St. PETER'S UNIVERSITY

St. Peter's Institute of Higher Education and Research
(Declared under section 3 of UGC Act 1956)
Avadi, Chennai – 600 054.

M.E (STRUCTURAL ENGINEERING) PROGRAMME

(I TO IV SEMESTERS)

REGULATIONS AND SYLLABI

(REGULATIONS – 2013)

(With a retrospective amendment in the credits from the batch of students admitted in 2014-15)

M.E (STRUCTURAL ENGINEERING) PROGRAMME
Regulations and Syllabi

(Effective from the Academic Year 2013-'14)

(With a retrospective amendment in the credits from the batch of students admitted in 2014-15)

1. **Eligibility:** Candidates who passed B.E / B.Tech. (Civil engineering) B.E (Structural Engineering) of the University or A.M.I.E. in the concerned subject or any other equivalent examination thereto are eligible for admission to Two Year M.E. (Structural Engineering) Programme.

2. **Duration:** Two Years Comprising 4 Semesters. Each semester has a minimum 90 working days with a minimum of 5 hours a day a minimum of 450 hours per Semester. Candidates who have completed the duration of the programme of study are permitted to appear for the arrear subjects examinations, if any within two years after the duration of the programme.

3. **Medium:** English is the medium of instruction and examination.

4. Weightage for Continuous and End Assessment: The weightage for Continuous assessment (CA) and End Assessment (EA) is 25: 75 unless the ratio is specifically mentioned in the scheme of Examinations. The question paper is to be set for a maximum of 100 Marks.

5. **Choice Based Credit System:** Choice Based Credit System is followed with one credit equivalent to one hour for a theory paper and two hours for a practical per week in a cycle of 18 weeks (that is, one credit is equal to 18 hours for each theory paper and one credit is equal to 36 hours for a practical in a semester) in the Time Table. The total credit for the programme (4 semesters) is 90.

6. **SCHEME OF EXAMINATION**

SEMESTER – I

Code No.	Course Title	L	T	P	C
Theory					
113SEPT01	Advanced Numerical Methods	4	1	0	5
113SEPT02	Concrete Structures	3	1	0	4
113SEPT03	Structural Dynamics	4	1	0	5
113SEPT04	Theory of Elasticity and Plasticity	4	1	0	5
113SEPT06	**Elective I:** Maintenance and Rehabilitation of Structures	4	0	0	4
113SEPT10	**Elective II:** Advanced Concrete Technology	4	0	0	4
	Total	**23**	**4**	**0**	**27**

SEMESTER – II

Code No.	Course Title	L	T	P	C
Theory					
213SEPT01	Finite Element Analysis	2	2	0	4
213SEPT02	Experimental Techniques and Instrumentation	2	2	0	4
213SEPT03	Steel Structures	3	1	0	4
213SEPT04	Earthquake Analysis and Design of Structures	3	1	0	4
213SEPT05	**Elective III:** Design of Bridges	3	1	0	4
213SEPT07	**Elective IV:** Pre-Stressed Concrete	3	1	0	4
Practical					
213SEPP01	Advanced Structural Engineering Laboratory	0	0	3	3
	Total	**16**	**8**	**3**	**27**

SEMESTER – III

Code No.	Course Title	L	T	P	C
Theory					
313SEPT03	**Elective V:** Industrial Structures	3	1	0	4
313SEPT05	**Elective VI:** Prefabricated Structures	3	1	0	4
313SEPT07	**Elective VII:** Stability of Structures	3	1	0	4
Project					
313SEPP01	Project Work (Phase I)* Viva voce	0	0	12	8
	Total	**9**	**3**	**12**	**20**

***** Candidates who have completed Project work (Phase I) successfully are eligible for Project Work (Phase - II) Examination.

SEMESTER – IV

Code No.	Course Title	L	T	P	C
Project					
413SEPP01	Project Work – Phase II* Viva Voce	0	0	24	16
	Total	**0**	**0**	**24**	**16**

LIST OF ELECTIVES

I Semester

Course Code	Electives	L	T	P	C
113SEPT05	Analysis and Design of Tall Buildings	3	1	0	4
113SEPT06	Maintenance and Rehabilitation of Structures	4	0	0	4
113SEPT07	Offshore Structures	3	1	0	4
113SEPT08	Optimization of Structures	3	1	0	4
113SEPT09	Matrix Methods for Structural Analysis	3	1	0	4
113SEPT10	Advanced Concrete Technology	4	0	0	4

II Semester

Course Code	Electives	L	T	P	C
213SEPT05	Design of Bridges	3	1	0	4
213SEPT06	Mechanics of Composite Materials	3	1	0	4
213SEPT07	Pre-Stressed Concrete	3	1	0	4
213SEPT08	Wind and Cyclone Effects on Structures	3	1	0	4
213SEPT09	Design of Sub Structures	3	1	0	4
213SEPT10	Computer Aided Analysis and Design	3	1	0	4

III Semester

Course Code	Electives	L	T	P	C
313SEPT01	Design of Shell and Spatial Structures	3	1	0	4
313SEPT02	Design of Steel Concrete Composite Structures	3	1	0	4
313SEPT03	Industrial Structures	3	1	0	4
313SEPT04	Nonlinear Analysis of Structures	3	1	0	4
313SEPT05	Prefabricated Structures	3	1	0	4
313SEPT06	Theory of Plates	3	1	0	4
313SEPT07	Stability of Structures	3	1	0	4

7. **Passing Requirements:** The minimum pass mark (raw score) be 50% in End Assessment (EA) and 50% in Continuous Assessment (CA) and End Assessment (EA) put together. No minimum mark (raw score) in Continuous Assessment (CA) be prescribed unless it is specifically mentioned in the Scheme of Examination.

8. **Grading System:** Grading System on a 10 Point Scale be followed with 1 mark = 0.1 Grade point to successful candidates as given below.

CONVERSION TABLE

(1 mark = 0.1 Grade Point on a 10 Point Scale)

Range of Marks	**Grade Point**	**Letter Grade**	**Classification**
90 to 100	9.0 to 10.0	O	First Class
80 to 89	8.0 to 8.9	A	First Class
70 to 79	7.0 to 7.9	B	First Class
60 to 69	6.0 to 6.9	C	First Class
50 to 59	5.0 to 5.9	D	Second Class
0 to 49	0 to 4.9	**F**	**Reappearance**

Procedure for Calculation

Cumulative Grade Point Average (CGPA) = $\frac{\text{Sum of Weighted Grade Points}}{\text{Total Credits}}$

$$= \frac{\sum (CA+EA)\ C}{\sum C}$$

Where Weighted Grade Points in each Course = Grade Points (CA+EA) multiplied by Credits

= (CA+EA)C

Weighted Cumulative Percentage of Marks(WCPM) = CGPAx10

C- Credit, CA-Continuous Assessment, EA- End Assessment

9. **Pattern of the Question Paper:** The question paper for End Assessment will be set for three hours and for the maximum of 100 marks with following divisions and details.

Part A: 10 questions (with equal distribution to all units in the syllabus). Each question carries 2 marks.

Part B: 5 questions with either or type (with equal distribution to all units in the syllabus). Each question carries 16 marks. The total marks scored by the candidates will be reduced to the maximum prescribed in the Regulations.

10. **Effective Period of Operation for the Arrear Candidates:** Two Year grace period is provided for the candidates to complete the arrear examination, if any.

Registrar

11. **Syllabus**

I Semester

113SEPT01 ADVANCED NUMERICAL METHODS

OBJECTIVES:

- To develop the ability to apply the concepts of Matrix theory and Liner programming in Engineering problems.
- To familiarize the students in calculus of variations
- To expose the students to confirm the mapping and Fourier transform techniques.

Unit I CALCULUS OF VARIATION

Introduction – Euler's equation – several dependent variables Lagrange's equation of Dynamics –Integrals involving derivatives higher that the First – Problem with constrains – Direct methods and eigen value problems.

Unit II MATRIX THEORY

Eigen values using QR transformations – generalized eigenvectors – canonical forms –singular value decomposition and application – Pseudo inverse – least square approximation.

Unit III LINEAR PROGRAMMING PROBLEM

Graphical method– simplex method – Big M Technique –Integer Programming.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS

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 FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS

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 Poison's equations.

REFERENCES:

1. Taha H.A. "Operation Research – An Introduction", Prenite Hall of India. 2001
2. K.H. Rosen , Discrete Mathematics and its Applications , Mc- Graw Hill Book Company, 1999
3. Gupta A.S Calculus of Variations with Applications, Prentice – Hal of India New Delhi,1997
4. 5.Sankara Rao , K. Introduction to partial Differential Equations , Prentice – Hall of India, New Delhi, 1995
5. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
6. Spiegel, M.R., "Theory and Problems of Complex Variables and its Application (Schaum's Outline Series)", McGraw Hill Book Co., 1981.

113SEPT02 CONCRETE STRUCTURES

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

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

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

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

Inelastic behaviour of concrete beams and frames, moment - rotation curves, moment redistribution.

UNIT V DUCTILE DETAILING

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.

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.

113SEPT03 STRUCTURAL DYNAMICS

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.

UNIT I PRINCIPLES OF VIBRATION ANALYSIS
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.

UNIT II DYNAMIC RESPONSE OF TWO DEGREE OF FREEDOM SYSTEMS
Mathematical models of two degree of freedom systems, free and forced vibrations of two degree of freedom systems, normal modes of vibration, applications.

UNIT III DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS
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.

UNIT IV DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS
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.

UNIT V DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE
Damping in MDOF systems, Nonlinear MDOF systems, Wilson Theta method, Newmark beta method, step-by-step numerical integration techniques .

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.

113SEPT04 THEORY OF ELASTICITY AND PLASTICITY

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

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

UNIT II ELASTICITY SOLUTION
Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar coordinates.

UNIT III TORSION OF NON-CIRCULAR SECTION
St.venant's approach - Prandtl's approach – Membrane analogy - Torsion of thin walled open and closed sections.

UNIT IV BEAMS ON ELASTIC FOUNDATIONS
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
Physical Assumptions – Yield criteria – Failure theories – Applications of thick cylinder – Plastic stress strain relationship. Elasto-plastic problems in bending and torsion.

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 noncircular 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 Jersy, 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.

II Semester

213SEPT01 FINITE ELEMENT ANALYSIS

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

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

UNIT II FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS
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
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
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
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)

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.

213SEPT02 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION

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
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 – Longterm monitoring – vibrating wire sensors– Fibre optic sensors.

UNIT II MEASUREMENT OF VIBRATION AND WIND FLOW
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
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
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
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.

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.

213SEPT03 STEEL STRUCTURES

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
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
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
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
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
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.

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.

213SEPT04 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

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

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

OUTCOMES:
At the end of this course the students will be able to understand the causes and effect of earthquake.
They will 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.

213SEPP01 ADVANCED STRUCTURAL ENGINEERING LABORATORY

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

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.

313SEPP01 PROJECT WORK (PHASE I)

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.

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.

413SEPP01 PROJECT WORK (PHASE II)

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.

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

LIST OF ELECTIVES

113SEPT05 ANALYSIS AND DESIGN OF TALL BUILDINGS

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

UNIT I LOADING AND DESIGN PRINCIPLES
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
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.

UNITIII ANALYSIS AND DESIGN
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
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
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.

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.

113SEPT06 MAINTENANCE AND REHABILITATION OF STRUCTURES

OBJECTIVES:
To study the damages, repair and rehabilitation of structures.

UNIT I INTRODUCTION
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
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
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
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
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.

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.

113SEPT07 OFFSHORE STRUCTURES

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

UNIT I WAVE THEORIES
Wave generation process, small, finite amplitude and nonlinear wave theories.

UNIT II FORCES OF OFFSHORE STRUCTURES
Wind forces, wave forces on small bodies and large bodies - current forces and use of Morison equation.

UNIT III OFFSHORE SOIL AND STRUCTURE MODELLING
Different types of offshore structures, foundation modeling, fixed jacket platform structural modeling.

UNIT IV ANALYSIS OF OFFSHORE STRUCTURES
Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V DESIGN OF OFFSHORE STRUCTURES
Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipe lines.

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.

113SEPT08 OPTIMIZATION OF STRUCTURES

OBJECTIVES:
To study the optimization methodologies applied to structural engineering

UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES
Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

UNIT II LINEAR AND NON-LINEAR PROGRAMMING
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.

UNIT III GEOMETRIC PROGRAMMING
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
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
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.

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

113SEPT09 MATRIX METHODS FOR STRUCTURAL ANALYSIS

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

UNIT I ENERGY CONCEPTS IN STRUCTURES
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 aij and kij – Betti's law – Applications of Betti's law: Forces not at the coordinates – Strain energy in systems and in Elements.

UNIT II CHARACTERSTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY
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 form Virtual Work-Computing Stiffness and Flexibility Coefficients.

UNIT III TRANSFORMATION OF INFORMATION IN STRUTURES
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
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
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.

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

113SEPT10 ADVANCED CONCRETE TECHNOLOGY

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

UNIT III MIX DESIGN
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
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
Process of manufacturing of concrete, methods of transportation, placing and curing. Extreme weather concreting, special concreting methods. Vacuum dewatering – Underwater Concrete.

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.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Santhakumar.A.R. ;"Concrete Technology",Oxford University Press,2007.
5. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2003.

213SEPT05 DESIGN OF BRIDGES

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

UNIT I SHORT SPAN RC BRIDGES
Types of bridges and loading standards - Choice of type - I.R.C. specifications for road bridges – Design of RCC solid slab bridges -analysis and design of slab culverts , Tee beam and slab bridges.

UNIT II Design principles **of LONG SPAN RC BRIDGES**
continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts.

UNIT III PRESTRESSED CONCRETE BRIDGES
Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long term deflections.

UNIT IV STEEL BRIDGES
General – Railway loadings – dynamic effect – Railway culvert with steel beams – Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

UNIT V BEARINGS AND SUBSTRUCTURES
Different types of bearings – Design of bearings – Design of piers and abutments of different types – Types of bridge foundations – Design of foundations.

OUTCOME:
At the end of this course students will be able to design different types of RCC bridges, Steel bridges and pre-stressed concrete bridges with the bearings and substructures.

REFERENCES:

1. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd. 2004.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 2001.
3. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008.
4. Raina V.K." Concrete Bridge Practice" Tata McGraw Hill Publishing Company, New Delhi, 1991.

213SEPT06 MECHANICS OF COMPOSITE MATERIALS

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

UNIT I INTRODUCTION
Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites and Short Fiber Composites.

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

UNIT III ANALYSIS OF LAMINATED COMPOSITES
Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates – Static, Dynamic and Stability analysis for Simpler cases of composite plates, Interlaminar stresses.

UNIT IV FAILURE AND FRACTURE OF COMPOSITES
Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT V APPLICATIONS AND DESIGN
Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues

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 Chandrashekara.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.

213SEPT07 PRE-STRESSED CONCRETE

OBJECTIVES:
Principle of prestressing, analysis and design of prestressed concrete structures.

UNIT I PRINCIPLES OF PRESTRESSING
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
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
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
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
Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.

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.

213SEPT008 WIND AND CYCLONE EFFECTS ON STRUCTURES

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

UNIT I INTRODUCTION
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
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
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
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.

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.

213SEPT09 DESIGN OF SUB STRUCTURES

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

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.

213SEPT10 COMPUTER AIDED ANALYSIS AND DESIGN

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

UNIT I COMPUTER GRAPHICS
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
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
Computer Aided Design of Steel and RC structural elements – Detailing of reinforcement – Detailed Drawing .

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

UNIT V ARTIFICIAL INTELLIGENCE
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.

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.

The Practical examination will be through external mode.

REFERENCES:
1. Krishnamoorthy C.S and Rajeev S., "Computer Aided Design", Narosa Publishing House, New Delhi, 1991.
2. GrooverM.P.andZimmers 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

313SEPT0 DESIGN OF SHELL AND SPATIAL STRUCTURES

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

UNIT I CLASSIFICATION OF SHELLS
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
Folded Plate structures, structural behaviour, types, design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT III INTRODUCTION TO SPACE FRAME
Space frames - configuration - types of nodes - general principles of design Philosophy - Behaviour.

UNIT IV ANALYSIS AND DESIGN
Analysis of space frames – detailed design of Space frames – Introduction to Computer Aided Design and Software Packages.

UNIT V SPECIAL METHODS
Application of Formex Algebra, FORMIAN for generation of configuration.

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.

313SEPT02 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

OBJECTIVES:
To develop an understanding of the behaviour and design study of Steel concrete composite elements and structures.

UNIT I INTRODUCTION
Introduction to steel - concrete composite construction – Coes – Composite action – Serviceability and - Construction issues.

UNIT II DESIGN OF CONNECTIONS
Shear connectors – Types – Design of connections in composite structures – Degree of shear connection – Partial shear interaction

UNIT III DESIGN OF COMPOSITE MEMBERS
Design of composite beams, slabs, columns, beam – columns - design of composite trusses.

UNIT IV COMPOSITE BOX GIRDER BRIDGES
Introduction - behaviour of box girder bridges - design concepts.

UNIT V CASE STUDIES
Case studies on steel - concrete composite construction in buildings - seismic behaviour of composite structures.

OUTCOMES:
At the end of this course students will be in a position to design composite beams, columns, trusses and box-girder bridges including the related connections.
They will get exposure on case studies related to steel-concrete constructions of buildings.

REFERENCES:
1. Johnson R.P., "Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings", Vol.I, Blackwell Scientific Publications, 2004.
2. Oehlers D.J. and Bradford M.A., "Composite Steel and Concrete Structural Members, Fundamental behaviour", Pergamon press, Oxford, 1995.
3. Owens.G.W and Knowles.P, "Steel Designers Manual", Steel Concrete Institute(UK), Oxford Blackwell Scientific Publications, 1992.

313SEPT03 INDUSTRIAL STRUCTURES

OBJECTIVES:
To study the requirements, planning and design of Industrial structures**.**

UNIT I PLANNING AND FUNCTIONAL REQUIREMENTS
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
Steel and RCC - Gantry Girder, Crane Girders - Design of Corbels and Nibs – Design of Staircase.

UNIT III POWER PLANT STRUCTURES
Types of power plants – Containment structures - Cooling Towers - Bunkers and Silos - Pipe supporting structures

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

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

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.

313SEPT04 NONLINEAR ANALYSIS OF STRUCTURES

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

UNIT I INTRODUCTION TO NONLINEAR ANALYSIS
Material nonlinearity, geometric nonlinearity; statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

UNIT II INELASTIC ANALYSIS OF FLEXURAL MEMBERS
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
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
Elastic and inelastic analysis of uniform and variable thickness plates

UNIT V NONLINEAR VIBRATION AND INSTABILITY
Nonlinear vibration and Instabilities of elastically supported beams.

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.

313SEPT05 PREFABRICATED STRUCTURES

OBJECTIVES:
To Study the design principles, analysis and design of elements**.**

UNIT I DESIGN PRINCIPLES
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
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
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
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
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 hyperprefabricated shells, Erection and jointing, joint design, hand book based design.

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 Mokk, 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.
4. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland Betor Verlag, 2009.
5. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row, 1990.

313SEPT06 THEORY OF PLATES

OBJECTIVES:
To study the behaviour and analysis of thin plates and the behaviour of anisotropic and thick plates.

UNIT I INTRODUCTION TO PLATES THEORY
Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT II RECTANGULAR PLATES
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
Symmetrical bending of circular plates.

UNIT IV SPECIAL AND APPROXIMATE METHODS.
Energy methods, Finite difference and Finite element methods.

UNIT V ANISOTROPIC PLATES AND THICK PLATES 9
Orthotropic plates and grids, moderately thick plates.

OUTCOMES:
At the end of this course students will be able to analyze different types of plates (rectangular and circular) under different boundary connections by various classical methods and approximate methods.
They will also know behavior of orthotropic and thick plates and grids.

REFERENCES:

1. Ansel C.Ugural, ”Stresses in plate and shells”, McGraw Hill International Edition, 1999.
2. Bairagi, “Plate Analysis”, Khanna Publishers, 1996.
3. Chandrashekahara, K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2001.
4. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
5. Szilard, R., “Theory and Analysis of Plates – classical and numerical methods, Prentice Hall Inc., 2004.
6. Timoshenko.S.P, and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, New York, 2003.

313SEPT07 STABILITY OF STRUCTURES

OBJECTIVES:
To study the concept of buckling and analysis of structural elements.

UNIT I BUCKLING OF COLUMNS
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
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.

UNIT III TORSIONAL AND LATERAL BUCKLING
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.

UNIT IV BUCKLING OF PLATES
Governing differential equation - Buckling of thin plates, various edge conditions -Analysis by equilibrium and energy approach – Finite difference method.

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

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.

Registrar