NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)
Erode-638 052, Tamilnadu, India, Phone: 04294 – 225585

Curriculum and Syllabus
for
M.E – Structural Engineering [R13]

(This Curriculum and Syllabi are applicable to Students admitted from the academic year 2013-2014 onwards)

AUGUST 2013

Approved by first governing body

NANDHA ENGINEERING COLLEGE, ERODE-52

REGULATINS2013

M.E. (STRUCTURAL ENGINEERING)
I SEMESTER (FULL TIME)
CURRICULUM & SYLLABUS

SEMESTER I

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
13ST101	Applied Mathematics for Structural Engineering	3	1	0	4
13ST102	Concrete Structures	3	1	0	4
13ST103	Structural Dynamics	3	1	0	4
13ST102	Theory of Elasticity and Plasticity	3	1	0	4
E1	Elective – I	3	0	0	3
E2	Elective - II	3	0	0	3
	TOTAL	**18**	**4**	**0**	**22**

SEMESTER II

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
13ST201	Finite Element Analysis	3	1	0	4
13ST202	Experimental Techniques and Instrumentation	2	0	2	3
13ST203	SteelStructures	3	1	0	4
13ST204	EarthquakeAnalysisandDesignof Structures	3	0	0	3
E3	Elective - III	3	0	0	3
E4	Elective - IV	3	0	0	3

PRACTICAL					
Course code	**Course Title**	**L**	**T**	**P**	**C**
13ST221	AdvancedStructuralEngineering Laboratory	0	0	4	2
	TOTAL	**17**	**2**	**6**	**22**

SEMESTER III

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
E4	Elective - V	3	1	0	4
E5	Elective - VI	3	0	0	3
E6	Elective - VII	3	0	0	3

PRACTICAL					
Course code	**Course Title**	**L**	**T**	**P**	**C**
13ST321	Practical Training (4 Weeks)	0	0	0	1
13ST322	Project Work Phase I	0	0	6	2
	TOTAL	**9**	**1**	**6**	**13**

SEMESTER IV

PRACTICAL					
Course code	**Course Title**	**L**	**T**	**P**	**C**
13ST421	Project Work Phase II	0	0	30	15
	TOTAL	**0**	**0**	**30**	**15**

M.E. (STRUCTURAL ENGINEERING)
(PART-TIME)

I SEMESTER

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
13ST101	Applied Mathematics for Structural Engineering	3	1	0	4
13ST102	Concrete Structures	3	1	0	4
E1	Elective – I	3	0	0	3
	TOTAL	**9**	**2**	**0**	11

II SEMESTER

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
13ST103	Structural Dynamics	3	1	0	4
13ST104	Theory of Elasticity and Plasticity	3	1	0	4
E2	Elective - II	3	0	0	3
	TOTAL	9	2	0	11

III SEMESTER

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
13ST201	FiniteElementAnalysis	3	1	0	4
13ST202	Experimental Techniques and Instrumentation	2	0	2	3
E3	Elective - III	3	0	0	3

PRACTICAL					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
13ST221	AdvancedStructuralEngineering Laboratory	0	0	4	2
	TOTAL	8	1	6	12

IV SEMESTER

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
13ST203	SteelStructures	3	1	0	4
13ST204	EarthquakeAnalysisandDesignof Structures	3	0	0	3
E4	Elective - IV	3	0	0	3
	TOTAL	9	1	0	10

V SEMESTER

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
E5	Elective - V	3	1	0	4
E6	Elective - VI	3	0	0	3
E7	Elective - VII	3	0	0	3

PRACTICAL					
13ST321	Practical Training (4 Weeks)	0	0	0	1
13ST322	Project Work Phase - I	0	0	6	2
	TOTAL	9	1	6	13

VI SEMESTER

Course Code	**Course Title**	**L**	**T**	**P**	**C**
PRACTICAL					
13ST421	Project Work Phase II	0	0	30	15
				TOTAL	15

LIST OF ELECTIVES
M.E STRUCTURAL ENGINEERING

ELECTIVES					
Course code	**Course Title**	**L**	**T**	**P**	**C**
13STX01	Design of Tall Buildings	3	1	0	4
13STX02	Industrial Structures	3	1	0	4
13STX03	Prestressed Concrete	3	0	0	3
13STX04	Off Shore Structures	3	0	0	3
13STX05	Prefabricated Structures	3	0	0	3
13STX06	Advanced Concrete Technology	3	0	0	3
13STX07	Design of Bridges	3	1	0	4
13STX08	Advanced Structural Analysis	3	1	0	4
13STX09	Design of Shell and Spacial Structures	3	0	0	3
13STX10	Design of Steel Concrete Composite Structures	3	1	0	4
13STX11	Maintenance and Rehabilitation of Structures	3	0	0	3
13STX12	Mechanics of Composite Materials	3	0	0	3
13STX13	Non-Linear Analysis of Structures	3	0	0	3
13STX14	Stability of Structures	3	0	0	3
13STX15	Theory of Plates	3	0	0	3
13STX16	Wind and Cyclone Effects on Structures	3	0	0	3

13ST101 APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERING

L	T	P	C
3	1	0	4

OBJECTIVE:

To make available the advanced concepts of Engineering Mathematics to the engineers and to provide the necessary mathematical skills that are needed in modelling physical processes.

LEARNING OUTCOME:

- To familiarize the students in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications.
- To expose the students to variation formulation and numerical integration techniques and their applications to obtain solutions for buckling, dynamic response, heat and flow problems of one and two dimensional conditions.

UNIT I :ONE DIMENSIONAL WAVE AND HEAT EQUATIONS (10+3)

Laplace transform methods for one-dimensional wave equation –Displacements in a long string –longitudinal vibration of an elastic bar – Fourier transform methods for one-dimensional heat conduction problems in infinite and semi-infinite rods.

UNIT II:ELLIPTIC EQUATION (9+3)

Laplace equation-properties of harmonic functions-Solution of Laplace's equation by means of Fourier transforms in a half plane, in an infinite strip and in a semi-infinite strip-Solution of Poisson equation by Fourier transform method.

UNIT III: CALCULUS OF VARIATIONS (9+3)

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-Variational problems with moving boundaries-Direct methods – Ritz and Kantorovich methods.

UNIT IV: EIGEN VALUE PROBLEMS (9+3)

Methods of solutions : Faddeev – Leverrier Method, Power Method with deflation – Approximate Methods: Rayleigh- Ritz method.

UNIT V: NUMERICAL INTEGRATION (8+3)

Gaussian Quadrature – One and Two Dimensions- Gauss Hermite Quadrature – Monte Carlo Method – Multiple Integration by using mapping function.

TOTAL: 60 Hours

REFERENCES:

1. Sankara Rao,K., "Introduction to Partial Differential Equations",Prentice Hall of India Pvt.Ltd.,New Delhi,1997.
2. Rajasekaran.S, "Numerical Methods in Science and Engineering A Practical Approach",A.H.Wheeler and Company Private Limited,1986.
3. Gupta,A.S., "Calculus of variations with Applications", Prentice Hall of India Pvt.Ltd.,New Delhi,1997.
4. Andrews,L.C. and Shivamoggi, B.K., "Integral Transforms for Engineers",Prentice Hall of India Pvt.Ltd.,New Delhi,2003.

13ST102 CONCRETE STRUCTURES

L	T	P	C
3	1	0	4

OBJECTIVE:

The course Objective is to make familiar to students in the field of inelastic behavior of concrete structures which helps them to learn about yield line theory, rotation curves and ductile detailing.

LEARNING OUTCOME:

At the end of the course the students would

- To study the behaviour of Reinforced Concrete Structures.
- To study the analysis of structures and Hillerborgs strip method of slabs.
- To familiarize students for the design of flat slabs and plates.
- To make understand students the detailing for ductility and quality control of concrete.

UNIT I:OVERALL REVIEW (9)

Review of limit state design of beams, slabs and columns according to IS Codes. Calculation of deflection and crack width according to IS and ACI Codes.

UNIT II:DESIGN OF SPECIAL RC ELEMENTS (9)

Design of slender columns - Design of RC walls - ordinary and shear walls. Strut and tie method of analysis for Corbels and Deep Beams, Design of Corbels, Deep-beams and grid floors.

UNIT III: FLAT SLABS AND FLAT PLATES (9)

Design of flat slabs and flat plates according to IS and ACI methods - Design of shear reinforcement - Design of spandrel beams - Yield line theory and Hillerborgs strip method of design of slabs.

UNIT IV: INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES (9)

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.

UNIT V: DETAILING AND FIELD PRACTICE (9)

Detailing for ductility - Fire resistance of structural members – Quality of control of concrete

TOTAL: 45 Hours

REFERENCES:

1. Unnikrishna Pillai and Devdas Menon “Reinforced concrete Design’, Tata McGraw Hill Publishers Company Ltd., New Delhi,2009.
2. Varghese, P.C., “Limit State Design of Reinforced Concrete”, Prentice Hall of India,2009.
3. Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India,2005.
4. Sinha.N.C. and Roy S.K., “Fundamentals of Reinforced Concrete”, S.Chand and Company Limited, New Delhi,2009.

13ST103 STRUCTURAL DYNAMICS

L	T	P	C
3	1	0	4

OBJECTIVE:

To expose the students the principles and methods of dynamic analysis of structures and to prepare them for designing the structures for wind, earthquake and other dynamic loads.

LEARNING OUTCOME:

At the end of the course the students would

- To be capable of formulating the equations of motion by equilibrium and energy methods.
- Have learnt the concept of single degree of freedom systems and effects of damping.
- Have gained knowledge of formulating equations of motion of two degree of freedom.
- Have studied the formulation of mathematical models for impact loading.

UNIT I: PRINCIPLES OF VIBRATION ANALYSIS (9+3)

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

UNIT II: TWO DEGREE OF FREEDOM SYSTEMS (9+3)

Equations of Motion of Two degree of freedom systems, normal modes of vibration, applications.

UNIT III: DYNAMIC ANALYSIS OF MDOF (9+3)

Multi degree of freedom systems, Orthogonality of normal modes, approximate methods. Mode superposition technique, Numerical Integration procedure.

UNIT IV: DYNAMIC ANALYSIS CONTINUOUS SYSTEMS (9+3)

Free and forced vibration of continuous systems, Rayleigh – Ritz method – Formulation using Conservation of Energy – Formulation using Virtual Work.

UNIT V: PRACTICAL APPLICATIONS (9+3)

Idealization and formulation of mathematical models for wind, earthquake, blast and impact loading, aerodynamics, gust phenomenon, principles of analysis.

TOTAL: 60 Hours

REFERENCES:

1. Mario Paz, Structural Dynamics: “Theory and Computation”, Kluwer Academic Publication, 2004.
2. Anil K.Chopra, “Dynamics of Structures”, Pearson Education,2007.
3. John M.Biggs, “Introduction to Structural Dynamics”, McGraw Hill,1964.
4. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, “Wind Effects on Civil Engineering Structures”, Elsevier Publications,1984.

13ST104 THEORY OF ELASTICITY AND PLASTICITY

L	T	P	C
3	1	0	4

OBJECTIVE:

To make students to understand the concept of elasticity, plane stress and plane strain problems, membrane analogy, torsion and energy thermos this helps in 3D stress and strain analysis.

LEARNING OUTCOME:

At the end of the course the students would

- Have grasped the analysis of stress and strain and formulate equilibrium equations.
- To make students to gain knowledge to solve two dimensional problems in Cartesian and polar co-ordinates.
- To learn the concept of torsion of non-circular section.
- To formulate equations of principle of virtual work ad understand energy theorem.

UNIT I: ELASTICIT **(9+3)**

Analysis of stress and strain, Equilibrium equations - Compatibility equations – stress strain relationship. Generalized Hooke's law.

UNIT II: ELASTICITY SOLUTION **(9+3)**

Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar co-ordinates.

UNIT III :TORSION OF NON-CIRCULAR SECTION **(9+3)**

St.venant's approach - Prandtl's approach – Membrane analogy - Torsion of thin walled open and closed sections.

UNIT IV: ENERGY METHODS **(9+3)**

Strain energy – Principle of virtual work – Energy theorems – Rayleigh Ritz method –Finite difference method – Application to elasticity problems.

UNIT V: PLASTICITY **(9+3)**

Physical Assumptions – Yield criteria - Plastic stress strain relationship. Elastic plastic problems in bending – torsion and thick cylinder.

TOTAL: 60 Hours

REFERENCES:

1. Timoshenko, S. and Goodier J.N."Theory of Elasticity", McGraw Hill Book Co., Newyork, 2010.
2. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi,1988.
3. Chou P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering Approaches", D.Van Nostrand Co., Inc., London,1967.
4. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt. Ltd., New Delhi,2000.

13ST201 FINITE ELEMENT ANALYSIS

L	T	P	C
3	1	0	4

OBJECTIVE:

The course objective is to develop the skills of the students in boundary value problems, Approximation concept, Plate bending and shell elements, meshing and its types and nonlinear variation problems.

LEARNING OUTCOME:

At the end of the course the students would

- To study the energy principles, finite element concept, stress analysis, meshing, nonlinear problems and applications.
- Have learnt the concepts of boundary value problems and its solutions.
- Have gained knowledge of plane stress, plain strain and axisymmetric problems related to Triangular and Quadrilateral elements.
- Have been capable of formulating and solving problems related to material and Geometric non linearity.

UNIT I: INTRODUCTION (9+3)

Boundary Value Problems – Approximate Solutions – Variational and Weighed Residual Methods – Ritz and Galerkin Formulations – Concept of Piecewise Approximation and Finite Element – Displacement and Shape Functions –Weak Formulation – Minimum Potential Energy – Generation of Stiffness Matrix and Load Vector.

UNIT II :STRESS ANALYSIS (9+3)

Two Dimensional problems – Plane Stress, Plane Strain and Axisymmetric Problems – Triangular and Quadrilateral Elements Natural Coordinates – Isoparametric Formulation - Numerical Integration – Plate Bending and Shell Elements — Brick Elements –Elements for Fracture Analysis

UNIT III: MESHING AND SOLUTION PROBLEMS (9+3)

Higher Order Elements – p and h Methods of Mesh Refinement – ill conditioned Elements – Discretisation Errors – Auto and Adaptive Mesh Generation Techniques - Error Evaluation

UNIT IV: NONLINEAR, VIBRATION AND THERMAL PROBLEMS (9+3)

Material and Geometric Nonlinearity – Methods of Treatment – Consistent System Matrices – Dynamic Condensation – Eigen Value Extraction - thermal analysis.

UNIT V: APPLICATIONS (9+3)

Modeling and analysis using recent softwares.

TOTAL: 60 Hours

REFERENCES:

1. S. S. Bhavikatti, “Finite Element Analysis”, New Age Publishers,2010.
2. C. S. Krishnamoorthy, “Finite Element Analysis: Theory and Programming”, Tata McGraw-Hill,1994.
3. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited, New Delhi,2005.
4. Bathe, K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall Inc., 2009.
5. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, McGraw – Hill,1979.

L	T	P	C
2	1	2	3

13ST202 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION

OBJECTIVE:

The course objective is to make students to know the concepts of measurements of static and dynamic response of Structures and to analyze the structure.

LEARNING OUTCOME:

At the end of the course the students would

- Have known the methods of stress analysis errors are measurements and their principle related to their applications.
- Have learnt about vibrational measurements with data acquisition system.
- Have gained knowledge of principle of pressure and flow measurements.
- Have known about the non-destructive testing methods and its advantages.

UNIT I: FORCES AND STRAIN MEASUREMENT (6+6)

Choice of Experimental stress analysis methods, Errors in measurements – Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines – Long-term monitoring – vibrating wire sensors– Fibre optic sensors.

UNIT II: VIBRATION MEASUREMENTS (6+6)

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

UNIT III :ACOUSTICS AND WIND FLOW MEASURES (6+6)

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modelling – direct and indirect model analysis.

UNIT IV: DISTRESS MEASUREMENTS AND CONTROL (6+6)

Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half cell, construction and use – damage assessment – controlled blasting for demolition – Techniques for residual stress measurements.

UNIT V: NON DESTRUCTIVE TESTING METHODS (6+6)

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating, Advanced NDT methods – Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR , Ground penetrating radar (GPR).

TOTAL: 60 Hours

REFERENCES:

1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi,1996.
2. Dalley .J.W and Riley.W.F, “Experimental Stress Analysis”, Mc Graw Hill Book Company, N.Y.1991.
3. Srinath.L.S, Raghavan.M.R, ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, “Experimental Stress Analysis”, Tata McGraw Hill Company, New Delhi,1984.
4. Bray.D.E. and Stanley.R.K., “Course Material on Non-destructive Evaluation”,Mc Graw Hill Publishing Company, New York,1989.
5. Ravisankar.K.and Chellappan.A., “Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures”, SERC, Chennai,2007.
6. Ganesan.T.P, “Model Analysis of Structures”, University Press, India,2000.

13ST203 STEEL STRUCTURES

L	T	P	C
3	1	0	4

OBJECTIVE:

The course objective is to highlight students in general, the load on structures with lateral loads and design of connections and analysis of steel structure. This also explains the plastic analysis of structure. This will also serve as a basis for this research.

LEARNING OUTCOME:

At the end of the course the students would

- To study the behaviour of members and connections, analysis and design of steel towers, chimneys. Study the design of with cold formed steel and plastic analysis of structures.
- Have gained knowledge of behaviour of members and connections and design of cable frames.
- Have grasped the knowledge to design chimneys, transmission line towers.
- Have learned the concept of analysis of portal frames and effect of shear force on plastic moments.

UNIT I :GENERAL **(9 + 3)**

Design of members subjected to lateral loads and axial loads, Analysis and design of Industrial Buildings and bents, Sway and non-sway frames, Design of Purlins, Louver rails, Gable column and Gable wind girder - Design of Moment Resisting Base Plates – Analysis of Gable Frames.

UNIT II: DESIGN OF CONNECTIONS **(9 + 3)**

Types of connections – Welded and riveted – Throat and Root Stresses in Fillet Welds – Seated Connections – Unstiffened and stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections.

UNIT III :ANALYSIS AND DESIGN OF STEEL TOWERS **(9 + 3)**

Analysis and Design of Microwave / Transmission Line Towers - Types of bracing patterns - Sag and Tension calculations. Design of Self supporting Chimney – Design of Base Plates, Foundations and Anchor bolts and Guyed Steel Chimney - Guy ropes - Stresses due to wind. Along with load calculation - Gust Factor Method.

UNIT IV: PLASTIC ANALYSIS OF STRUCTURES **(9 + 3)**

Introduction, Shape factor, Moment redistribution, combined mechanisms, Analysis of portal frames, Effect of axial force - Effect of shear force on plastic moment, Connections - Requirement – Moment resisting connections. Design of Straight Corner Connections – Haunched Connections – Design of continuous beams.

UNIT V: DESIGN OF LIGHT GAUGE STEEL STRUCTURES **(9 + 3)**

Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members – Wall Studs.

Total: 60 Hours

REFERENCES:

1. Subramanian.N, “Design of Steel Structures”, Oxford University Press,2008.
2. Dayaratnam.P, “Design of Steel Structures”, A.H.Wheeler, India,2008.
3. Linton E. Grinter, “Design of Modern Steel Structures”, Eurasia Publishing House, New Delhi,1996.
4. John E. Lothers, “Design in Structural Steel”, Prentice Hall of India, New Delhi,1990.
5. Lynn S. Beedle, “Plastic Design of Steel Frames”, John Wiley and Sons, New York,1990.

13ST204 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to gain knowledge of earth quake monitoring and seismic instrumentation, estimation of earth quake parameters, dynamics of structures and Earth quake resistant design of masonry and Reinforced Concrete structures.

LEARNING OUTCOME:

At the end of the course the students would

- Have grasped the knowledge of seismology and characteristics of strong earth quake motion.
- Have learnt the dynamics of structures and evaluations of earth quake forces.
- Have gained knowledge of principle earth quake resistant design.
- Have been capable of design of earth quake resistant masonry and RC structures.
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UNIT I: EARTHQUAKES AND GROUND MOTION (9)

Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation.

UNIT II: EFFECTS OF EARTHQUAKE ON STRUCTURES (9)

Dynamics of Structures (SDOFS/ MDOFS), Response Spectra - Average Response Spectra - Design Response Spectra, Evaluation of Earthquake Forces as per codal provisions, Effect of Earthquake on Different Types of Structures, Lessons Learnt From Past Earthquakes

UNIT III :EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES (9)

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.

UNIT IV: EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES (9)

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis - Design and detailing – Rigid Frames – Shear wall – Coupled Shear wall.

UNIT V: SPECIAL TOPICS (9)

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, Important structures.

TOTAL: 45Hours

REFERENCES:

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. Course Notes "Design of Reinforced Concrete Buildings", IIT Kanpur, June,1999.
4. Paulay,T and Priestly, M.N.J., “Aseismic Design of Reinforced Concrete and Masonry buildings”, John Wiley and Sons,1991.
5. Bruce A Bolt, “Earthquakes” W H Freeman and Company, New York,2004.
6. Bungale S.Taranath "Structural Analysis and Design of Tall Buildings – Mc Graw Hill Book Company, New York,1999.

13STX01 DESIGN OF TALL BUILDINGS

L	T	P	C
3	1	0	4

OBJECTIVE:

This course objective is to develop the knowledge of design principles of tall buildings, gravity loading, earth quake loading and 3 dimensional analysis & modeling, stability of tall building.

LEARNING OUTCOME:

At the end of the course the students would

- Have the knowledge of types of high performance concrete loading & design philosophy.
- Have studied about the behaviour of rigid & braced frames.
- Have gained the knowledge of analysis of building as a structural system.
- Have gained the capacity to analyze the stability of total buildings.

UNIT I: DESIGN PRINCIPLES AND LOADING (9 + 3)

Design philosophy, loading, sequential loading, and materials - high performance, concrete - Fibre reinforced Concrete - Light weight concrete design mixes. Gravity loading Wind loading Earthquake loading.

UNIT II: BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS (9 + 3)

Factors affecting growth, Height and Structural form. High rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, futrigger - braced and hybrid mega systems.

UNIT III: ANALYSIS AND DESIGN (9 + 3)

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.

UNIT IV: STRUCTURAL ELEMENTS (9 + 3)

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: STABILITY OF TALL BUILDINGS (9 + 3)

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: 60 Hours

REFERENCES:

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. Beedle.L.S. “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi,1986.

13STX02 INDUSTRIAL STRUCTURES

L	T	P	C
3	1	0	4

OBJECTIVE:

This course objective is to form the layout requirement regarding lighting and ventilation and fire safety design of foundation, testing of towers and chimneys.

LEARNING OUTCOME:

At the end of the course the students would

- Have studied the planning considerations and production against fire and safety.
- Have the capacity to design containment structures.
- Have grasped the ability to design of substation structure and its testing.
- Have learnt the design of auxiliary structures such as bunkers and silos.

UNIT I: PLANNING AND FUNCTIONAL REQUIREMENTS (9 + 3)

Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety – Protection against noise and vibration - Guidelines of Factories Act.

UNIT II :INDUSTRIAL BUILDINGS (9 + 3)

Roofs for Industrial Buildings - Steel and RCC - Gantry Girders - Design of Corbels and Nibs – Machine foundations.

UNIT III: POWER PLANT STRUCTURES (9 + 3)

Types of power plants – Design of Turbo generator foundation – containment structures.

UNIT IV: POWER TRANSMISSION STRUCTURES (9 + 3)

Transmission Line Towers - Substation Structures - Tower Foundations – Testing Towers.

UNIT V: AUXILLIARY STRUCTURES (9 + 3)

Chimneys and cooling Towers – Bunkers and Silos – Pipe supporting structures.

TOTAL: 60 Hours

REFERENCES:

1. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill,1985.
2. Santhakumar A.R.an d Murthy S.S., “Transmission Line Structures”, Tata McGraw Hill, 1992.
3. Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, Tata McGraw Hill, 1976.
4. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers,2004.

13STX03 PRESTRESSED CONCRETE

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop the skill of the student in gaining knowledge of prestressing principles, design of beams and tension and compression members and design of composite members.

LEARNING OUTCOME:

At the end of the course the students would

- Have built the capacity to design the flexural member and determine the ultimate flexural strength and design of shear bond and torsion.
- Have gained the capacity to analyse and design tanks and piles and found out its field where applied.
- Have learnt about the design of composite members and cylindrical water tanks.
- Have grasped the knowledge of design analysis and their application with advantages.

UNIT I: PRINCIPLES OF PRESTRESSING (9)

Principles of Prestressing - types and systems of prestressing, need for High Strength materials, Analysis methods losses, deflection (short-long term), camber, cable layouts.

UNIT II: DESIGN OF FLEXURAL MEMBERS (9)

Behaviour of flexural members, determination of ultimate flexural strength – Codal provisions -Design of flexural members, Design for shear, bond and torsion. Design of end blocks.

UNIT III :DESIGN OF CONTINUOUS BEAMS (9)

Analysis and design of continuous beams - Methods of achieving continuity – concept of linear transformations, concordant cable profile and gap cables

UNIT IV: DESIGN OF TENSION AND COMPRESSION MEMBERS (9)

Design of tension members - application in the design of prestressed pipes and prestressed concrete cylindrical water tanks - Design of compression members with and without flexure - its application in the design piles, flagmasts and similar structures.

UNIT V: DESIGN OF COMPOSITE MEMBERS (9)

Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.

TOTAL: 45 Hours

REFERENCES:

1. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill Publishing Co,2000.
2. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co., 1998.
3. Lin.T.Y., “Design of Prestressed Concrete Structures”, John Wiley and Sons Inc,1981.
4. Rajagopalan.N, Prestressed Concrete, Narosa Publications, New Delhi,2008.

13STX04 OFFSHORE STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop the knowledge of wave theories, wave generation, process and current forces. This also gives exposure to analysis of offshore structures and its dynamics.

LEARNING OUTCOME:

At the end of the course the students would

- Have grasped the knowledge of finite amplitude wave theory for wave generation process.
- Have grasped the content of offshore soil foundation modelling.
- Have developed the capacity of dynamic analysis for offshore structures.
- Have learnt about design of helipads, cables and pipe lines.

UNIT I: WAVE THEORIES (8)

Wave generation process, small and finite amplitude wave theories.

UNIT II: FORCES OF OFFSHORE STRUCTURES (8)

Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

UNIT III: OFFSHORE SOIL AND STRUCTURE MODELLING (9)

Different types of offshore structures, foundation modelling, structural modelling.

UNIT IV: ANALYSIS OF OFFSHORE STRUCTURES (10)

Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V: DESIGN OF OFFSHORE STRUCTURES (10)

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

TOTAL: 45 Hours

REFERENCES:

1. Chakrabarti, S.K. “Hydrodynamics of Offshore Structures”, Computational Mechanics Publications,1987.
2. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex,2000.
3. Reddy, D.V. and Arockiasamy, M., “Offshore Structures”, Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.

13STX05 PREFABRICATED STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop the knowledge of designing prefabricated structures.

LEARNING OUTCOME:

At the end of the course the students would

- Have gained the knowledge of IS CODE specifications for prefabricated structure.
- Have grasped the content of slab design, insulation requirements.
- Have gained the knowledge of load bearing and load transferring panels in buildings.
- Have learnt the content of building industrial with prefabricated material.

UNIT I: DESIGN PRINCIPLES (9)

General Civil Engineering requirements, specific requirements for planning and layout of prefabricates plant. IS Code specifications. Modular co-ordination, standardization, Disuniting 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.

UNIT II :REINFORCED CONCRETE (9)

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.

UNIT III :FLOORS , STAIRS AND ROOFS (9)

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.

UNIT IV: WALLS (9)

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.

UNIT V: INDUSTRIAL BUILDINGS AND SHELL ROOFS (9)

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 hypar-prefabricated shells, Erection and jointing, joint design, hand book based design.

TOTAL: 45Hours

REFERENCES:

1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam/ London/New York,1966.
2. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland Betor Verlag,1978.
3. Gerostiza. C.Z., Hendrikson, C. and Rehat D.R., Knowledge Based Process Planning for Construction and Manufacturing, Academic Press, Inc.,1989.
4. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row,1990.

13STX06 ADVANCED CONCRETE TECHNOLOGY

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop skills of students in the area of aggregates, properties of hard and fresh concrete, mix design and properties & applications of high performance concrete this will also serve as prerequisite of research.

LEARNING OUTCOME:

At the end of the course the students would

- Have studied the properties of material, grade of cement & testing of aggregate & chemical compositions.
- Have grasped the knowledge of properties of fresh concrete & their durability, the mix design also known.
- Have learnt the type of special concrete.
- Have obtained the capacity of concrete under extreme weather conditions.

UNIT I: CONCRETE MAKING MATERIALS (9)

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified grading, Testing of aggregates. Cement, Grade of cement, Chemical composition, testing of concrete, Hydration of cement, Structure of hydrated cement, special cements. Water Chemical admixtures, Mineral admixture.

UNIT II: CONCRETE (9)

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage, Variability of concrete strength, durability of concrete.

UNIT III: MIX DESIGN (9)

Principles of concrete mix design, Methods of concrete mix design, Testing of Concrete. Statistical quality control- sampling and acceptance criteria.

UNIT IV: SPECIAL CONCRETE (9)

Light weight concrete, Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete, Super plasticised concrete, hyper plasticized concrete, Epoxy resins and screeds for rehabilitation - properties and applications - high performance concrete. High performance fibre reinforced concrete, self-compacting-concrete.

UNIT V: CONCRETING METHODS (9)

Process of manufacturing of concrete, methods of transportation, placing and curing. Extreme weather concreting, special concreting methods. Vacuum dewatering - underwater concrete, special form work.

TOTAL: 45Hours

REFERENCES:

1. Neville, A.M., Properties of Concrete, Prentice Hall, London,2000.
2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi,2011.
3. A.R.Santhakumar ;"Concrete Technology",Oxford University Press,2007.

13STX07 DESIGN OF BRIDGES

L	T	P	C
3	1	0	4

OBJECTIVE:

This course objective is to develop skills of students in designing various types of bridges.

LEARNING OUTCOME:

At the end of the course the students would

- Have studied the concept of road bridges on IRC specifications.
- Have studied the design of slab culverts-beam, slab bridges.
- Have grasped the knowledge of long span girder bridges.
- Have learnt the design of plate girder bridges, bearings and substructures.

UNIT I: INTRODUCTION (6)

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.

UNIT II :SHORT SPAN BRIDGES (9 + 3)

Load distribution theories, analysis and design of slab culverts, tee beam and slab bridges.

UNIT III :LONG SPAN GIRDER BRIDGES (12 + 3)

Design principles of continuous bridges, box girder bridges, and balanced cantilever bridges.

UNIT IV: DESIGN OF PRESTRESSED BRIDGES (9 + 3)

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.

UNIT V :
DESIGN OF PLATE GIRDER BRIDGES, BEARINGS AND SUBSTRUCTURES (9+ 3)

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: 60 Hours

REFERENCES:

1. Ponnuswamy, S., “Bridge Engineering”, Tata McGraw Hill,2008.
2. Johnson Victor, D. “Essentials of Bridge Engineering”, Oxford and IBH Publishing Co. New Delhi,1990.
3. Harrison H.B., “Structural Analysis and Design Vol.I and II”, Pergamon Press,1991.
4. Hinton E.and Owen D.R.J., “Finite Element Programming”, Academic Press,1977.
5. Rao. S.S., " Optimisation Theory and Applications ", Wiley Eastern Limited, New Delhi, 1977.
6. Richard Forsyth (Ed.), “Expert System Principles and Case Studies”, Chapman and Hall, 1996.

13STX08 ADVANCED STRUCTURAL ANALYSIS

L	T	P	C
3	1	0	4

OBJECTIVE:

The course Objective is to make familiar to students in the field of inelastic energy concepts which helps them to learn about analysis of structures.

LEARNING OUTCOME:

- To educate the students to analyze the structures by flexibility method and stiffness method.
- At the end of the course the students will have the confidence in applying this method to pin jointed Trusses, continuous beams, grids and frames.

UNITI : FUNDAMENTAL CONCEPTS OF STRUCTURES (9 + 3)

Introduction -Types of Matrices – Matrix addition, Matrix multiplication, Inverse of a matrix of fourth order – Force and Displacement measurements - Force and Displacement Methods of Structural Analysis- Principles of superposition. Characteristics of Structures – Stiffness and Flexibility: Introduction to Equilibrium – Structures with single coordinate – Two coordinates – Stiffness and flexibility matrices in n Coordinates – Stiffness and flexibility matrices in constrained measurements.

UNIT II :ENERGY CONCEPTS IN STRUCTURES (9 + 3)

Strain energy in terms of stiffness and flexibility matrices – Properties of stiffness and flexibility matrices – Interpretation of coefficients - Betti's Law – Other energy theorems - using matrix notations. Transformation of Information: Indeterminate Structures – Transformation of System force to element forces – Element Flexibility to System Flexibility – System Displacement to Element Displacement - Stiffness and Flexibility Matrices of the elements-Normal coordinates and orthogonal Transformation.

UNIT III: FLEXIBILITY METHOD (9 + 3)

Statically Determinate and Indeterminate Structures – Choice of redundant leading to ill and well Conditioned matrices – Automatic choice of redundant – Rank technique – Transformation to one set of Redundant to another – Internal forces due to thermal expansion and lack of fit – Reducing the size of Flexibility matrix – Application to pin-jointed plane truss – Continuous beams – Frames – Grids.

UNIT IV: STIFFNESS METHOD (9 + 3)

Introduction – Development of the stiffness method – Analogy between flexibility and stiffness – Analysis due to thermal expansion - lack of fit – Application of stiffness approach to pin jointed plane and space Trusses – Continuous beams – Frames.

UNIT V: ANALYSIS BY SUBSTRUCTURES (9 + 3)

Analysis by substructures using the stiffness and flexibility method with tridiagonalisation. Analysis by Iteration: Iteration method for frames with non-prismatic members – Iteration method applied to rigidly Connected members – Efficiency of iteration method.

TOTAL: 60 Hours

REFERENCES:

1. F. M. Rubinstein, Matrix Computer Methods of Structural Analysis, Prentice Hall,1966.
2. Mc Guire and R. H. Gallagher, Matrix Structural Analysis, John Wiley,1999.
3. J. R. William Weaver and James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers & Distributors,2004.

13STX09 DESIGN OF SHELL AND SPATIAL STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop the skills of students in the areas of design of shell, folded plate ,space frames & the application of FORMAIN software.

LEARNING OUTCOME:

At the end of the course the students would

- Have studied the concept of structural design in shell.
- Have learn the design of circular domes, conical roofs by ASCE manual no:31.
- Have grasped the knowledge of pyramidal roof, design philosophy of space frame structures.
- Have learnt the special methods for structural analysis.

UNIT I :CLASSIFICATION OF SHELLS (6+6)

Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31.

UNIT II: FOLDED PLATES (6+6)

Folded Plate structures, structural behaviour, types, design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT III: INTRODUCTION TO SPACE FRAME (6+6)

Space frames - configuration - types of nodes - general principles of design Philosophy - Behaviour.

UNIT IV: ANALYSIS AND DESIGN (6+6)

Analysis of space frames – detailed design of Space frames – Introduction to Computer Aided Design and Software Packages.

UNIT V: SPECIAL METHODS (6+6)

Application of Formex Algebra, FORMIAN for generation of configuration.

TOTAL: 60Hours

REFERENCES:

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co.,New York,1982.
2. Santhakumar.A.R and Senthil.R, “Proceedings of International Conference on Space Structures”, Anna University, Chennai,1997.
3. Subramanian.N ,”Principles of Space Structures”, Wheeler Publishing Co.,1999.
4. Ramasamy, G.S., “Design and Construction of Concrete Shells Roofs”, CBS Publishers, 1986.
5. ASCE Manual No.31, “Design of Cylindrical Shells”.

13STX10 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop skills in design of composite beam, column, slab, trusses, this also helps to develop skills in design of connections and seismic behaviour of composite structures.

LEARNING OUTCOME:

At the end of the course the students would

- Have gained the knowledge regarding composite construction.
- Have grasped the design of composite beam –column and trusses.
- Have learnt to checks for shear connection in composite structures.
- Have studied the concrete composite structures in building

UNIT I: INTRODUCTION (9 + 3)

Introduction to steel - concrete composite construction - theory of composite structures - construction.

UNIT II: DESIGN OF COMPOSITE MEMBERS (9 + 3)

Design of composite beams, slabs, columns, beam – columns - design of composite trusses.

UNIT III: DESIGN OF CONNECTIONS (9 + 3)

Types of connections, Design of connections in the composite structures – shear connections. Degree of shear connection – Partial shear interaction

UNIT IV: COMPOSITE BOX GIRDER BRIDGES (9 + 3)

Introduction - behaviour of box girder bridges - design concepts.

UNIT V: GENERAL (9 + 3)

Case studies on steel - concrete composite construction in buildings – seismic behaviour of composite structures.

TOTAL: 60 Hours

REFERENCES:

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications, UK,2004.
2. Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford,1995.
3. Proceedings of Workshop on “Steel Concrete Composite Structures”, Anna University, 2007.

13STX11 MAINTENANCE AND REHABILITATION OF STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop the ability of students to assess the strength, durability of structures materials for repair and strengthening and stabilisation techniques for repair. This also serves as a perquisite for research.

LEARNING OUTCOME:

At the end of the course the students would

- Have obtained the capacity to evaluate a damaged structure and cause of deterioration.
- Have gained well founded knowledge on serviceability and effects due to climate and cover thickness.
- Have grasped the concept of strengthening of buildings and special concrete and mortar available for repair.

UNIT I: MAINTENANCE AND REPAIR STRATEGIES (8)

Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.

UNIT II: SERVICEABILITY AND DURABILITY OF CONCRETE (8)

Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking. - Effects due to climate, temperature, chemicals, corrosion - design and construction errors - Effects of cover thickness and cracking.

UNIT III :MATERIALS AND TECHNIQUES FOR REPAIR (15)

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement and polymers coating for rebars loadings from concrete, mortar and dry pack, vacuum concrete, Gunite and Concrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection

UNIT IV: REPAIRS TO STRUCTURES (10)

Repair of structures distressed due to earthquake – Strengthening using FRP - Strengthening and stabilization techniques for repair.

UNIT V:DEMOLITION OF STRUCTURES (4)

Engineered demolition techniques for structures - case studies

TOTAL: 45Hours

REFERENCES:

1. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical, UK,1991.
2. Santhakumar A.R., "Concrete Technology" Oxford University Press,2007, Printed in India by Radha Press, New Delhi, 110 031
3. Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications pvt. Ltd., 2001.
4. Dayaratnam.P and Rao.R, "Maintenance and Durability of Concrete Structures", University Press, India, 1997.

13STX12 MECHANICS OF COMPOSITE MATERIALS

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop knowledge on composite construction, properties unidirectional fibre components, residual stress, interlaminar struss and failure of composites.

LEARNING OUTCOME:

At the end of the course the students would

- Have grasped the knowledge of composites and composite material.
- Have learnt the concepts of soil mechanics and elasticity for anisotropic materials and steels and residual stresses.
- Have obtained capacity to evaluate to analyse anisotropic and orthotropic plates, static, dynamic and stability analysis of composite of plates.
- Have studied the application of composites

UNIT I: INTRODUCTION (9)

Introduction to Composites, Classifying composite materials, Commonly used fibre and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites.

UNIT II: STRESS STRAIN RELATIONS (9)

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses

UNIT III :ANALYSIS OF LAMINATED COMPOSITES (9)

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross plylaminates. Static, dynamic and stability analysis for simpler cases of composite plates. Interlaminar stresses.

UNIT IV: FAILURE AND FRACTURE OF COMPOSITES (9)

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT V: APPLICATIONS AND DESIGN (9)

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues

TOTAL: 45Hours

REFERENCES:

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2006.
2. Michael W.Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw Hill, 1999.
3. Mukhopadhyay.M, " Mechanics of Composite Materials and Structures", University Press, India, 2004.

13STX13 NONLINEAR ANALYSIS OF STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop the knowledge of elastic inelastic non linear, vibration and instability of beams and hysteric analysis of members subjected to cyclic loading.

LEARNING OUTCOME:

At the end of the course the students would

- Have grasped the knowledge of nonlinear mechanics of bars of uniform and variable thickness.
- Have obtained capacity to analysis flexural members subjected to small deformation of uniform and variable stiffness members.
- Have studied the analysis of uniform and variable thickness of plates.
- Have learnt the non linear instabilities of beam.

UNIT I :ELASTIC ANALYSIS OF FLEXURAL MEMBERS (9)

Introduction to nonlinear mechanics; statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

UNIT II: INELASTIC ANALYSIS OF FLEXURAL MEMBERS (9)

Inelastic analysis of uniform and variable thickness members subjected to small Deformations; inelastic analysis of flexible bars of uniform and variable stiffness members with and without axial restraints.

UNIT III :VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS (9)

Vibration theory and analysis of flexible members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading.

UNIT IV: ELASTIC AND INELASTIC ANALYSIS OF PLATES (9)

Elastic and inelastic analysis of uniform and variable thickness plates.

UNIT V: NONLINEAR VIBRATION AND INSTABILITY (9)

Nonlinear vibration and Instabilities of elastically supported beams.

TOTAL: 45Hours

REFERENCES:

1. Sathyamoorthy, M.,"Nonlinear Analysis of Structures", CRC Press, Boca Raton, Florida,1997.
2. Fertis, D. G.,"Nonlinear Mechanics", CRC Press, Boca Raton, Florida,1998.
3. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press,2004.

13STX14 STABILITY OF STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course Objective is to develop the skill of the students to analyse columns for various boundary condition using equilibrium and effect of shear on buckling. This also develops the knowledge of torsional and lateral buckling of simply supported and cantilever beams. This course will serve as a prerequisite for research.

LEARNING OUTCOME:

- Have learnt the concept of vibration approach to stability analysis for calculating buckling of columns.
- Have gained the knowledge of moment distribution of beam column frames.
- Have grasped the concept of torsion and lateral buckling of cantilever beam which is helpful in design of beams.

UNIT I: BUCKLING OF COLUMNS (12)

States of equilibrium - Classification of buckling problems - 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. Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

UNIT II :BUCKLING OF BEAM-COLUMNS AND FRAMES (9)

Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.

UNIT III: TORSIONAL AND LATERAL BUCKLING (9)

Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever.

UNIT IV: BUCKLING OF PLATES (9)

Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach - Approximate and Numerical techniques.

UNIT V: INELASTIC BUCKLING (6)

Double modulus theory - Tangent modulus theory - Shanley's model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.

TOTAL: 45 Hours

REFERENCES:

1. Timoshenko, S., and Gere., "Theory of Elastic Stability", McGraw Hill Book Company,1963.
2. Chajes, A. "Principles of Structures Stability Theory", Prentice Hall,1974.
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, "Stability Analysis and Design of Structures", springer, New York,2004.

13STX15 THEORY OF PLATES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to gain the knowledge of laterally loaded thin plates and anisotropic plates and moderately thick plates which is helpful for understanding the behaviour of plates.

LEARNING OUTCOME:

At the end of the course the students would

- Have learnt the concept of plates under various boundary conditions which helps to calculate plates with small deflection.
- Have grasped the knowledge of bending of circular plates which gives the confidence of designing circular plates.
- Have gained the capacity of formulating energy equations for finite element methods.

UNIT I: INTRODUCTION TO PLATES THEORY (10)

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT II: RECTANGULAR PLATES (12)

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge Conditions, plates on elastic foundation.

UNIT III :CIRCULAR PLATES (8)

Symmetrical bending of circular plates.

UNIT IV: SPECIAL AND APPROXIMATE METHODS (8)

Energy methods, Finite difference and Finite element methods.

UNIT V: ANISOTROPIC PLATES AND THICK PLATES (7)

Orthotropic plates and grids, moderately thick plates.

TOTAL: 45 Hours

REFERENCES:

1. Timoshenko, S. and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, New York,1990.
2. Bairagi, “Plate Analysis”, Khanna Publishers,1996.
3. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company,2006.
4. Szilard, R., “Theory and Analysis of Plates”, Prentice Hall Inc.,1995.
5. Chandrashekahara, K. Theory of Plates, University Press (India) Ltd.,Hyderabad,2001.

13STX16 WIND AND CYCLONE EFFECTS ON STRUCTURES

L	T	P	C
3	1	0	3

OBJECTIVE:

This course objective is to develop to knowledge of effect of wind on structure and codal provision for design of tall structures. This also gives knowledge of cyclone effects on structures for helping in window glass design.

LEARNING OUTCOME:

At the end of the course the students would

- Have learnt the concept of gust factor, drag effects which helps in shape factor in analysis of tall buildings.
- Have gained the concept of formulating modelling and interpretation of aero-elastic models.
- Have grasped the knowledge of assessing the cyclone effects of building.

UNIT I: INTRODUCTION (10)

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

UNIT II :WIND TUNNEL STUDIES (5)

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

UNIT III :EFFECT OF WIND ON STRUCTURES (12)

.Wind on structures, Rigid structures, Flexible structures, Static and dynamic effects, Tall buildings, chimneys.

UNIT IV: IS CODES AND SPECIAL STRUCTURES (12)

Application to design, IS 875 code method, Buildings, Chimneys, Roofs, Shelters.

UNIT V: CYCLONE EFFECTS (6)

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

TOTAL: 45 Hours

REFERENCES:

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.