinates – stress function in polar coordinates- membrane analogy - Torsion of non-circular section - torsion of thin rectangular section and hollow thin walled sections-Energy methods - Principle of virtual work - Energy theorem - Rayleigh Ritz methods.

MODULE - III **15**

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 Verma, PDS, "Theory of Elasticity", Vikas Publishing Pvt. Ltd. New Delhi -1997.

11SE103 COMPUTER ANALYSIS OF STRUCTURES

3 1 0 4

Objective:

- To study the advanced method of analysis such as Flexibility method and Stiffness method with the application of computer software tools. Direct stiffness method are also covered.

MODULE - I **15**

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

MODULE - II **15**

Flexibility Method and Stiffness 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. 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.

MODULE - III **15**

Matrix Displacement Methods – Special Topics and Direct Stiffness Method: Static condensation Technique – Substructure technique - Transfer Matrix method – Symmetry & Anti symmetry of structures – Reanalysis technique. 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, NewDelhi, 2001.
3. Beaufait, F.W., "Computer Methods of Structural Analysis", Prentice Hall 1970.
4. Holzer, S.M., "Computational Analysis of Structures", Elsevier Science Publishing Co., Inc, 1988
5. Kanchi M. B., "Matrix methods of Structural analysis", New Age International, 1993.

11SE104 STRUCTURAL DYNAMICS

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

3 1 0 4

Objective:

- To expose the students about the principles and methods of dynamic analysis of structures and to prepare them for designing the structures for wind, earthquake and other dynamic loads. They will be able to estimate the aptitude, frequency and vibration by various techniques

MODULE – I **15**

Principles of Vibration Analysis: Equations of motion by equilibrium and energy methods, free and forced vibration of single degree of freedom systems, Effect of damping, Transmissibility.

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

MODULE – II **15**

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

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

MODULE - III **15**

Practical Applications: Idealization and formulation of mathematical models for wind, earthquake, blast and impact loading, aerodynamics, gust phenomenon, principles of analysis. Numerical methods for solving Dynamic problems.

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. John M.Biggs, "Introduction to Structural Dynamics", McGraw Hill, 1964.
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.

11SE105 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 9456-1980,IS 12070-1987,IS 14593-1998,IS 2810-1979,IS 5249-1992 codes are permitted)

3 0 0 3

Objective:

- To study the analyze and design of different types of foundation and retaining structures.

MODULE - I **15**

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

MODULE - II **15**

Pile foundations – types, method of installation, Codal practices for permissible load under vertical and lateral loads, structural design of pile caps; Diaphragm wall design and construction.

MODULE - III **15**

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

11CM103 ADVANCED CONCRETE TECHNOLOGY

(IS 456:2000, 10262:2009, 4926:1996, SP23 codes are permitted.)

(Common to M.E. Construction Engineering & Management and Structural Engineering)

3 0 0 3

Objective:

- To review the basics of concrete ingredient
- To study the properties of fresh and hardened concrete properties
- To understand the durability of concrete

MODULE - I **15**

Concrete Ingredients: Composition of OPC - Manufacture - Modified Portland Cements - Hydration process of Portland Cements - Structure of Hydrated Cement Pastes - Mineral admixtures - Slags - Pozzolans and Fillers - Chemical admixtures - Solutes - Retarders - Air entraining agents - Water proofing compounds - Plasticizers and super plasticizers - Shape and mechanical properties - Absorption and Physical durability - Chemical stability -Packing characteristics

MODULE - II **15**

Fresh and Hardened Concrete: Workability - Mix proportioning – Mixes incorporating Fly ash, Silica fume, GGBS -Mixes for High Performance Concrete - Mix design methods - variations in concrete strength - Interfacial transition zone - Fracture strength - Mechanical properties - High Strength Concrete - Shrinkage - Creep - Other properties- NDT systems

MODULE - III **15**

Durability of Concrete: Basic consideration - Stability of constituents - Chemical attack - Corrosion of reinforcing Steel.

Special Concretes: Fibre Reinforced Concrete - Self Compacting Concrete - Polymer Concrete – Geopolymer Concrete - Super Plasticized Concrete – Light Weight Concrete – Roller Compacted Concrete – Reactive Powder Concrete – RMC – Basalt Fibre Concrete –Wisper concrete- Recycled Aggregate Concrete - High Density Concrete – HVFA Concrete- Vacuum Concrete- Foam Concrete- Bacterial Concrete

TOTAL : 45

REFERENCE BOOKS

1. Nevile, A.M. “Properties of Concrete", 4th edition, Longman, 1995.
2. Metha, P.K. and Montreio, P.J.M., “Concrete Structure Properties and Materials", 2nd edition Prentice Hall, 1998.
3. Mindass and Young, “Concrete", Prentice Hall, 1998

11SE106 ADVANCED STRUCTURAL ENGINEERING LABORATORY

0 0 3 1

Objective:

- To impart the practical knowledge to the students about the testing and studying the properties of structural – concrete elements

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

REQUIRED LABORATORY EQUIPMENTS

1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring
6. Demec Gauge
7. Electrical Strain Gauge with indicator
8. Rebound Hammer
9. Ultrasonic Pulse Velocity Tester
10. Dial Gauges
11. Clinometer
12. Vibration Exciter
13. Vibration Meter
14. FFT Analyser
15. Vibrating Table(mode shape)

REFERENCE BOOK

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

11SE201 FINITE ELEMENT ANALYSIS

3 1 0 4

Objective:

- To study about stress analysis, meshing, nonlinear and thermal analysis.

MODULE - I **15**

Introduction: Value problem - Approximate solution - Variation and weighted residual methods - Ritz and Gale kin formulations - Concepts of piecewise approximation and Finite Elements - Displacement and Shape functions - Weak formulation - Minimum potential energy - Generation of Stiffness Matrix and Load vector.

MODULE - II **15**

Stress analysis, meshing and solution problems: Two Dimensional problems - Plane stress, Plain strain and Axi symmetric problems - Triangular and quadrilateral elements - Natural coordinates – iso-parametric formulation - Numerical integration - Plate bending and Shell elements - Brick elements - Elements for fracture analysis-Higher order elements - P and H methods of refinement - Ill conditioned elements - Discretisation errors -Auto and adaptive mesh generation techniques - Error evaluation.

MODULE - III **15**

Nonlinear and Vibration problems & Thermal analysis: Material and Geometric nonlinearity - Methods of treatment - Consistent system matrices – Dynamic condensation - Eigen value extraction- Application to thermal analysis problems. Application of Finite element method based on commercial software packages.

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.

11SE202 STABILITY OF STRUCTURES

3 1 0 4

Objective:

- At the end of this course, students will be in a position to understand the phenomenon of buckling and its effects on structural components.
- To study the concept of buckling and analysis of structural elements.

MODULE - I **15**

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 – imperfect columns, non- prismatic columns, Built-up columns – Rayleigh Ritz, Galerkins approach –Effect of shear on buckling

MODULE - II **15**

Buckling of Beam-Columns, Frames and Plates: Theory of beam column – Stability analysis of beam column with single and several concentrated loads, distributed load and end couples – 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 – Post buckling behaviour of plates.

MODULE - III **15**

Torsional, Lateral and Inelastic 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 – 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.

11SE203 DESIGN OF CONCRETE STRUCTURES

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

3 0 0 3

Objective:

- To make the students be familiar with the limit state design of RCC beams and columns
- At the end of the course the students shall be in a position to design hypostatic RC beams and frames and other structures such as deep beams and grid floors

MODULE - I **15**

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

MODULE - II **15**

Flat slabs and Flat Plates: Design of flat slabs and flat plates according to IS methods - Design of shear reinforcement - Design of spandrel beams - Yield line theory and Hillerborgs strip method of design of slabs. Design of grid floors.

MODULE - III **15**

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 – Quality control of concrete.

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., “Limit State Design of Reinforced Concrete”, Prentice Hall of India, 2007.
4. Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India, 2005.

11SE204 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

(IS 1893, IS 13920 SP34, SP32 & IS 4326 codes are permitted)

3 0 0 3

Objective:

- To study the effect of earthquakes, analysis and design of earthquake resistant structures.

MODULE - I **15**

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. Characteristics of strong earthquake motion, 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.

MODULE - II **15**

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, Earthquake resistant masonry buildings - Design consideration – Guidelines.

MODULE - III **15**

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

11SE205 STRUCTURAL ENGINEERING DESIGN STUDIO

0 0 3 1

Objective:

- At the end of the laboratory classes the students would be known how to plan, analysis and design the buildings and the preparation of detailed drawings.
- Planning, Analysis and Design of industrial structures, Multi storeyed buildings, Bridges, Towers, Storage structures, Material handling equipment and special structures. Geotechnical aspects in foundation design. Special emphasis on earthquake resistant design. Design, detailing and preparation of drawings of the above.

11SE301 DESIGN OF STEEL AND STEEL CONCRETE COMPOSITE STRUCTURES

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

3 0 0 3

Objective:

- To impart knowledge on steel constructions
- At the end of this course students will be in a position to design bolted and welded connections in industrial structures, light gauge sections and all related connections incorporating the recommendations of IS 800-2007 code.

MODULE - I **15**

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. 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.

MODULE - II **15**

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 - 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.

MODULE - III **15**

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.

11SE302 INDUSTRIAL TRAINING

0 0 0 1

Objective:

- To impart the knowledge to the students about field situations/conditions and train them how to handle these situations.
- The student will make at least two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits.

11SE011 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

Objective:

- At the end of this course the students shall be able to plan and design the Engineering, Chemical and Textile Industries.
- They will be able to design the structures such as Silos, Bunkers and Chimneys.

MODULE - I **15**

General Planning and Functional 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 – 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.

MODULE - II **15**

Industrial Buildings: Roofs for Industrial buildings – Steel and RC roofing– Design and detailing of R.C. gable frames – Folded Plates and North Light Shell Roofs – Gantry Girders – Design of Corbels and Nibs – Machine Foundations.

MODULE - III **15**

Power plant and Power Transmission Structures: Bunkers and Silos – Chimneys and Cooling Towers – High pressure boilers and piping design – Nuclear containment 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., “Deign 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.

11CM202 MAINTENANCE AND REHABILITATION OF STRUCTURES

(Common to M.E.Construction Engineering & Management and Structural Engineering)

3 0 0 3

Objective:

- To bring about an exposure to serviceability and durability criteria.
- To study the development of maintenance and repair strategy.
- To study the development of repair materials.

MODULE - I **15**

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, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

MODULE - II **15**

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

MODULE - III **15**

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.

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.

11SE012 PRESTRESSED CONCRETE STRUCTURES

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

3 0 0 3

Objective:

- At the end of this course the student shall have a knowledge of methods of pre-stressing and the problems involved in design of various pre-stressed concrete elements under codal provision**s.**

MODULE - I **15**

Principles of pre-stressing - Methods of pre-stressing- Materials -Pre-tensioning and post-tensioning - Losses of pre-stress. Design and choice of sections for Post-tensioned and Pre-tensioned beams based on working stress approach-check for limit state of collapse-Layout of cables in post-tensioned beams - short term and long term deflections- codal requirements.

MODULE - II **15**

Limit state of flexure and shear resistance of cracked and uncracked sections-Design of shear and flexure reinforcement-Transmission of pre-stressing force by bond in pre-tensioned members- Check for transmission length- Design of anchorage zone for post-tensioned beams by I.S.Code methods and Guyon's method.

MODULE - III **15**

Types of composite construction involving precast, pre-stressed units -Analysis for stress-Design for flexure and shear. Design of tank wall incorporating the recommendations of I.S: 3370 part III and IV codes- Types of prestressed concrete pipes-Design of pipes- Methods of achieving continuity in prestressed concrete continuous beams.

TOTAL: 45

REFERENCE BOOKS

1. Krishnaraju, N., "Prestressed Concrete", Tata Mc Graw Hill publishing co. Ltd,2007.
2. Shinha, N.C. and Roy S.K., "Fundamentals of prestressed concrete", S.Chand and company Ltd.,

11SE013 DESIGN OF BRIDGES

(IS456:2000, IS 458-1971,IRC 5-1998,IRC 6-2001,IRC 21-1978,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

Objective:

- To study the loads, forces on bridges and design of several types of bridges.

MODULE - I **15**

Introduction, short and long 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, tee beam and slab bridges. Design principles of continuous bridges, box girder bridges, balanced cantilever bridges.

MODULE - II **15**

Design of Prestressed Bridges: Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – 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 – Diaphragms – End block – short term and long term deflections.

MODULE - III **15**

Design of Plate girder Bridges, bearings and Substructures**:** Design of riveted and welded plate girder bridges for highway and railway loading – wind effects – main section, splicing, curtailment, stiffeners – Different types of bearings – Design of bearings – Design of masonry and concrete piers and abutments – Types of bridge foundations – Design 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.

11SE014 THEORY OF PLATES, SHELLS AND SPACE FRAMES

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

3 0 0 3

Objective:

- To study the behavior of plates, shells and space frames.

MODULE - I **15**

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

MODULE - II **15**

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

MODULE - III **15**

Introduction to Space frame: Space frames – Configuration – Types of nodes – General principles of design Philosophy – Behaviour.

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", Mc Graw Hill Book Co., NewYork, 1982.
4. Subramanian.N, "Principles of Space Structures", Wheeler Publishing Co.1999.
5. Ramasamy G.S, "Design and Construction of Concrete Shells Roofs", CBS Publishers, 1986.

11SE015 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

Objective:

- To study the behaviour, analysis and design of tall structures.

MODULE - I **15**

Loading and behaviour of various structural systems**:** Design philosophy, Loading, sequential loading, materials - high performance concrete - Fiber reinforced Concrete - Light weight concrete - design mixes. Gravity loading Wind and Earthquake loading. 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.

MODULE - II **15**

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, computerised general three dimensional analysis. 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.

MODULE - III **15**

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).

11SE016 COMPOSITE MATERIALS MECHANISM

3 0 0 3

Objective:

- To study the behaviour of composite materials and to investigate the failure and fracture characteristics.

MODULE - I **15**

Introduction to composites, classifying composite materials, commonly used fiber and matrix constituents, Composite construction, properties of unidirectional Long Fiber composites, Short Fiber composites. Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear elasticity for Anisotropic materials, rotations of stresses, strains, residual stresses.

MODULE - II **15**

Analysis of Laminated composites: Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Interlaminar stresses.

MODULE - III **15**

Failure and Fracture of composites**:** Netting analysis, failure criterion, maximum stress, maximum strain, fracture mechanics of composites, Sandwich Construction. Metal and ceramic matrix composites, applications of composites, composite joints, design with composites, Review, 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.
5. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", University Press, India, 2004.

11SE017 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

Objective:

- To study the concept of wave theories, forces and design of jacket towers, pipes and cables**.**

MODULE - I **15**

WAVE THEORIES AND FORCES OF OFFSHORE STRUCTURES: Wave generation process, small and finite amplitude wave theories. Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

MODULE - II **15**

OFFSHORE SOIL AND STRUCTURE MODELLING: Different types of offshore structures, foundation modeling, structural modeling.

MODULE - III **15**

ANALYSIS AND DESIGN OF OFFSHORE STRUCTURES: Static method of analysis, foundation analysis and dynamics of offshore structures. Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

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.

11SE018 OPTIMIZATION OF STRUCTURES

3 0 0 3

Objective:

- To study the optimization methodologies applied to structural engineering.

MODULE - I **15**

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

MODULE - II **15**

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.
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.

MODULE - III **15**

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. 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 multistorey 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

11SE019 PREFABRICATED STRUCTURES

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

3 0 0 3

Objective:

- To Study the design principles, analysis and design of Prefabricated structures.

MODULE - I **15**

Design principles and Reinforced concrete **:** General Civil Engineering requirements, specific requirements for planning and layout of prefabricates plant. IS Code specifications. Modular coordination, standardization, Demoulding of Prefabricates, production, transportation, erection, stages of loading and codal provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls. Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column and column to column.

MODULE - II **15**

Floors , Stairs, Roofs and Walls: Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure. Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.

MODULE - III **15**

Industrial buildings and Shell roofs: Components of single-storey industrial sheds with crane gantry systems, R.C. Roof trusses, Roof panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hyper-prefabricated shells, erection and jointing, joint design, hand book based design.

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.

11SE020 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

Objective:

- To study the concept of wind effects, analysis and design of structures.

MODULE - I **15**

Introduction, Spectral studies, Gust factor, Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects.
Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.

MODULE - II **15**

Effect of wind on structures: IS codes and special structures, wind on structures, rigid structures, Flexible structures, Static and Dynamic effects, Tall buildings, Chimneys. application to design, IS875 code method, buildings, chimneys, roofs, shelters

MODULE - III **15**

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.

11SE021 EXPERIMENTAL METHODS AND MODEL ANALYSIS

3 0 0 3

Objective:

- To introduce the basic concept to the students about the testing techniques and methods adopted for different types of loading.

MODULE - I **15**

General: Basic concept in measurements, measurement in displacement, strain pressure, force torque etc, type of strain gauges (Mechanical, Electrical resistance, Acoustical etc.) strain gauge circuits-The potentiometer and Wheatstone bridge. Use of lead wires switches etc. Use of electrical resistance strain gauge in transducer applications.

MODULE - II **15**

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.

MODULE - III **15**

Testing techniques: Non destructive testing techniques. Photo elasticity – optics of photo elasticity – Plolariscope - Isoclinics and Isochromatics - methods of stress separation- laws of similitude- model materials- model testing- testing large scale structures- holographic techniques.

TOTAL: 45

REFERENCE BOOKS

1. Rangan C S ,"Instrumentation – Devices and systems ",Tata Mcgraw –hill Publishing Co Ltd.,Newdelhi.,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 Delhi, 1984.

11SE022 CORROSION AND ITS PREVENTION

(IS 456-2000,IS 516-1959,IS 13311 Part 1-1992,IS 13311 Part 2-1992,SP 65 codes are permitted.)

3 0 0 3

Objective:

- To study the environmental effects on structures, corrosion, tests and prevention of corrosion.

MODULE - I **15**

Introduction: Corrosion of steel reinforcement in concrete, definition of corrosion, forms of corrosion, phenomenon of corrosion, corrosion initiation-environment-cover thickness-quality of cover concrete –type of steel and critical chloride-presence of cracks, corrosion propagation - electrochemical process – physical process, theory of reinforcement corrosion-basic corrosion cell-anode and cathode-electrolyte- corrosion potential and rate of corrosion.

MODULE - II **15**

Identification and appraisal of Corrosion: Corrosion process and mechanism – approach to investigation-visual observation and documentation, in situ testing of concrete-rebound hammer test, cover meter survey-(UPV) Ultrasonic pulse velocity test –core sampling and testing, in situ testing of steel rebar –carbonation test and pH value, chloride content-half cell potential survey-resistivity mapping –measurement of corrosion rate.

MODULE - III **15**

Protective measures: Coating to reinforcement-metallic coatings-epoxy coatings-cement based coatings – coating to prestressing steel, galvanized reinforcement, stainless steel, non-ferrous reinforcement and coating to concrete surface, improving the concrete, corrosion resistant steel. Definition of inhibitor-anodic and cathodic inhibitors-rice husk ash, fly ash, electrochemical removal of chloride from concrete, non-metallic materials, carbon FRP, Glass FRP.

TOTAL: 45

REFERENCE BOOKS

1. Fontanna, G.Mars, “Corrosion Engineering”, Third Edition, McGraw – Hill Book Company.
2. Kumar Mehta, P “Concrete Structure Properties and Materials”, Prentice – Hall, INC, Englewood Cliffs, New Jersey.