

**AFFILIATED INSTITUTIONS**  
**ANNA UNIVERSITY :: CHENNAI 600 025**  
**REGULATIONS - 2013**  
**M.E. STRUCTURAL ENGINEERING**  
**I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS**

**SEMESTER I**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>						
1.	MA7154	Advanced Mathematical Methods	3	1	0	4
2.	ST7101	Concrete Structures	3	0	0	3
3.	ST7102	Structural Dynamics	3	0	0	3
4.	ST7103	Theory of Elasticity and Plasticity	3	0	0	3
5.		Elective I	3	0	0	3
6.		Elective II	3	0	0	3
<b>TOTAL</b>			<b>18</b>	<b>1</b>	<b>0</b>	<b>19</b>

**SEMESTER II**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>						
1.	ST7201	Finite Element Analysis	2	0	2	3
2.	ST7202	Experimental Techniques and Instrumentation	2	0	2	3
3.	ST7203	Steel Structures	3	0	0	3
4.	ST7204	Earthquake Analysis and Design of Structures	3	0	0	3
5.		Elective III	3	0	0	3
6.		Elective IV	3	0	0	3
<b>PRACTICAL</b>						
7.	ST7211	Advanced Structural Engineering Laboratory	0	0	4	2
<b>TOTAL</b>			<b>16</b>	<b>0</b>	<b>8</b>	<b>20</b>

**SEMESTER III**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>						
1.		Elective V	3	0	0	3
2.		Elective VI	3	0	0	3
3.		Elective VII	3	0	0	3
<b>PRACTICAL</b>						
4.	ST7311	Seminar	0	0	2	1
5.	ST7312	Practical Training (4 Weeks)	-	-	-	1
6.	ST7313	Project Work (Phase I)	0	0	12	6
<b>TOTAL</b>			<b>9</b>	<b>0</b>	<b>14</b>	<b>17</b>

**SEMESTER IV**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
<b>PRACTICAL</b>						
1.	ST7411	Project Work (Phase – II)	0	0	24	12
<b>TOTAL</b>			<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 68**

**LIST OF ELECTIVES****SEMESTER – I (Elective – I & II)**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ST7001	Analysis and Design of Tall Buildings	3	0	0	3
2.	ST7002	Maintenance and Rehabilitation of Structures	3	0	0	3
3.	ST7003	Offshore Structures	3	0	0	3
4.	ST7004	Optimization of Structures	3	0	0	3
5.	ST7005	Matrix Methods for Structural Analysis	3	0	0	3
6.	CN7001	Advanced Concrete Technology	3	0	0	3

**SEMESTER – II (Elective – III & IV)**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
7.	ST7006	Design of Bridges	3	0	0	3
8.	ST7007	Mechanics of Composite Materials	3	0	0	3
9.	ST7008	Pre-stressed Concrete	3	0	0	3
10.	ST7009	Wind and Cyclone Effects on Structures	3	0	0	3
11.	ST7010	Design of Sub Structures	3	0	0	3
12.	ST7011	Computer Aided Analysis and Design	3	0	2	4

**SEMESTER –III (Elective – V, VI & VII)**

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
13.	ST7012	Design of Shell and Spatial Structures	2	0	2	3
14.	ST7013	Design of Steel Concrete Composite Structures	3	0	0	3
15.	ST7014	Industrial Structures	3	0	0	3
16.	ST7015	Nonlinear Analysis of Structures	3	0	0	3
17.	ST7016	Prefabricated Structures	3	0	0	3
18.	ST7017	Theory of Plates	3	0	0	3
19.	ST7018	Stability of Structures	3	0	0	3

**OBJECTIVES:**

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

**UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Laplace transform, Definitions, properties – Transform error function, Bessel's function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation.

**UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Fourier transform: Definitions, properties – Transform of elementary functions, Dirac Delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poisson's equations.

**UNIT III CALCULUS OF VARIATIONS 9+3**

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Problems with constraints – Direct methods – Ritz and Kantorovich methods.

**UNIT IV CONFORMAL MAPPING AND APPLICATIONS 9+3**

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

**UNIT V TENSOR ANALYSIS 9+3**

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Innerproduct – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient, divergence and curl.

**TOTAL (L: 45 +T: 15): 60 PERIODS**

**OUTCOME:**

- On completion of the course the students will enable to solve boundary value problems using Laplace and Fourier transform techniques. They will also solve Fluid flow and heat flow problems using conformal mapping.

**REFERENCES:**

1. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
2. James, G., "Advanced Modern Engineering Mathematics, 3<sup>rd</sup> Edition, Pearson Education, 2004.
3. Ramaniah.G. "Tensor Analysis", S.Viswanathan Pvt. Ltd., 1990.
4. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
5. Spiegel, M.R., "Theory and Problems of Complex Variables and its Application (Schaum's Outline Series)", McGraw Hill Book Co., 1981.

**OBJECTIVES:**

- To make the students be familiar with the limit state design of RCC beams and columns
- To design special structures such as Deep beams, Corbels, Deep beams, and Grid floors
- The students will have confident to design the flat slab as per Indian standard, yield line theory and strip method.
- To design the beams based on limit analysis and detail the beams, columns and joints for ductility

**UNIT I DESIGN PHILOSOPHY 9**

Limit state design - beams, slabs and columns according to IS Codes. Calculation of deflection and crack width according to IS Code - Design of slender columns

**UNIT II DESIGN OF SPECIAL RC ELEMENTS 9**

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 YIELD LINE BASED DESIGN 9**

Design of flat slabs and flat plates according to IS method – Check for shear - Design of spandrel beams - Yield line theory and Hillerborg's 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.

**UNIT V DUCTILE DETAILING 9**

Concept of Ductility – Detailing for ductility – Design of beams, columns for ductility - Design of cast-in-situ joints in frames – Fire resistance of Reinforced concrete members.

**TOTAL: 45 PERIODS****OUTCOME:**

- On completion of this course the students will have the confidence to design various concrete structures and structural elements by limit state design and detail the same for ductility as per codal requirements.

**REFERENCES:**

1. Gambhir.M.L., "Design of Reinforced Concrete Structures", Prentice Hall of India, 2012.
2. Purushothaman, P, "Reinforced Concrete Structural Elements: Behaviour Analysis and Design", Tata McGraw Hill, 1986
3. Unnikrishna Pillai and Devdas Menon "Reinforced Concrete Design', Third Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2007.
4. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2005.
5. Varghese, P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, 2007.

**OBJECTIVES:**

- 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.

<b>UNIT I</b>	<b>PRINCIPLES OF VIBRATION ANALYSIS</b>	<b>9</b>
Mathematical models of single degree of freedom systems - Free and forced vibration of SDOF systems, Response of SDOF to special forms of excitation, Effect of damping, Transmissibility.		
<b>UNIT II</b>	<b>DYNAMIC RESPONSE OF TWO DEGREE OF FREEDOM SYSTEMS</b>	<b>9</b>
Mathematical models of two degree of freedom systems, free and forced vibrations of two degree of freedom systems, normal modes of vibration, applications.		
<b>UNIT III</b>	<b>DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS</b>	<b>9</b>
Mathematical models of Multi-degree of freedom systems, orthogonality of normal modes, free and forced vibrations of multi degree of freedom systems Mode superposition technique, Applications.		
<b>UNIT IV</b>	<b>DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS</b>	<b>9</b>
Mathematical models of continuous systems, Free and forced vibration of continuous systems, Rayleigh – Ritz method – Formulation using Conservation of Energy – Formulation using Virtual Work, Applications.		
<b>UNIT V</b>	<b>DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE</b>	<b>9</b>
Damping in MDOF systems, Nonlinear MDOF systems, Wilson Theta method, Newmark beta method, step-by-step numerical integration techniques.		

**TOTAL : 45 PERIODS**

**OUTCOME:**

- After completion of the course the students will have the knowledge of vibration analysis of systems/structures with different degrees of freedom and they know the method of damping the systems.

**REFERENCES:**

1. Anil K.Chopra, Dynamics of Structures, Pearson Education, 2007.
2. Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill, 1986, IOS Press, 2006.
3. Mario Paz, Structural Dynamics -Theory and Computation, Kluwer Academic Publishers, 2004.
4. Roy R.Craig, Jr, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2011.

<b>ST7103</b>	<b>THEORY OF ELASTICITY AND PLASTICITY</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVES:**

- To understand the concept of 3D stress, strain analysis and its applications to simple problems.

<b>UNIT I</b>	<b>ELASTICITY</b>	<b>9</b>
Analysis of stress and strain, Equilibrium equations - Compatibility equations - stress strain relationship. Generalized Hooke's law.		
<b>UNIT II</b>	<b>ELASTICITY SOLUTION</b>	<b>9</b>
Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar co-ordinates.		
<b>UNIT III</b>	<b>TORSION OF NON-CIRCULAR SECTION</b>	<b>9</b>
St.venant's approach - Prandtl's approach – Membrane analogy - Torsion of thin walled open and closed sections.		

**UNIT IV BEAMS ON ELASTIC FOUNDATIONS 9**  
 Beams on Elastic foundation – Methods of analysis – Elastic line method – Idealization of soil medium – Winkler model – Infinite beams – Semi infinite and finite beams – Rigid and flexible – Uniform cross section – Point load and udl – Solution by finite differences.

**UNIT V PLASTICITY 9**  
 Physical Assumptions – Yield criteria – Failure theories – Applications of thick cylinder – Plastic stress strain relationship. Elasto-plastic problems in bending and torsion.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- On completion of this course the students will be familiar to the concept of elastic analysis of plane stress and plane strain problems, beams on elastic foundation and torsion on non-circular section.
- They also have sufficient knowledge in various theories of failure and plasticity.

**REFERENCES:**

1. Ansel.C.Ugural and Saul.K.Fenster, "Advanced Strength and Applied Elasticity," Fourth Edition, Prentice Hall Professional technical Reference, New Jersey, 2003.
2. Chakrabarty.J, "Theory of Plasticity", Third Edition, Elsevier Butterworth - Heinmann – UK, 2006.
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
4. Slater R.A.C, "Engineering Plasticity", John Wiley and Son, New York, 1977.
5. Timoshenko, S. and Goodier J.N."Theory of Elasticity", McGraw Hill Book Co., New York, 1988.

**ST7201 FINITE ELEMENT ANALYSIS L T P C**  
**2 0 2 3**

**OBJECTIVES:**

- To study the energy principles, finite element concept, stress analysis, meshing, linear problems and applications.

**UNIT I INTRODUCTION 9+3**  
 Historical Background - Basic Concept of FEM - Engineering problems and governing differential equations – Finite element modeling – Discretisation - Node, Element - different types of element – Approximate Solutions – Principle of minimum potential energy, Rayleigh-Ritz method and Galerkins methods.

**UNIT II FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS 9+3**  
 One dimensional problems - Coordinate systems – global, local and natural coordinate systems, shape functions – Bar, beam and truss element - Generation of Stiffness Matrix and Load Vector.

**UNIT III FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS 9+3**  
 Two Dimensional problems – Plane Stress, Plane Strain Problems – Triangular and Quadrilateral Elements – Isoparametric Formulation - Natural Coordinates, Shape function, stiffness matrix- Axisymmetric Problems - Higher Order Elements - Numerical Integration.

**UNIT IV MESH GENERATION AND SOLUTION PROBLEMS 9+3**  
 Convergence: Requirements for convergence – p and h Methods of Mesh Refinement – ill conditioned Elements – Discretisation Errors – Auto and Adaptive Mesh Generation Techniques - Error Evaluation.

**UNIT V SOFTWARE APPLICATION****6**

Preprocessing - Mesh generation – region and block representation, generation of node numbers, mesh plotting- Post Processing – Types of data available – displaying results graphically – listing nodal and element solution data.

**Practical lab:** Generation of models & analysis of simple models using latest Finite Element software(Not for theory Exam)

**6****TOTAL (L:45+T:15) : 60 PERIODS****TEXT BOOK:****REFERENCES:**

1. J.N.Reddy, An Introduction to the Finite Element Method, McGraw Hill, International Edition, 1993.
2. S.S.Rao, “Finite Element Method in Engineering”, Pergamon Press, 1989.
3. Chandrupatla & Belagundu, “Finite Elements in Engineering”, Prentice Hall of India Private Ltd.,1997.
4. Cook, Robert Davisetal, “ Concepts and Applications of Finite Element Analysis “, Wiley, John & Sons, 1999
5. C.S.krishnamoorthy, “Finite Element Analysis”,”Theory and Programming:, Tata McGraw-Hill, 1995
6. David Hutton, “ Fundamentals of Finite Element Analysis”, Tata McGraw- Hill publishing Company limited, New Delhi, 2005
7. K.J.Bathe, Finite Elements Procedures in Engineering analysis, Prentice Hall Inc., 1995.
8. O.C.Zienkiewicz, and R.L.Taylor, The Finite Elements Methods , Mc Graw Hill , 1987.
9. S.Moaveni, Finite Element Analysis : Theory and Application with ANSYS, Prentice Hall Inc., 1999.
10. Chennakesava R. Alavala “Finite Element Methods: Basic Concepts and Applications”, Prentice Hall Inc., 2010.

**ST7202 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION****L T P C  
2 0 2 3****OBJECTIVES:**

- To learn the principles of measurements of static and dynamic response of structures and carryout the analysis of results.

**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 MEASUREMENT OF VIBRATION AND WIND FLOW****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 – wind tunnels – Flow meters – Venturimeter – Digital data Acquisition systems.

**UNIT III 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 – Structural Health Monitoring.

**UNIT IV 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).

**UNIT V MODEL ANALYSIS****6+6**

Model Laws – Laws of similitude – Model materials – Necessity for Model analysis – Advantages – Applications – Types of similitude – Scale effect in models – Indirect model study – Direct model study - Limitations of models – investigations – structural problems – Usage of influence lines in model studies.

**TOTAL (L: 30 + P: 30): 60 PERIODS****OUTCOMES:**

- At the end of this course students will know about measurement of strain, vibrations and wind blow.
- They will be able to analyze the structure by non-destructive testing methods and model analysis.

**REFERENCES:**

1. Dalley .J.W and Riley.W.F, "Experimental Stress Analysis", McGraw Hill Book Company, N.Y. 1991
2. Ganesan.T.P, "Model Analysis of Structures", University Press, India, 2000.
3. Ravisankar.K.and Chellappan.A., "Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures", SERC, Chennai, 2007.
4. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2006.
5. Sirohi.R.S., Radhakrishna.H.C, "Mechanical Measurements", New Age International (P) Ltd. 1997.

**ST7203****STEEL STRUCTURES****L T P C  
3 0 0 3****OBJECTIVES:**

- To study the behaviour of members and connections, analysis and design of Industrial buildings and roofs, chimneys. Study the design of with cold formed steel and plastic analysis of structures.

**UNIT I GENERAL****9**

Design of members subjected to combined forces – Design of Purlins, Louver rails, Gable column and Gable wind girder – Design of simple bases, Gusseted bases and Moment Resisting Base Plates.

**UNIT II DESIGN OF CONNECTIONS****9**

Types of connections – Welded and Bolted – 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 INDUSTRIAL BUILDINGS****9**

Analysis and design of different types of Live pan, Pratt and north light trusses roofs – Analysis and design of industrial buildings – Sway and non sway frames – Aseismic design of steel buildings.



**UNIT IV PLASTIC ANALYSIS OF STRUCTURES 9**

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**

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: 45 PERIODS**

**OUTCOMES:**

- At the end of this course students will be in a position to design bolted and welded connections in industrial structures.
- They also know the plastic analysis and design of light gauge steel structures.

**REFERENCES:**

1. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1990.
2. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing, 2000.
3. Subramanian.N, Design of Steel Structures, Oxford University Press, 2008.
4. Wie Wen Yu, Design of Cold Formed Steel Structures, Mc Graw Hill Book Company, 1996.

**ST7204 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES L T P C  
3 0 0 3**

**OBJECTIVES:**

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

**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 - 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 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 – Capacity based Design and detailing – Rigid Frames – Shear walls.

**UNIT V VIBRATION CONTROL TECHNIQUES****9**

Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies, Important structures.

**TOTAL: 45 PERIODS****OUTCOMES:**

- At the end of this course the students will be able to understand the causes and effect of earthquake.
- They will be able to design masonry and RC structures to the earthquake forces as per the recommendations of IS codes of practice.

**REFERENCES:**

1. Bruce A Bolt, "Earthquakes" W H Freeman and Company, New York, 2004.
2. C. A. Brebbia, "Earthquake Resistant Engineering Structures VIII", WIT Press, 2011
3. Mohiuddin Ali Khan "Earthquake-Resistant Structures: Design, Build and Retrofit", Elsevier Science & Technology, 2012
4. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2009.
5. Paulay, T and Priestley, M.J.N., "Seismic Design of Reinforced Concrete and Masonry buildings", John Wiley and Sons, 1992.
6. S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.

**ST7211 ADVANCED STRUCTURAL ENGINEERING LABORATORY****L T P C  
0 0 4 2****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 and evaluate
  - a. Drift of the frame.
  - b. Stiffness of the frame.
  - c. Energy dissipation capacity of the frame.
6. Determination of in-situ strength and quality of concrete using
  - i) rebound hammer and ii) Ultrasonic Pulse Velocity Tester.
7. Effect of admixtures in concrete for workability, strength and durability

**TOTAL: 60 PERIODS****LABORATORY EQUIPMENTS REQUIREMENTS**

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

**OUTCOMES:**

- On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behaviour.
- They will be able to test dynamic testing on steel beams, static cyclic load testing of RC frames and non-destruction testing on concrete.

**REFERENCES:**

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

**ST7311****SEMINAR****L T P C  
0 0 2 1****OBJECTIVES:**

- To work on a specific technical topic in Structural Engineering and acquire the skills of written and oral presentation.
- To acquire writing abilities for seminars and conferences.

**SYLLABUS:**

The students will work for two hours per week guided by a group of staff members. They will be asked to give a presentation on any topic of their choice related to Structural Engineering and to engage in discussion with the audience. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will defend their presentation. Evaluation will be based on the technical presentation and the report and also on the interaction shown during the seminar.

**TOTAL: 30 PERIODS****OUTCOME:**

- The students will be trained to face an audience and to tackle any problem during group discussion in the Interviews.

**ST7312****PRACTICAL TRAINING (4 Weeks)****L T P C  
- - - 1****OBJECTIVES:**

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

**SYLLABUS:**

The students individually undertake training in reputed Structural Engineering Companies during the summer vacation for a specified period of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

**OUTCOME:**

- They are trained in tackling a practical field/industry orientated problem related to Structural Engineering.

**ST7313**

**PROJECT WORK (PHASE I)**

**L T P C**  
**0 0 12 6**

**OBJECTIVES:**

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

**SYLLABUS:**

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

**TOTAL: 180 PERIODS**

**OUTCOME:**

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

**ST7411**

**PROJECT WORK (PHASE II)**

**L T P C**  
**0 0 24 12**

**OBJECTIVE:**

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

**SYLLABUS:**

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

**TOTAL: 360 PERIODS**

**OUTCOME:**

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

**ST7001**

**ANALYSIS AND DESIGN OF TALL BUILDINGS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

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

**UNIT I           LOADING AND DESIGN PRINCIPLES**

**9**

Loading- sequential loading, Gravity loading, Wind loading, Earthquake loading, - Equivalent lateral force, modal analysis - combination of loading, – Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design.

**UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9**

Factors affecting growth, height and structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

**UNIT III ANALYSIS AND DESIGN 9**

Modeling 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 - Computerized three dimensional analysis – Assumptions in 3D analysis – Simplified 2D analysis.

**UNIT IV STRUCTURAL ELEMENTS 9**

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**

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 PERIODS**

**OUTCOMES:**

- On completion of this course students will be able to know the behavior of tall buildings due to various types of loads.
- They will be able to analyze and design such buildings by approximate, accurate and simplified methods.

**REFERENCES:**

1. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.
2. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc., 2005.
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. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 1988.

**ST7002 MAINTENANCE AND REHABILITATION OF STRUCTURES L T P C  
3 0 0 3**

**OBJECTIVES:**

- To study the damages, repair and rehabilitation of structures.

**UNIT I INTRODUCTION 9**

General Consideration – Distresses monitoring – Causes of distresses – Quality assurance – Defects due to climate, chemicals, wear and erosion – Inspection – Structural appraisal – Economic appraisal.

**UNIT II BUILDING CRACKS 9**

Causes – diagnosis – remedial measures – Thermal and Shrinkage cracks – unequal loading – Vegetation and trees – Chemical action – Foundation movements – Techniques for repair – Epoxy injection.

**UNIT III MOISTURE PENETRATION****9**

Sources of dampness – Moisture movement from ground – Reasons for ineffective DPC – Roof leakage – Pitched roofs – Madras Terrace roofs – Leakage of Concrete slabs – Dampness in solid walls – condensation – hygroscopic salts – remedial treatments – Ferro cement overlay – Chemical coatings – Flexible and rigid coatings.

**UNIT IV DISTRESSES AND REMEDIES****9**

Concrete Structures: Introduction – Causes of deterioration – Diagnosis of causes – Flow charts for diagnosis – methods of repair – repairing, spalling and disintegration – Repairing of concrete floors and pavements.

Steel Structures : Types and causes for deterioration – preventive measures – Repair procedure – Brittle fracture – Lamellar tearing – Defects in welded joints – Mechanism of corrosion – Design of protect against corrosion – Design and fabrication errors – Distress during erection.

Masonry Structures: Discoloration and weakening of stones – Biotical treatments – Preservation – Chemical preservatives – Brick masonry structures – Distresses and remedial measures.

**UNIT V STRENGTHENING OF EXISTING STRUCTURES****9**

General principle – relieving loads – Strengthening super structures – plating – Conversation to composite construction – post stressing – Jacketing – bonded overlays – Reinforcement addition – strengthening the substructures – under pinning – Increasing the load capacity of footing – Design for rehabilitation.

**TOTAL: 45 PERIODS****OUTCOME:**

- At the end of this course students will be in a position to point out the causes of distress in concrete, masonry and steel structures and also they will be able to suggest the remedial measures.

**REFERENCES:**

1. Allen R.T and Edwards S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987
2. Dayaratnam.P and Rao.R, "Maintenance and Durability of Concrete Structures", University Press, India, 1997.
3. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical, UK, 1991.
4. Dodge Woodson.R,"Concrete Structures – protection, repair and rehabilitation", Elsevier Butterworth – Heinmann, UK, 2009.
5. Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications Pvt. Ltd., 2001.
6. Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" – Rand D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.

**ST7003****OFFSHORE STRUCTURES****L T P C  
3 0 0 3****OBJECTIVES:**

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

**UNIT I WAVE THEORIES****9**

Wave generation process, small, finite amplitude and nonlinear wave theories.

**UNIT II FORCES OF OFFSHORE STRUCTURES****9**

Wind forces, wave forces on small bodies and large bodies - current forces and use of Morison equation.

<b>UNIT III</b>	<b>OFFSHORE SOIL AND STRUCTURE MODELLING</b>	<b>9</b>
Different types of offshore structures, foundation modeling, fixed jacket platform structural modeling.		
<b>UNIT IV</b>	<b>ANALYSIS OF OFFSHORE STRUCTURES</b>	<b>9</b>
Static method of analysis, foundation analysis and dynamics of offshore structures.		
<b>UNIT V</b>	<b>DESIGN OF OFFSHORE STRUCTURES</b>	<b>9</b>
Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipe lines.		

**TOTAL: 45 PERIODS**

**OUTCOME:**

- On completion of this course students will be able to determine the forces due to ocean waves and analyze and design offshore structures like platform, helipads, jackets, towers etc.,

**REFERENCES:**

1. API RP 2A-WSD, Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design - API Publishing Services, 2005
2. Chakrabarti, S.K., Handbook of Offshore Engineering by, Elsevier, 2005.
3. Chakrabarti, S.K., Hydrodynamics of Offshore Structures, WIT press, 2001.
4. Dawson.T.H., Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
5. James F. Wilson, Dynamics of Offshore Structures, John Wiley & Sons, Inc, 2003.
6. Reddy, D.V. and Arockiasamy, M., Offshore Structures, Vol.1 and Vol.2, Krieger Publishing Company, 1991.
7. Turgut Sarpkaya, Wave Forces on Offshore Structures, Cambridge University Press, 2010.

<b>ST7004</b>	<b>OPTIMIZATION OF STRUCTURES</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVES:**

- To study the optimization methodologies applied to structural engineering

<b>UNIT I</b>	<b>BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES</b>	<b>9</b>
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).		
<b>UNIT II</b>	<b>LINEAR AND NON-LINEAR PROGRAMMING</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>GEOMETRIC PROGRAMMING</b>	<b>9</b>
Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty.		

**UNIT IV DYNAMIC PROGRAMMING****9**

Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods.

**UNIT V STRUCTURAL APPLICATIONS****9**

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 PERIODS****OUTCOME:**

- On completion of this course students will have sufficient knowledge on various optimization techniques like linear programming, non-linear programming, geometric and dynamic programming and they will also in a position to design various structural elements for minimum weight.

**REFERENCES:**

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

**ST7005****MATRIX METHODS FOR STRUCTURAL ANALYSIS****L T P C****3 0 0 3****OBJECTIVES:**

- To Study the Energy Concepts in Structures, Characteristics and Transformation of Structures.

**UNIT I ENERGY CONCEPTS IN STRUCTURES****9**

Introduction – Strain Energy – Symmetry of The Stiffness And Flexibility Matrices – Strain Energy in Terms of Stiffness And Flexibility Matrices – Stiffness And Flexibility Coefficients in Terms of Strain Energy – Additional properties of [a] and [k] – another Interpretation of coefficients  $a_{ij}$  and  $k_{ij}$  – Betti's law – Applications of Betti's law: Forces not at the coordinates – Strain energy in systems and in Elements.

**UNIT II CHARACTERISTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY****9**

Introduction – Structure with Single Coordinate- Two Coordinates-Flexibility and Stiffness Matrices in Coordinates- Examples-Symmetric Nature of Matrices- Stiffness and Flexibility Matrices in Constrained Measurements- Stiffness and Flexibility of Systems and Elements-Computing Displacements and Forces from Virtual Work-Computing Stiffness and Flexibility Coefficients.

**UNIT III TRANSFORMATION OF INFORMATION IN STRUTURES****9**

Determinate- Indeterminate Structures-Transformation of System Forces to Element Forces- Element Flexibility to System Flexibility - System Displacement to Element Displacement-Element Stiffness to System Stiffness-Transformation of Forces and Displacements in General –Stiffness and Flexibility in General –Normal Coordinates and Orthogonal Transformation-Principle of Contregradience

**UNIT IV THE FLEXIBILITY METHOD****9**

Statically Determinate Structures –Indeterminate Structures-Choice of Redundant Leading to Ill and Well Conditioned Matrices-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 V THE STIFFNESS METHOD****9**

Introduction-Development of Stiffness Method- Stiffness Matrix for Structures with zero Force at some Coordinates-Analogy between Flexibility and Stiffness-Lack of Fit-Stiffness Matrix with Rigid Motions-Application of Stiffness Approach to Pin Jointed Plane Trusses-Continuous Beams-Frames-Grids-Space Trusses and Frames-Introduction Only-Static Condensation Technique-Choice of Method-Stiffness or Flexibility.

**TOTAL : 45 PERIODS****REFERENCE S:**

1. K. Rubinstein.F.M., " Matrix Computer Methods of Structural Analysis", Prentice Hall, Inc. N.J., 1966
2. Rubinstein.F.M., " Matrix Computer Methods of Structural Analysis", Prentice Hall, Inc. N.J., 1966
3. Dr. Devadas Menon., "Advanced Structural Analysis", Narosa Publishing House, New Delhi, 2009
4. Pandit G.S. and Gupta S.P., "Structural Analysis-A Matrix Approach", Tata McGraw-Hill PublishingCompany Limited, New Delhi, 1997
5. Reddy C.S., "Basic Structural Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997

**CN7001****ADVANCED CONCRETE TECHNOLOGY****L T P C  
3 0 0 3****OBJECTIVES :**

- To study the properties of concrete making materials, tests, mix design, special concretes and various methods for making concrete.

**UNIT I CONCRETE MAKING MATERIALS****9**

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, 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 TESTS ON CONCRETE****9**

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage – Durability of concrete.

**UNIT III MIX DESIGN****9**

Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method – 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 – High performance concrete. High performance fiber reinforced concrete, Self-Compacting-Concrete, Geo Polymer Concrete, Waste material based concrete – Ready mixed 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.

**TOTAL : 45 PERIODS****OUTCOME:**

- On completion of this course the students will know various tests on fresh, hardened concrete, special concrete and the methods of manufacturing of concrete.

**REFERENCES:**

1. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
2. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2010.



<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites and Short Fiber Composites.		
<b>UNIT II</b>	<b>STRESS STRAIN RELATIONS</b>	<b>9</b>
Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses		
<b>UNIT III</b>	<b>ANALYSIS OF LAMINATED COMPOSITES</b>	<b>9</b>
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.		
<b>UNIT IV</b>	<b>FAILURE AND FRACTURE OF COMPOSITES</b>	<b>9</b>
Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.		
<b>UNIT V</b>	<b>APPLICATIONS AND DESIGN</b>	<b>9</b>
Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues		

**TOTAL: 45 PERIODS**

**OUTCOME:**

- On completion of this course students will have sufficient knowledge on behavior of various composite materials and they have an idea of failure and fracture mechanisms.

**REFERENCES:**

1. Agarwal.B.D., Broutman.L.J., and Chandrashekar.K. "Analysis and Performance of Fiber Composites", John-Wiley and Sons, 2006.
2. Daniel.I.M., and Ishai.O, "Engineering Mechanics of Composite Materials", Oxford University Press, 2005.
3. Hyer M.W., and White S.R., "Stress Analysis of Fiber-Reinforced Composite Materials", D.Estech Publications Inc., 2009
4. Jones R.M., "Mechanics of Composite Materials", Taylor and Francis Group 1999.
5. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", Universities Press, India, 2005.

<b>ST7008</b>	<b>PRE-STRESSED CONCRETE</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVES:**

- Principle of prestressing, analysis and design of prestressed concrete structures.

<b>UNIT I</b>	<b>PRINCIPLES OF PRESTRESSING</b>	<b>9</b>
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Principles of Prestressing - types and systems of prestressing, need for High Strength materials, Analysis methods losses, deflection (short-long term), camber, cable layouts.

<b>UNIT II</b>	<b>DESIGN OF FLEXURAL MEMBERS</b>	<b>9</b>
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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 PERIODS**

**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.

**ST7009 WIND AND CYCLONE EFFECTS ON STRUCTURES L T P C**  
**3 0 0 3**

**OBJECTIVES:**

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

**UNIT I INTRODUCTION 9**  
Introduction, Types of wind – Characteristics of wind – Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects - Dynamic nature of wind – Pressure and suctions - Spectral studies, Gust factor.

**UNIT II WIND TUNNEL STUDIES 9**  
Wind Tunnel Studies, Types of tunnels, - Prediction of acceleration – Load combination factors – Wind tunnel data analysis – Calculation of Period and damping value for wind design - Modeling requirements, Aero dynamic and Aero-elastic models.

**UNIT III EFFECT OF WIND ON STRUCTURES 9**  
Classification of structures – Rigid and Flexible – Effect of wind on structures - Static and dynamic effects on Tall buildings – Chimneys.

**UNIT IV DESIGN OF SPECIAL STRUCTURES 9**  
Design of Structures for wind loading – as per IS, ASCE and NBC code provisions – design of Tall Buildings – Chimneys – Transmission towers – Industrial sheds.

**UNIT V CYCLONE EFFECTS 9**  
Cyclone effect on – low rise structures – sloped roof structures - Tall buildings. Effect of cyclone on claddings – design of cladding – use of code provisions in cladding design – Analytical procedure and modeling of cladding.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- On completion of this course, students will be able to design high rise structures subjected wind load, even structures exposed to cyclone.
- Students will be conversant with various code provisions for the design of structures for wind load.

**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. Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers, London, 1980.
4. Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1972.

**ST7010****DESIGN OF SUB STRUCTURES****L T P C  
3 0 0 3****OBJECTIVES:**

- To gain familiarity with different types of foundation.
- To explore the students to the design of shallow foundations and deep foundations.
- To understand the concept of designing well, machine and special foundations.

**UNIT I SHALLOW FOUNDATIONS****9**

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

**UNIT II PILE FOUNDATIONS****9**

Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles – different shapes of piles cap – structural design of pile cap.

**UNIT III WELL FOUNDATIONS****9**

Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

**UNIT IV MACHINE FOUNDATIONS****9**

Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

**UNIT V SPECIAL FOUNDATIONS****9**

Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retaining walls.

**TOTAL: 45 PERIODS****OUTCOMES:**

- On completion of this course students will enable to select appropriate foundations type based on available soil conditions.
- They will be a position to determine the load carrying capacity of each type of foundation.
- They will be through knowledge about the design of reinforced concrete shallow foundations, pile foundations, well foundations, and machine foundations.

**REFERENCES:**

1. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing co., New York, 1986.
2. Swamy Saran, Analysis and Design of substructures, Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
3. Tomlinson.M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995.
4. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi – 2009.

**ST7011****COMPUTER AIDED ANALYSIS AND DESIGN****L T P C  
3 0 2 4****OBJECTIVES:**

- To learn the principles of computer graphics, structural analysis, Finite Element Analysis and Application packages, Optimization and Artificial Intelligence

**THEORY****UNIT I            COMPUTER GRAPHICS****7 + 5**

Graphic primitives – Transformations – Basics of 2D drafting – Modelling of curves and surfaces – Wire frame modelling – Solid Modelling - Graphic standards - Drafting Software packages .

**UNIT II            STRUCTURAL ANALYSIS****7+5**

Computer method of structural analysis – Simulation and Analysis of steel sections I, channel and Angle – RCC and Composite members - Nonlinear Analysis through software packages

**UNIT III            STRUCTURAL DESIGN****7+5**

Computer Aided Design of Steel and RC structural elements – Detailing of reinforcement – Detailed Drawing .

**UNIT IV            OPTIMIZATION****7+5**

Introduction to Optimization – Applications of Linear programming – Simplex Algorithm – Post Optimality Analysis – Project scheduling – CPM and PERT Applications.

**UNIT V            ARTIFICIAL INTELLIGENCE****7+5**

Introduction – Heuristic Research – Knowledge based Expert Systems – Architecture and Applications – Rules and Decision tables – Inference Mechanisms – Simple Applications – Genetic Algorithm and Applications – Principles of Neural Network – Expert system shells.

**TOTAL ( L : 35 P:25) : 60 PERIODS****PRACTICAL****LIST OF EXERCISES**

1. 2-D Frame Modelling and Analysis.
2. 3 – D Frame Modelling and Analysis.
3. Non Linear Analysis using Design software.
4. Design and Detailing of Structural Elements.
5. Simulation and Analysis of steel beam using FEA software.
6. Simulation and Analysis of R.C.Beam using FEA software.
7. Simulation and Analysis of Composite element s using FEA software.
8. Eigen Value Buckling analysis using FEA software.

**REFERENCES:**

1. Krishnamoorthy C.S and Rajeev S., "Computer Aided Design", Narosa Publishing House, New Delhi, 1991.
2. Groover M.P. and Zimmers E.W. Jr., "CAD/CAM, Computer Aided Design and Manufacturing", Prentice Hall of India Ltd, New Delhi, 1993.
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.
7. V.L. Shah "Computer Aided Design in Reinforced Concrete" Structural Publishers

**ST7012****DESIGN OF SHELL AND SPATIAL STRUCTURES****L T P C  
2 0 2 3****OBJECTIVES:**

- Study the behaviour and design of shells, folded plates, space frames and application of FORMIAN software.

**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 (L:30 + P:30) : 60 PERIODS****OUTCOME:**

- On completion of this course students will be able to analyze and design various types of shells, folded plates and space frames manually and also using computer Aided design and software packages.

**REFERENCES:**

1. Billington.D.P, "Thin Shell Concrete Structures", McGraw Hill Book Co., New York, 1982.
2. ASCE Manual No.31, Design of Cylindrical Shells.
3. Ramasamy, G.S., "Design and Construction of Concrete Shells Roofs", CBS Publishers, 1986.
4. Subramanian.N, "Principles of Space Structures", Wheeler Publishing Co. 1999.
5. Varghese.P.C., Design of Reinforced Concrete Shells and Folded Plates, PHI Learning Pvt. Ltd., 2010.





**UNIT IV TRANSMISSION LINE STRUCTURES AND CHIMNEYS 9**  
Analysis and design of transmission line towers - Sag and Tension calculations, Testing of towers – Design of self supporting chimney, Design of Chimney bases.

**UNIT V FOUNDATION 9**  
Design of foundation for Towers, Chimneys and Cooling Towers - Machine Foundation - Design of Turbo Generator Foundation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- On completion of this course student will be able to plan industrial structures for functional requirements.
- They will be able to design various structures such as Bunkers, Silos, Cooling Towers, Chimneys, and Transmission Towers with required foundations.

**REFERENCES:**

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

**ST7015 NONLINEAR ANALYSIS OF STRUCTURES L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To study the concept of nonlinear behaviour and analysis of elements and simple structures.

**UNIT I INTRODUCTION TO NONLINEAR ANALYSIS 9**  
Material nonlinearity, geometric nonlinearity; 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: 45 PERIODS**

**OUTCOMES:**

- At the end of this course student will have enough knowledge on inelastic and vibration analysis of Flexural members.
- Also they will know the difference between elastic and inelastic analysis of plates and Instabilities of elastically supported beams.

**REFERENCES:**

1. Fertis, D.G, Nonlinear Mechanics, CRC Press, 1999.
2. Reddy.J.N, Non linear Finite Element Analysis, Oxford University Press, 2008.
3. Sathyamoorthy.M, Nonlinear Analysis of Structures, CRC Press, 2010.

**ST7016****PREFABRICATED STRUCTURES****L T P C  
3 0 0 3****OBJECTIVES:**

- To Study the design principles, analysis and design of elements.

**UNIT I DESIGN PRINCIPLES****9**

General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and code 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 hyper-prefabricated shells, Erection and jointing, joint design, hand book based design.

**TOTAL: 45 PERIODS****OUTCOMES:**

- At the end of this course student will have good knowledge about the prefabricated elements and the technologies used in fabrication and erection.
- They will be in a position to design floors, stairs, roofs, walls and industrial buildings, and various joints for the connections.

**REFERENCES:**

1. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III & IV Bauverlag, GMBH, 1971.
2. Laszlo Mokka, Prefabricated Concrete for Industrial and Public Structures, Akademiai Kiado, Budapest, 2007.
3. Lewicki.B, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam/ London/New York, 1998.



<b>UNIT I</b>	<b>BUCKLING OF COLUMNS</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>BUCKLING OF BEAM-COLUMNS AND FRAMES</b>	<b>9</b>
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 – Use of stability function to determine the critical load.		
<b>UNIT III</b>	<b>TORSIONAL AND LATERAL BUCKLING</b>	<b>9</b>
Torsional buckling – Combined Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported and cantilever beams.		
<b>UNIT IV</b>	<b>BUCKLING OF PLATES</b>	<b>9</b>
Governing differential equation - Buckling of thin plates, various edge conditions -Analysis by equilibrium and energy approach – Finite difference method.		
<b>UNIT V</b>	<b>INELASTIC BUCKLING</b>	<b>9</b>
Double modulus theory - Tangent modulus theory - Shanley's model - Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.		

**TOTAL: 45 PERIODS**

**OUTCOME:**

- On completion of this course student will know the phenomenon of buckling and they are in a position to calculate the buckling load on column, beam – column, frames and plates using classical and approximate methods.

**REFERENCES:**

1. Ashwini Kumar, "Stability Theory of Structures", Allied publishers Ltd., New Delhi, 2003.
2. Chajes, A. "Principles of Structures Stability Theory", Prentice Hall, 1974.
3. Gambhir, "Stability Analysis and Design of Structures", springer, New York, 2004.
4. Simitser.G.J and Hodges D.H, "Fundamentals of Structural Stability", Elsevier Ltd., 2006.
5. Timoshenko.S.P, and Gere.J.M,"Theory of Elastic Stability",McGraw Hill Book Company, 1963.