PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare students to excel in research and to succeed in Structural engineering profession through global, rigorous post graduate education

II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve structural engineering problems

III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems

IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate structural engineering issues to broader social context.

V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

PROGRAMME OUTCOMES (POs):
On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.
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# M.E. Structural Engineering

**Regulations – 2017**

**Choice Based Credit System**

**Curricula and Syllabi**

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## SEMESTER II
### ELECTIVE III & IV

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## SEMESTER III
### ELECTIVE V & VI

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## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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OBJECTIVES:

- The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering. This course covers a broad spectrum of mathematical techniques such as Laplace Transform, Fourier Transform, Calculus of Variations, Conformal Mapping and Tensor Analysis. Application of these topics to the solution of problems in physics and engineering is stressed.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS


UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS


UNIT III CALCULUS OF VARIATIONS

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 – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS


UNIT V TENSOR ANALYSIS


TOTAL: 60 PERIODS

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems.
- Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields.
REFERENCES:

ST5101 ADVANCED CONCRETE STRUCTURES

OBJECTIVE:
- 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
- To make the students 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. interaction curve generation for axial force and bending

UNIT II DESIGN OF SPECIAL RC ELEMENTS

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 BEAMS AND COLUMNS
Inelastic behaviour of concrete beams and Baker’s method, moment - rotation curves,ductility definitions, evaluation

UNIT V DUCTILE DETAILING

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.

TOTAL: 45 PERIODS
REFERENCES:

ST5102 DYNAMICS OF STRUCTURES

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

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, applications-examples related to structural engineering

UNIT II 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, response spectrum method, Applications.

UNIT IV DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS

UNIT V DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE

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:
ST5103  THEORY OF ELASTICITY AND PLASTICITY  L T P C  3 0 0 3

OBJECTIVE:
- To understand the concept of 3D stress, strain analysis and its applications.

UNIT I  ELASTICITY  9

UNIT II  2D STRESS STRAIN PROBLEMS  9
Plane stress and plane strain - Simple two dimensional problems in Cartesian and Polar Co-ordinates.

UNIT III  TORSION OF NON-CIRCULAR SECTION  9
St.Venant’s approach - Prandtl’s approach – Membrane analogy - Torsion of Thin Walled- Open and Closed sections-Design approach to open web section subjected to torsion

UNIT IV  BEAMS ON ELASTIC FOUNDATIONS  9

UNIT V  PLASTICITY  9

TOTAL: 45 PERIODS

OUTCOME:
- 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 will also have sufficient knowledge in various theories of failure and plasticity.

REFERENCES:

ST5201  ADVANCED STEEL STRUCTURES  L T P C  3 0 0 3

OBJECTIVE:
- 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

UNIT III ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS
Analysis and design of different types of trusses – Analysis and design of industrial buildings – Sway and non sway frames – Aseismic design of steel buildings.

UNIT IV PLASTIC ANALYSIS OF STRUCTURES

UNIT V DESIGN OF LIGHT GAUGE STEEL STRUCTURES

TOTAL: 45 PERIODS

OUTCOME:
- 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:

ST5202 STABILITY OF STRUCTURES L T P C
3 0 0 3

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

UNIT I BUCKLING OF COLUMNS
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.

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:
1963.

ST5203 EXPERIMENTAL TECHNIQUES

OBJECTIVE:
• 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 – Long-
term 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 –
UNIT III DISTRESS MEASUREMENTS AND CONTROL 9

UNIT IV NON DESTRUCTIVE TESTING METHODS 9

UNIT V MODEL ANALYSIS 9

TOTAL : 45 PERIODS

OUTCOME:
• 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:

ST5204 FINITE ELEMENT ANALYSIS OF STRUCTURES L T P C 3 0 0 3

OBJECTIVE :
• To study the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems.

UNIT I INTRODUCTION 9
Approximate solutions of boundary value problems - Methods of weighted residuals, approximate solution using variational method, Modified Galerkin method, Boundary conditions and general comments-continuity, compatibility, convergence aspects.
Basic finite element concepts - Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method.

UNIT II APPLICATION : AXIAL DEFORMATION OF BARS, AXIAL SPRING ELEMENT. 9
UNIT III  ANALYSIS OF FRAMED STRUCTURES  9

UNIT IV  PLATES AND SHELLS  9
Introduction to Plate Bending Problems - Finite Element Analysis of Thin Plate -Finite Element Analysis of Thick Plate -Finite Element Analysis of Skew Plate - Introduction to Finite Strip Method -Finite Element Analysis of Shell.

UNIT V  APPLICATIONS  9

TOTAL : 45 PERIODS

OUTCOME:
- On completion of this course, the students will know the concept of finite element analysis and enable to analyze framed structure, Plate and Shells and modify using recent softwares.

REFERENCES:

ST5211  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 Response 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. Non-Destructive Test on concrete
   i) Rebound hammer and ii) Ultrasonic Pulse Velocity Tester.

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

TOTAL: 60 PERIODS

OUTCOME:
- 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:

ST5212 PRACTICAL TRAINING I (2 Weeks) L T P C
0 0 0 1

OBJECTIVE:
- 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 Industries during the summer vacation for a specified period of two 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.
OBJECTIVE:

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

UNIT I  EARTHQUAKE 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

UNIT IV  EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES  9

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

OUTCOME:

- 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:
ST5311 PRACTICAL TRAINING II (2 Weeks) L T P C 0 0 0 1

OBJECTIVE:
- 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 Industries during the summer vacation for a specified period of two 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.

ST5312 SEMINAR L T P C 0 0 2 1

OBJECTIVE:
- 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.

ST5313 PROJECT WORK (PHASE I) L T P C 0 0 1 2 6

OBJECTIVE:
- 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.

ST5411 PRACTICAL TRAINING III (2 Weeks) L T P C
0 0 0 1

OBJECTIVE:
• 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 Industries during the summer vacation for a specified period of two 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.

ST5412 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.
OBJECTIVE:

- 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 – Thermal and Shrinkage cracks – unequal loading – Vegetation and trees –
Chemical action – Foundation movements – Remedial measures - 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 – Membrane treated roofs - Leakage of Concrete
slabs – Dampness in solid walls – condensation – hygroscopic salts – remedial treatments – Ferro
cement overlap – 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 – Materials and 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 substructures – under pinning – Enhancing 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:

3. Denison Campbell, Allen and Harold Roper, “Concrete Structures, Materials, Maintenance
Rand D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
OBJECTIVE:
- 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

OUTCOME:
- 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:
ST5003 OFFSHORE STRUCTURES

OBJECTIVE:
- 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 - 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 pipelines.

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:

ST5004 MATRIX METHODS FOR STRUCTURAL ANALYSIS

OBJECTIVES:
- To study the concepts, characteristics and transformation of structures using matrix approach

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 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 CHARACTERSTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY

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

TOTAL : 45 PERIODS

OUTCOMES:
• On completion of this course students will be able to use matrix approach for solving structural engineering problems
• Students will have a thorough understanding of both flexibility and stiffness approach of analysis.

REFERENCE S:

ST5005 THE THEORY OF PLATES

OBJECTIVE:
• 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  9
Rectangular plates. Simply supported rectangular plates, Navier solution and Levy’s method, Rectangular plates with various edge conditions, plates on elastic foundation. Moody’s chart (for analysis of plates with various boundary conditions/loading)

UNIT III  CIRCULAR PLATES  9
Symmetrical bending of circular plates.

UNIT IV  SPECIAL AND APPROXIMATE METHODS.  9
Energy methods, Finite difference and Finite element methods.

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

OUTCOME:
- 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:

ST5006  MECHANICS OF COMPOSITE MATERIALS  L T P C  3 0 0 3

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

UNIT I  INTRODUCTION  9
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  9
Concepts in solid mechanics, Hooke’s law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses

UNIT III  ANALYSIS OF LAMINATED COMPOSITES  9
UNIT IV  FAILURE AND FRACTURE OF COMPOSITES  9
Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT V  APPLICATIONS AND DESIGN  9
Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues

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

REFERENCES:

ST5007  ANALYSIS AND DESIGN OF TALL BUILDINGS  L T P C
3 0 0 3

OBJECTIVE:
• 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 ISSUES  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

OUTCOME:
- 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:

ST5008  INDUSTRIAL STRUCTURES  L T P C 3 0 0 3

OBJECTIVE:
- To study the requirements, planning and design of Industrial structures.

UNIT I  PLANNING AND FUNCTIONAL REQUIREMENTS  9

UNIT II  INDUSTRIAL BUILDINGS  9
Steel and RCC - Gantry Girder, Crane Girders - Design of Corbels and Nibs – Design of Staircase.

UNIT III  POWER PLANT STRUCTURES  9
Types of power plants – Containment structures - Cooling Towers - Bunkers and Silos - Pipe supporting structures

UNIT IV  TRANSMISSION LINE STRUCTURES AND CHIMNEYS  9
Analysis and design of steel monopoles, transmission line towers – Sag and Tension calculations, Methods of tower testing – Design of self supporting and guyed chimney, Design of Chimney bases.

UNIT V  FOUNDATION  9

TOTAL: 45 PERIODS
OUTCOME:

- 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:


ST5009 PRESTRESSED CONCRETE

OBJECTIVE:

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

UNIT I PRINCIPLES OF PRESTRESSING

Basic concepts of Prestressing - Types and systems of prestressing - Need for High Strength materials, Analysis methods, losses of prestress – Short and Long term deflections – Cable layouts.

UNIT II DESIGN OF FLEXURAL MEMBERS

Behaviour of flexural members, determination of ultimate flexural strength – Various Codal provisions - Design of flexural members, Design for shear, bond and torsion. Transfer of prestress – Box girders.

UNIT III DESIGN OF CONTINUOUS AND CANTILEVER BEAMS

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

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, flag masts and similar structures.

UNIT V DESIGN OF COMPOSITE MEMBERS

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

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course students will have sufficient knowledge on various methods of prestressing and the concepts of partial pre-stressing.
- They will be in a position to design beams, pipes, water tanks, posts and similar structures.

REFERENCES:


ST5010 WIND AND CYCLONE EFFECTS ON STRUCTURES L T P C

3 0 0 3

OBJECTIVE:

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

UNIT I INTRODUCTION 9

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

UNIT V CYCLONE EFFECTS 9

TOTAL: 45 PERIODS

OUTCOME:

- 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:

ST5011  NONLINEAR ANALYSIS OF STRUCTURES  L T P C
3 0 0 3

OBJECTIVE:
- 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 bar systems 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 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 flexural 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.

OUTCOME:
- 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:

ST5012  DESIGN OF SUB STRUCTURES  L T P C
3 0 0 3

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

UNIT I  SHALLOW FOUNDATIONS  9
UNIT II     PILE FOUNDATIONS  9

UNIT III     WELL FOUNDATIONS  9

UNIT IV     MACHINE FOUNDATIONS  9

UNIT V     SPECIAL FOUNDATIONS  9

TOTAL: 45 PERIODS

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

REFERENCES:

ST5013     OPTIMIZATION OF STRUCTURES  L T P C
                      3 0 0 3

OBJECTIVE:
• To study the optimization methodologies applied to structural engineering

UNIT I     BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES  9
UNIT II LINEAR AND NON-LINEAR PROGRAMMING 9

UNIT III GEOMETRIC PROGRAMMING 9
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:

ST5014 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES L T P C 3 0 0 3

OBJECTIVE:
• To develop an understanding of the behaviour and design concrete composite elements and structures.

UNIT I INTRODUCTION 9
Introduction to steel - concrete composite construction – Codes – Composite action – Serviceability and Construction issues in design.
UNIT II DESIGN OF COMPOSITE MEMBERS
Design of composite beams, slabs, columns, beam – columns - Design of composite trusses.

UNIT III DESIGN OF CONNECTIONS

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.

TOTAL: 45 PERIODS

OUTCOME:
• 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:

ST5015 DESIGN OF BRIDGES L T P C
3 0 0 3

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

UNIT I GENERAL INTRODUCTION AND 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 LONG SPAN RC BRIDGES
Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges.

UNIT III PRESTRESSED CONCRETE BRIDGES

UNIT IV STEEL BRIDGES
UNIT V BEARINGS AND SUBSTRUCTURES 9

TOTAL: 45 PERIODS

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:

ST5016 DESIGN OF SHELL AND SPATIAL STRUCTURES L T P C 3 0 0 3

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

UNIT I CLASSIFICATION OF SHELLS 9
Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31. application to design of shell roofs of water tanks(membrane analyses)

UNIT II FOLDED PLATES 9
Folded Plate structures, structural behaviour, types, design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT III INTRODUCTION TO SPACE FRAME 9
Space frames - configuration - types of nodes - Design Philosophy - Behaviour.

UNIT IV ANALYSIS AND DESIGN 9
Analysis of space frames – Design of Nodes – Pipes - Space frames – Introduction to Computer Aided Design.

UNIT V SPECIAL METHODS 9
Application of Formex Algebra, FORMIAN for generation of configuration.

TOTAL: 45 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:

ST5017 COMPUTER AIDED ANALYSIS AND DESIGN

OBJECTIVES:
- To learn the principles of computer graphics, structural analysis, structural design, Finite Element Analysis, Optimization and Artificial Intelligence supported by software tools.

THEORY

UNIT I COMPUTER GRAPHICS

UNIT II STRUCTURAL ANALYSIS

UNIT III STRUCTURAL DESIGN

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

PRACTICAL

LIST OF EXERCISES
1. 2-D Frame Modelling and Analysis.
2. 3 – D Frame Modelling and Analysis.
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 elements using FEA software.
8. Eigen Value Buckling analysis using FEA software.

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

- On completion of this course students will be familiar and will have sufficient knowledge on the concepts and working principle of various structural engineering softwares

REFERENCES: