M. Tech.

IN

STRUCTURAL ENGINEERING

CURRICULUM AND SYLLABUS

(with effect from AY 2022-2023 onwards)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI – 620 015

TAMIL NADU, INDIA
VISION AND MISSION OF THE INSTITUTE

Vision of the Institute

To be a University globally trusted for technical excellence where learning and research integrate to sustain society and industry.

Mission of the Institute

- To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
- To create a converging learning environment to serve a dynamically evolving society.
- To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
- To be an intellectual ecosystem where human capabilities can develop holistically.

VISION AND MISSION OF THE DEPARTMENT

Vision of the Department

Shaping infrastructure development with societal focus.

Mission of the Department

Achieve International Recognition by:

- Developing Professional Civil Engineers
- Offering Continuing Education
- Interacting with Industry with emphasis on R&D
CURRICULUM

The total minimum credits for completing the M. Tech. Programme in Structural Engineering is 66.

### SEMESTER I

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MA624</td>
<td>Applied Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>CE651</td>
<td>Theory of Elasticity and Plasticity</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>CE653</td>
<td>Structural Dynamics</td>
<td>3</td>
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<tr>
<td>4.</td>
<td>CE653</td>
<td>Elective 1</td>
<td>3</td>
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<td>5.</td>
<td>CE653</td>
<td>Elective 2</td>
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<td>6.</td>
<td>CE653</td>
<td>Elective 3</td>
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<td>CE659</td>
<td>Structural Engineering Laboratory</td>
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<td><strong>TOTAL</strong></td>
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### SEMESTER II

<table>
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<tbody>
<tr>
<td>1.</td>
<td>CE652</td>
<td>Advanced Reinforced Concrete Design</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CE654</td>
<td>Finite Element Analysis of Structural Members</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>CE656</td>
<td>Advanced Design of Metal Structures</td>
<td>3</td>
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<tr>
<td>4.</td>
<td>CE656</td>
<td>Elective 4</td>
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<tr>
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<td>CE656</td>
<td>Elective 5</td>
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<td>CE656</td>
<td>Elective 6</td>
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<td>7.</td>
<td>CE660</td>
<td>Structural Design &amp; Computation Laboratory</td>
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<td><strong>TOTAL</strong></td>
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## SUMMER TERM

<table>
<thead>
<tr>
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<th>Course Title</th>
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<tbody>
<tr>
<td>1.</td>
<td></td>
<td>Practical Training/Industrial Internship (4 Weeks)</td>
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## SEMESTER III

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<tr>
<td>CE697</td>
<td>Project Work Phase-I</td>
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## SEMESTER IV

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<tbody>
<tr>
<td>CE698</td>
<td>Project Work Phase-II</td>
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<td><strong>TOTAL</strong></td>
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## LIST OF ELECTIVES

<table>
<thead>
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<tbody>
<tr>
<td>1.</td>
<td>CE661</td>
<td>Matrix Methods of Structural Analysis</td>
<td>3</td>
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<tr>
<td>2.</td>
<td>CE662</td>
<td>Stochastic Processes in Structural Mechanics</td>
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<tr>
<td>3.</td>
<td>CE663</td>
<td>Random Vibrations and Structural Reliability</td>
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<tr>
<td>4.</td>
<td>CE664</td>
<td>Fracture Mechanics</td>
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<td>CE665</td>
<td>Structural Optimization</td>
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<td>CE666</td>
<td>Failure Analysis of Structures</td>
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<td>7.</td>
<td>CE667</td>
<td>Stability of Structures</td>
<td>3</td>
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<tr>
<td>8.</td>
<td>CE668</td>
<td>Theory of Plates and Shells</td>
<td>3</td>
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<tr>
<td>9.</td>
<td>CE669</td>
<td>Advanced Steel and Concrete Composite Structures</td>
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<tr>
<td>10.</td>
<td>CE670</td>
<td>Seismic Design of Structures</td>
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## LIST OF OPEN ELECTIVES

<table>
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<tbody>
<tr>
<td>1.</td>
<td>CE668</td>
<td>Theory of Plates and Shells</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>CE680</td>
<td>Advanced Concrete Technology</td>
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<tr>
<td>3.</td>
<td>CE683</td>
<td>Design of Bridges</td>
<td>3</td>
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</tbody>
</table>
Course Code : MA624
Course Title : Applied Mathematics
Number of Credits : 4
Course Type : Core

Course Learning Objectives
1. To develop students with knowledge in Laplace and Fourier transform.
2. To familiarize the students in the field of differential equations to solve boundary value problems associated with engineering applications.
3. To expose the students to calculus of variation, conformal mappings and tensor analysis.
4. To familiarize students in the field of bilinear transformations.
5. To expose students to the concept of vector analysis.

Course Content
Vector spaces and subspaces, solution of linear systems, Linear independence, basis, and dimension, The four fundamental subspaces, Linear transformations, Orthogonal vectors and subspaces, Cosines and projections onto lines, Projections and least squares, The fast Fourier transform, Eigenvalues and eigenvectors, Diagonalization of a matrix, Difference equations and powers of matrices, Similarity transformations.

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


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

Reference Books


Course outcomes

At the end of the course student will be able

1. To solve boundary value problems using Laplace and Fourier transform techniques.
2. To solve fluid flow and heat flow problems using conformal mapping.
3. To develop the mathematical methods of applied mathematics and mathematical physics with an emphasis on calculus of variation and integral transforms.
4. To apply vector calculus in linear approximations, optimization, physics and engineering.
5. To solve physical problems such as elasticity, fluid mechanics and general relativity.
Course Code : CE651
Course Title : Theory of Elasticity and Plasticity
Number of Credits : 4
Course Type : Core

Course Learning Objectives
1. To make students understand the principles of elasticity and plasticity.
2. To familiarize students with basic equations of elasticity.
3. To expose students to two dimensional problems in Cartesian and polar coordinates.
4. To make students understand the principle of torsion of prismatic bars.
5. To familiarize students with the concepts of plasticity and yield criteria.

Course Content
Basic concepts of deformation of bodies – deformation gradient- Tensor notations of stress and strain in 3D field - Traction - Engineering and Cauchy stress and Green-Lagrange Strains - Cauchy form of equilibrium equation - Transformation of stress and strain in a 3D field - Equilibrium equations in 2D and 3D Cartesian coordinates

Compatibility equations - Stresses: Principal, Octahedral, Hydrostatic and deviatoric - Derivation of Constitutive law - reduction to isotropic and uniaxial case

Plane stress and plane strain problems - 2D problems in Cartesian coordinates as applied to beam bending using Airy's stress function - Problems in 2D - Polar coordinate - Equations of equilibrium and compatibility - stress concentration in holes - Circular disc subjected to diametral compressive loading - semi-infinite solid subjected to different types of loads. Thin and thick cylinders under internal pressure.

Torsion of sections - St. Venant's theory – Torsion of elliptical sections - Torsion of triangular sections - Prandtl's membrane analogy- Warping Torsion of rolled profiles - Torsion of thin-walled tubes


Reference Books
3. Chen and Han, Plasticity for Structural Engineers, Springer Verlag, 1998.

**Course outcomes**

At the end of the course student will be able

1. To apply elastic analysis to study the fracture mechanics.
2. To apply linear elasticity in the design and analysis of structures such as beams, plates, shells and sandwich composites.
3. To apply hyper-elasticity to determine the response of elastomer-based objects.
4. To analyse the structural sections subjected to torsion.
5. To understand various theories of failure and concept of plasticity.
Course Code : CE653
Course Title : Structural Dynamics
Number of Credits : 3
Course Type : Core

Course Learning Objectives
1. To introduce the concepts of dynamic loading and to study the dynamic response of SDOF, MDOF and continuous systems subjected to different types of dynamic loads.
2. To learn free and forced vibration response of structural systems.
3. To familiarize students with mathematical models representing real time problems of discrete and continuous vibratory systems.
4. To make students understand the principle of virtual displacements.
5. To expose students to the concept of resonance.

Course Content
Introduction to Dynamic analysis - Elements of vibratory systems and simple Harmonic Motion - Mathematical models of SDOF systems - Principle of Virtual displacements - Evaluation of damping resonance.

Fourier series expression for loading - (blast or earthquake) - Duhamel’s integral - Numerical methods - Expression for generalized system properties - vibration analysis - Rayleigh’s method - Rayleigh-Ritz method.

Evaluation of structural property matrices - Natural vibration - Solution of the Eigen value problem - Iteration due to Holzer and Stodola.

Idealization of multi-storeyed frames - analysis to blast loading - Deterministic analysis of earthquake response - lumped SDOF system.

Differential equation of motion - Beam flexure including shear deformation and rotatory inertia - Vibration analysis using finite element method for beams and frames.

Reference Books
Course outcomes

At the end of the course student will be able

1. To analyse structures subjected to blast loading and apply finite element method.
2. To analyse structures using various methods of vibration analysis.
3. To use structural property matrices to study structural behaviour.
4. To arrive at solution to Eigen value problem and idealize multi storied frames.
5. To perform deterministic analysis for earthquake response.


Course Code : CE652  
Course Title : Advanced Reinforced Concrete Design  
Number of Credits : 3  
Course Type : Core

Course Learning Objectives
1. To provide better understanding on theoretical background of RC structural elements under axial, bending and combined forces.
2. To understand 1D and 2D structural sections.
3. To familiarize with analytical tools such as yield line theory.
4. To get exposed to behaviour of concrete and steel.
5. To understand the failure criteria of concrete.

Course Content

Behaviour of slender RCC Columns- Failure modes and Interaction Curves- Additional Moment Method-Comparison of codal provisions- calculation of design moments for braced and unbraced columns-Principles of Moment magnification method-design of slender columns – Design of Tension member.

Yield line theory of slabs - Hillerberg method of design of slabs- Design of Flat slabs and flat plates -Shear in Flat Slabs and Flat Plates. Approximate analysis and design of Grid floors.


Reference Books
Course outcomes
At the end of the course student will be able
1. To understand structural behaviour of flexural members.
2. To compute deflection of flexural members.
3. To understand redistribution of moments.
4. To design compression members.
5. To understand the concept of shear and torsion.
Course Code : CE654
Course Title : Finite Element Analysis of Structural Members
Number of Credits : 4
Course Type : Core

Course Learning Objectives
1. To study the energy principles, finite element concept, stress analysis, meshing, nonlinear problems and applications.
2. To arrive at approximate solutions to finite element problems.
3. To perform finite element analysis on one dimensional and two dimensional problems.
4. To familiarize students with isoparametric element components.
5. To apply equilibrium equations, strain displacement relation, linear constitutive relation in practical problems.

Course Content
Direct stiffness method - Special characteristics of stiffness matrix - Assemblage of elements - Boundary condition and reaction - Analysis of framed Structures - 2D truss element - 2D beam element - Gauss elimination and LDLT decomposition - Basic steps in finite element analysis.

Differential equilibrium equations - strain displacement relation - linear constitutive relation - special cases - Principle of stationary potential energy - application to finite element methods. Some numerical techniques in finite element analysis.


Two dimensional isoparametric elements - Four noded quadrilateral elements - triangular elements - Computation of stiffness matrix for isoparametric elements numerical integration (Gauss quadrature) - Convergence criteria for isoparametric elements.
Analysis of plate bending: Basic theory of plate bending - displacement functions - plate bending Elements. Plane stress and plane strain analysis: Triangular elements - Rectangular elements

Reference Books

**Course outcomes**
At the end of the course student will be able

1. To use displacement models to solve practical problems in structural engineering.
2. To apply numerical techniques of finite element analysis to solve real time problems.
3. To make use of shape function and interpolation function to study structural behaviour.
4. To apply linear and quadratic elements in the finite element analysis of various types of structures.
5. To predict structural behaviour using strain displacement matrix and element stiffness matrix.
Course Code : CE656
Course Title : Advanced Design of Metal Structures
Number of Credits : 3
Course Type : Core

Course Learning Objectives
1. To compute wind load on structures and deflection of beams.
2. To understand design of stacks.
3. To get familiarized with cold formed steel sections and different types of connections.
4. To get exposed to design of compression and tension members.
5. To design members subjected to torsion and understand plastic analysis of structures.

Course Content
Steel metallurgy – mechanical properties – section classification - limit state method of design for structural steel – plastic analysis and design

Estimation of loads – structural systems for multi-story and industrial buildings - moment resisting frame, concentrically and eccentrically braced frame – pre-engineered building systems – moment resisting connections

Composite construction – shear connector – behaviour and design of steel concrete composite slabs, beams and columns

Fatigue behaviour and design – S-N curve approach – design category classification – design for variable repeated loading - fatigue assessment

Cold formed steel design – buckling and post-buckling behaviour of members – effective width method and direct strength method for design of cold-formed steel beams, columns, beam-columns

Reference Books
Course outcomes

At the end of the course student will be able

1. To compute wind load on structures and determine deflection of beams.
2. To understand design of stacks.
3. To get familiarized with cold formed steel sections and different types of connections.
4. To get exposed to design of compression and tension members.
5. To design members subjected to torsion and understand plastic analysis of structures.
Course Code : CE659
Course Title : Structural Engineering Laboratory
Number of Credits : 2
Course Type : Laboratory

Course Learning Objectives
1. To study the properties of concrete.
2. To learn the method of concrete mix design as per ACI and IS code and to get exposure to special concrete.
3. To carry out strength tests and non-destructive tests on concrete.
4. To investigate the structural behaviour of RC beams and measure strain.
5. To assess the dynamic behaviour of structural components.

Course Content
Properties of concrete ingredients – concrete mix design ACI/ IS method for M45 to M60 grade (IS), up to M80 grade (ACI), Design of Special Concrete like FRC, SCC, HPC - strength tests on concrete – Non-destructive tests on concrete. Use of various types of strain gauges - Mechanical and Electrical strain gauges – Specimen preparation and testing of R.C. beams and study of their behaviour.

Experiments on dynamic analysis - Assessment of the mode shapes and frequencies of Demo MDOF system - Assessment of the behaviour of structure under non-harmonic load - Assessment of the mode shape of cantilever beam - Assessment of the mode shape of simply supported beam.

Reference Books
Course outcomes
At the end of the course student will be able

1. To arrive at concrete mix design for various types of concrete as per codal provisions.
2. To be familiar with the properties of concrete and perform non-destruction testing on concrete.
3. To cast and test structural RC elements for strength and deformation behaviour.
4. To carry out dynamic testing on structural components.
5. To assess the behaviour of structures subjected to static cyclic load testing.
Course Code : CE660
Course Title : Structural Design & Computation Laboratory
Number of Credits : 2
Course Type : Laboratory

Course Learning Objectives
1. To learn the principles of computer graphics and application packages, optimization and artificial intelligence.
2. To expose students to computer aided drafting.
3. To familiarize students with 2D objects in drawing and enable them to prepare plan, elevation and sectional drawings.
4. To expose students to 3D modelling.
5. To apprise students with DBMS concepts.

Course Content
Module 1: Analysis, design and drafting with commercial software: (3 D modelling – RCC & STEEL)

(a) Modelling and analysis - applying known concepts of structural components, codal provisions for loads and dimensioning, analysis procedures etc.
(b) Design using software or manual design using spreadsheets software or Macros
(c) Drafting / detailing using commercial CAD software.
(Different groups may be assigned different buildings/structures)

Module 2: Programming for structural engineering using MATLAB or any programming language choice of student. Exercises include, but not limited to: Solution using Newton-Raphson method, Gauss elimination, Gauss-Jordan method, Linear Regression, Curve fitting by Polynomial Regression, Eigen value extraction by power method etc.

Module 3: Finite Element software fundamentals - modelling, analysis and postprocessing of simple planar, wire and shell models – introduction to different types of meshes, elements, analysis steps etc.

Reference Books

Course outcomes
At the end of the course student will be able
1. To work on spreadsheets and worksheets.
2. To understand regression and matrix inversion concepts.
3. To arrive at C programs to solve problems using numerical techniques.
4. To use computer methods of structural analysis to solve structural problems.
5. To work on finite element programming to solve real time problems.
**Course Code**: CE661  
**Course Title**: Matrix Methods of Structural Analysis  
**Number of Credits**: 3  
**Course Type**: Elective

### Course Learning Objectives

1. To introduce the classical, matrix and finite element methods of structural analysis.
2. To make students understand structural behaviour.
3. To enable students to analyse determinate and indeterminate structures.
4. To familiarize students with displacement method.
5. To expose students to analysis of substructures.

### Course Content

Generalized measurements - Degrees of freedom - Constrained measurements - Behavior of structures - Principle of superposition - Stiffness and flexibility matrices in single, two and n-co-ordinates - structures with constrained measurements.

Stiffness and flexibility matrices from strain energy - Betti’s law and its applications - Determinate and indeterminate structures - Transformation of element matrices to system matrices - Transformation of system vectors to element vectors.

Flexibility method applied to statically determinate and indeterminate structures – Choice of redundant - Transformation of redundant - Internal forces due to thermal expansion and lack of fit.
Stiffness method - Internal forces due to thermal expansion and lack of fit - Application to symmetrical structures - Comparison between stiffness and flexibility methods.

Analysis of substructures using the stiffness method and flexibility method with tridiagonalization - Analysis by Iteration method - frames with prismatic members - non-prismatic members.

### Reference Books


Course outcomes
At the end of the course student will be able

1. To understand energy concepts in structures, characteristics of structures, transformation of information in structures.
2. To perform analysis by iteration method and determine deflection of structures using Maxwell-Betti Law of Reciprocal Deflections.
3. To understand generalized and constrained measurements.
4. To apply principle of superposition in practical problems.
5. To understand fundamental relationships for structural analysis and develop analytical models.
Course Code : CE662
Course Title : Stochastic Processes in Structural Mechanics
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand the basic concept of random variables and its extension to stochastic processes.
2. To know the modelling of natural phenomena through random processes.
3. To learn probability distribution of a random variable.
4. To understand the concept of multiple random variables.
5. To familiarize students with covariance, conditional mean and variance.

Course Content
Basic Theory of Random variables - Probability distribution of a random variable, multiple random variables, main descriptors of a random variable – Moments, expectation, covariance, correlation, conditional mean and variance. Functions of random variables, moments of functions of random variables.


Properties of Random Processes - Level crossing peaks, Fractional occupation time, Envelopes, First-Passage time, Maximum value of a Random Process in a time interval.


Reference Books
Course outcomes
At the end of the course student will be able
1. To understand basic theory of stochastic processes and its relevance in the realistic modeling of natural phenomena.
2. To understand the basic theory of random variables, multiple random variables and random processes.
3. To be familiar with probability distribution of a random variable.
4. To be familiar with covariance, conditional mean and variance.
5. To understand the concept of Fourier analysis and data processing.
Course Code : CE663
Course Title : Random Vibrations and Structural Reliability
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. Identify sources of uncertainty in solid mechanics problems.
2. Develop probabilistic models or input/system parameter uncertainty.
3. Compute the reliability index for structural systems.
4. Compute bounds on effective properties for heterogeneous materials.
5. Compute statistics of response of random dynamical systems.

Course Content

Reference Books

Course outcomes
At the end of the course student will be able
1. To get an understanding of the various methods of reliability assessments and its application as well as importance.
2. To apply the knowledge of the application of reliability study in various fields of structural engineering and its relevance.
3. To understand various methods and techniques as well as provisions in reliability assessment.
4. To assess partial safety factors by FORM analysis.
5. To use crude Monte-Carlo Simulation technique to solve practical problems.
Course Code : CE664
Course Title : Fracture Mechanics
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand the concept of fracture mechanics.
2. To get exposed to method of stress analysis.
3. To understand failure mechanisms.
4. To understand design methods.
5. To understand stress intensity factor.

Course Content

Test Methods for fracture analysis, Case studies and discussions.

Reference Books

Course outcomes
At the end of the course student will be able
1. To understand fracture toughness and fracture energy.
2. To be familiar with energy release rate.
3. To get exposed to the concept of crack mouth opening displacement.
4. To understand fracture mechanics of concrete.
5. To be familiar with linear and nonlinear fracture mechanics.
Course Code : CE665

Course Title : Structural Optimization

Number of Credits : 3

Course Type : Elective

Course Learning Objectives

1. The objective of this course is to introduce the concepts of design optimization and review major conventional and modern optimization methods used in structural optimization applications.

2. To understand the formulation of structural optimization problems.

3. To get familiarized with the application of linear and non-linear programming to structural optimization.

4. To get exposed to unconstrained and constrained optimization.

5. To understand direct and indirect methods, direct search and gradient methods.

Course Content


Optimality criteria based methods, Reanalysis techniques - Approximation concepts - Design sensitivity, Optimization of sections, steel and concrete structures - framed structures, bridge structures.


Artificial Intelligence and Artificial Neural Networks based approaches for structural optimization problems.
Reference Books


Course outcomes

At the end of the course student will be able

1. To use the optimization tools for the design of structures effectively.
2. To understand the concept of optimality criteria and reanalysis techniques.
3. To use approximation concepts and stochastic optimization methods.
4. To be familiar with genetic algorithm and simulated annealing.
5. To be able to work in artificial intelligence and artificial neural networks.
**Course Code**: CE666  
**Course Title**: Failure Analysis of Structures  
**Number of Credits**: 3  
**Course Type**: Elective

**Course Learning Objectives**
1. To understand the causes of failure, failure modes and mechanism.
2. To know how engineering materials and components fail.
3. To understand the concept of design and manufacturing integrity.
4. To understand material selection procedure based on requirement.
5. To get exposed to legal problems in failure of structures.

**Course Content**


Macro micro level failures – component and sub-system failures - failure theories – analytical models – cases and type of problem in components – safety evaluation.


**Reference Books**
Course outcomes
At the end of the course student will be able
1. To identify the objective of study of fracture mechanics.
2. To model linear elastic fracture mechanics.
3. To simulate actual failure analysis problems in site.
4. To understand repair and maintenance of structures and product liability issues.
5. To analyse and design structures for failure prevention.
Course Code : CE667  
Course Title : Stability of Structures  
Number of Credits : 3  
Course Type : Elective

Course Learning Objectives
1. This course deals with stability problems in structural forms and systems.
2. It also takes care of special consideration for stability during design of structural elements.
3. It also aims for studying the buckling and analysis of structural elements.
4. To study the stability analysis problems in column, beam and beam-column.
5. To make students understand the phenomenon of buckling of frames and plates.

Course Content

Buckling of columns – Euler column – second order and fourth order equation method – Rayleigh-Ritz and numerical methods – Axially loaded column – Eccentrically loaded column – inelastic buckling

Buckling of frames – braced and unbraced frames – slope deflection equations, matrix method – effective length – alignment charts

Torsional and flexural-torsional buckling – torsion of thin walled open cross-section – flexural-torsional buckling of columns – lateral-torsional buckling of beams and beam-columns

Buckling of plates – Differential equation of plate buckling – critical load on plates for various boundary conditions – Energy method – Finite difference method

Reference Books
Course outcomes
At the end of the course student will be able
1. To understand stability of static and dynamic equilibrium.
2. To evaluate static stability criteria using stability equations.
3. To solve stability problems by energy method and finite difference method.
4. To predict critical loads on structures.
5. To create discrete and continuous models to solve stability problems.
**Course Code** : CE668  
**Course Title** : Theory of Plates and Shells  
**Number of Credits** : 3  
**Course Type** : Elective

### Course Learning Objectives
1. To introduce the concept of plate theory.
2. To study the behaviour and analysis of thin plates.
3. To study the procedure for rectangular plates and circular plates subjected to lateral loads.
4. To study the classification and behaviour of shells.
5. To study the membrane analysis of shells.

### Course Content
Thin plates with small deflection; assumptions - Long plates in cylindrical bending, strain energy in rectangular plates - governing differential equations (Kirchhoff Plate) and various boundary conditions.

Simply supported rectangular plates - Navier solution with various types of loads, rectangular plates with various boundary conditions - Navier's method for patch/point loads - Levy's method, Axisymmetric circular plates

Demonstration of numerical methods such as Rayleigh, Galerkin and Kantorovich methods.

Approximate analysis of Grids (Rankine-Grashoff) – Analysis of Folded Plates by Winter-Pei distribution

Overview on Orthotropic plates – Overview on Large deflection of plates and mid-plane stretching (Foppl- von Karman plate) – Overview on Mindlin Reissner Theory

Stability of rectangular plates fundamentals - some edge conditions- design applications such as section classification and simple postcritical method

Shells: structural behavior, classification, translational and rotational shells- hyperbolic paraboloid- elliptic paraboloid- Gaussian curvature - Overviews on Shell theories such as Higher order theories, Marguerre theory, DKJ Theory etc

Membrane theory of shells- cylindrical shells- shells of revolution including design
Reference Books


Course outcomes

At the end of the course student will be able

1. To assess the strength of thin plates under different types of loads.
2. To analyze thin plates using Navier’s method and Levy’s method.
3. Analyse circular plates under axi-symmetric deflection.
4. To classify different types of shells and study their behavior.
5. To analyze shells using membrane theory.
**Course Code**: CE669  
**Course Title**: Advanced Steel And Concrete Composite Structures  
**Number of Credits**: 3  
**Course Type**: Elective

### Course Learning Objectives

1. To introduce students to steel-concrete composite structures and types of shear connectors.
2. To make students understand analysis and design of composite beams and deflection of composite beams.
3. To make students be familiar with composite slabs, analysis and design of composite floor systems.
4. To get students exposed to types of composite columns.
5. To make students learn vibration of composite beams and cyclic behaviour of composite sections.

### Course Content


Introduction – Composite slabs – profiled sheeting – sheeting parallel to span – sheeting perpendicular to span – analysis and design of composite floor system.

Types of Composite columns – design of encased columns – design of in-filled columns – axial, uni-axial and bi-axially loaded columns.

Temperature – shrinkage and creep – vibration of composite beams – Cyclic behavior of composite section – case studies.

### Reference Books


Course outcomes
At the end of the course student will be able
1. To understand steel-concrete composite structures and types of shear connectors.
2. To understand analysis and design of composite beams and deflection of composite beams.
3. To be familiar with composite slabs, analysis and design of composite floor systems.
4. To get exposed to types of composite columns.
5. To learn vibration of composite beams and cyclic behaviour of composite sections.
Course Code : CE670
Course Title : Seismic Design of Structures
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To introduce the basics of earthquake engineering and how they influence the structural design.
2. To aim at introducing engineering seismology and building characteristics.
3. To make students understand structural irregularities, do's and don’ts in earthquake engineering design, code provision on different types of structures.
4. To make students be familiar with structural modelling and lateral load resisting design.
5. To make students get exposed to strength, stiffness and ductility requirements and energy dissipation devices.

Course Content

Provision of seismic code (IS1893, IS 13920) - Ductile Detailing – Building systems – frames – shear wall – braced frames – layout design of Moment Resisting Frames (MRF) – Design of Masonry structures

Cyclic loading behaviour of RCC and Steel elements (Damage Models) - base isolation – Energy dissipating devices – case studies.

Performance Based Seismic Design - Seismic performance evaluation of structural and non-structural components and systems.

Reference Books
Course outcomes
At the end of the course student will be able
1. To understand the basics of earthquake engineering and how they influence the structural design.
2. To understand engineering seismology and building characteristics.
3. To learn structural irregularities, do’s and don'ts in earthquake engineering design, code provision on different types of structures.
4. To be familiar with structural modelling and lateral load resisting design.
5. To get exposed to strength, stiffness and ductility requirements and energy dissipation devices.
**Course Code**: CE671

**Course Title**: Prefabricated Structures

**Number of Credits**: 3

**Course Type**: Elective

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**Course Learning Objectives**

1. To introduce prefabrication and its types.
2. To make students know the different types of prefabrication systems.
3. To make students learn different structural connections.
4. To make students exposed to erection of RC structures.
5. To make students familiarize with designing and detailing of prefabricated units.

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**Course Content**

Types of prefabrication, prefabrication systems and structural schemes - Disuniting of structures - Structural behavior of precast structures.

Handling and erection stresses - Application of pre-stressing of roof members; floor systems, two way load bearing slabs, Wall panels, hipped plate and shell structures.

Dimensioning and detailing of joints for different structural connections; construction and expansion joints.

Production, Transportation and erection - Shuttering and mould design - Dimensional tolerances - Erection of R.C. Structures, Total prefabricated buildings.

Designing and detailing prefabricated units for 1) industrial structures 2) Multistorey buildings and 3) Water tanks, silos bunkers etc., 4) Application of pre-stressed concrete in prefabrication.

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**Reference Books**

Course outcomes
At the end of the course student will be able
1. To get introduced to prefabrication and its types.
2. To know the different types of prefabrication systems.
3. To learn different structural connections.
4. To be exposed to erection of RC structures.
5. To be familiar with designing and detailing of prefabricated units.
Course Code : CE672  
Course Title : Smart Structures and Applications  
Number of Credits : 3  
Course Type : Elective

Course Learning Objectives
1. To introduce passive and active systems.
2. To familiarize students with components of smart systems.
3. To make students exposed to different types of smart materials.
4. To make students understand control systems.
5. To introduce the methods and techniques for developing and designing multifunctional structures.

Course Content
Introduction to passive and active systems – need for active systems – smart systems – definitions and implications - active control and adaptive control systems – examples.

Components of smart systems – system features and interpretation of sensor data – proactive and reactive systems – demo example in component level – system level complexity.


Reference Books
Course outcomes
At the end of the course student will be able
1. To understand the concept of passive and active systems.
2. To be familiar with components of smart systems.
3. To be exposed to different types of smart materials.
4. To better understand control systems.
5. To be familiar with the methods and techniques for developing and designing multifunctional structures.
**Course Learning Objectives**

1. To develop an understanding of the philosophy of pre-stressing design.
2. To study the design of indeterminate pre-stressed concrete structures.
3. To have a better understanding about the connections for pre-stressed concrete elements.
4. To design pre-stressed concrete bridges.
5. To study the design of pre-stressed concrete pipes and tanks.

**Contents**

Introduction – Important concepts of pre-stressing – Systems for Pre-stressing – The philosophy of design - Time dependent deformation of concrete and losses of pre-stress.

Flexural design of pre-stressed concrete elements – Shear, torsion and bond – Indeterminate pre-stressed concrete structures – Camber, deflection and crack control.

Pre-stressed concrete compression and tension members – Two way pre-stressed concrete floor systems – Connections for pre-stressed concrete elements.

Design of pre-stressed concrete bridges incorporating with long-term effects like creep, shrinkage, relaxation and temperature effects.

Circular prestressing- Design of Prestressed Concrete Pipes and water tanks.

**References**

Course outcomes
At the end of the course student will be able to
1. Ensure the design philosophy of prestressing
2. Design the flexural members due to shear, torsion, bond by incorporating the prestress losses.
3. Design the connections for compression and tension prestressing elements and floor systems.
4. Design the prestressed concrete girder bridges by incorporating the long-term effects
5. Design the prestressed concrete pipes and tanks
### Course Code
| CE674 |

### Course Title
- Analysis and Design of Tall Buildings

### Number of Credits
- 3

### Course Type
- Elective

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#### Course Learning Objectives

1. To introduce design philosophy, loading, different types of frames, types of shear walls.
2. To expose students to different lateral load resisting systems.
3. To make students understand approximate analysis, accurate analysis and reduction techniques.
4. To familiarize students with design of structural elements, buckling analysis, pdelta analysis.
5. To make students understand translational – torsional instability.

#### Course Content

- Design philosophy – Loading - Sequential loading, materials.

- High risk behavior, rigid frames, braced frames, in filled frames; shear walls, coupled shear walls, wall – frames, tubulars, cores, outrigger - braced and hybrid mega system.

- Approximate Analysis, Accurate Analysis and Reduction Techniques - Analysis of building for member forces - drift and twist - Computerized general three dimensional analysis.

- Structural elements - design, deflection, cracking, pre-stressing, shear flow - Design for differential movements, creep and shrinkage effects, temperature effects and fire.

- Overall buckling analysis of frames, wall – frames – second order effects of gravity loading – simultaneous first order and P-delta analysis, Translational - torsional instability, out of plumb effects.

#### Reference Books


Course outcomes
At the end of the course student will be able
1. To understand the design philosophy, loading, different types of frames, types of shear walls.
2. To be exposed to different lateral load resisting systems.
3. To understand approximate analysis, accurate analysis and reduction techniques.
4. To be familiar with design of structural elements, buckling analysis, p-delta analysis.
5. To understand translational – torsional instability.
Course Code : CE675
Course Title : Structures in Disaster Prone Areas
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To introduce earthquake resistant design, cyclone resistant design, flood resistant design, by laws.
2. To make students be familiar with traditional and modern structures, response of different structures to multi hazard, different types of foundation, ground improvement techniques.
3. To make students understand various methods of strengthening, strengthening of different structures exposed to multi hazard.
4. To make students get exposed to testing and evaluation of structures, classification of structures, qualification test, modern materials – disaster reduction.
5. To make students learn modern analysis, design and construction techniques, optimization for performance, damage survey, improve hazard resistance.

Course Content
Philosophy for design to resist Earthquake, Cyclone and flood – By-laws of urban and Semi-Urban areas - Traditional and modern structures.


Methods of strengthening for different disasters – Qualification test.

Use of modern materials, their impact on disaster reduction – Use of modern analysis, design and construction techniques, optimization for performance.

Damage surveys – Maintenance and modifications to improve hazard resistance – Different types of foundation and its impact on safety – Ground improvement techniques.

Reference Books

Course outcomes
At the end of the course student will be able
1. To understand earthquake resistant design, cyclone resistant design, flood resistant design, by laws.
2. To be familiar with traditional and modern structures, response of different structures to multi hazard, different types of foundation, ground improvement techniques.
3. To understand various methods of strengthening, strengthening of different structures exposed to multi hazard.
4. To be exposed to testing and evaluation of structures, classification of structures, qualification test, modern materials for disaster reduction.
5. To get to learn modern analysis, design and construction techniques, optimization for performance, damage survey, improve hazard resistance.
Course Code : CE676
Course Title : Design of Boiler Structures
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To introduce boiler structures, types of boilers.
2. To make students learn structural components of boilers, design and construction of boilers.
3. To make students understand safety monitoring and operation, drum lifting structure.
4. To familiarize students with design loads, foundation analysis.
5. To expose students to platform structure.

Course Content
Type of boilers: Top supported - Utility boilers - Tower type - Two pass system - Once through boiler - Bottom supported - Industrial boilers - Bi drum Layout configuration - Front mill layout - Rear mill layout - Side mill layout - column configuration for 210MW-250MW-500MW and lower capacity boilers.


- hanger spring - hopper truss work - goose neck truss work - wind box truss work - expansion measurement instrument.

Reference Books


Course outcomes

At the end of the course student will be able

1. To understand boiler structures, types of boilers.
2. To learn structural components of boilers, design and construction of boilers.
3. To understand safety monitoring and operation, drum lifting structure.
4. To be familiar with design loads, foundation analysis.
5. To be exposed to platform structure.
Course Code : CE677
Course Title : Structures for Power Plants
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To introduce power plant structure, different types of power plants.
2. To make students understand planning, analysis and design of power plants.
3. To make students be familiar with analysis and design of chimneys, cooling towers.
4. To make students exposed to analysis and design of turbo generator foundation.
5. To make students understand the components of intake towers, storage structures.

Course Content
Planning, Analysis and design of different types of power plants - Chimneys, Induced draught and Natural draught cooling towers, Turbo generator Foundation, Material handling structures, Intake towers, storage structures and other supporting structures for equipment.

Reference Books

Course outcomes
At the end of the course student will be able
1. To understand power plant structure, different types of power plants.
2. To understand planning, analysis and design of power plants.
3. To be familiar with the analysis and design of chimneys, cooling towers.
4. To be exposed to analysis and design of turbo generator foundation.
5. To understand the components of intake towers, storage structures.
Course Code : CE678
Course Title : Forensic Engineering and Rehabilitation of Structures
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand the causes of failure of structures.
2. To enable students to diagnose distress of structures.
3. To make students understand various environmental problems and natural hazards.
4. To expose students to modern techniques of retrofitting.
5. To familiarize students with case studies.

Course Content


Case studies – buildings - heritage buildings - high rise buildings - water tanks – bridges and other structures.

Reference Books


**Course outcomes**

At the end of the course student will be able

1. To understand the causes of failure of structures.
2. To diagnose distress of structures.
3. To understand various environmental problems and natural hazards.
4. To be exposed to modern techniques of retrofitting.
5. To be familiar with case studies.
Course Code : CE679
Course Title : Soil Structure Interaction
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To make students understand soil foundation interaction and its importance.
2. To familiarize students with model analysis, Winkler model for soil structure interaction analysis.
3. To expose students to beams and plates on elastic foundation.
4. To enable students to carry out elastic analysis of pile, soil-pile interaction analysis, dynamic soil-pile interaction.
5. To make students understand the concepts of laterally loaded pile.

Course Content


Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

Reference Books

Course outcomes
At the end of the course student will be able
1. To understand soil foundation interaction and its importance.
2. To be familiar with model analysis, Winkler model for soil structure interaction analysis.
3. To be exposed to beams and plates on elastic foundation.
4. To carry out elastic analysis of pile, soil-pile interaction analysis, dynamic soil-pile interaction.
5. To better understand the concepts of laterally loaded pile.
Course Code : CE680
Course Title : Advanced Concrete Technology
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To make students understand concrete admixtures, non-destructive testing, semi-destructive testing, special concrete.
2. To familiarize students with structure of hydrated cement paste, types of cement, cement production quality control.
3. To make students learn transition zone in concrete, measurement of workability, properties of concrete, concrete mix design.
4. To expose students to strength porosity relationship, failure modes in concrete, elastic behaviour in concrete.
5. To make students understand causes of concrete deterioration, permeability of concrete, durability of concrete, alkali aggregation reaction.

Course Content
Introduction to concrete – Mineral and chemical admixtures – Structure of hydrated cement paste – Calcium Aluminate Cement – Cement Production quality control
Transition zone in concrete – measurement of workability by quantitative empirical methods – concrete properties: setting and hardening.

Concrete Design mix for higher grades.

Strength-Porosity relationship – Failure modes in concrete – plastic and thermal cracking – maturity concept to estimate curing duration - Elastic behavior in concrete-
Creep, shrinkage and thermal properties of concrete.


Reference Books


**Course outcomes**

At the end of the course student will be able

1. To understand concrete technology, admixtures, non-destructive testing, semi-destructive testing, special concrete.

2. To be familiar with structure of hydrated cement paste, types of cement, cement production quality control.

3. To learn transition zone in concrete, measurement of workability, properties of concrete, rheological behaviour of concrete, economic concrete mix design.

4. To be exposed to strength-porosity relationship, failure modes in concrete, elastic behaviour in concrete, ageing properties and long term behaviour.

5. To better understand the causes of concrete deterioration, permeability of concrete, durability of concrete, alkali aggregation reaction.
Course Code : CE681
Course Title : Special Concrete
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand High Performance Concrete (HPC), fresh and hardened properties of HPC, mix design of HPC.
2. To understand the properties of Ultra HPC, Special HPC.
3. To familiarize students in reactive powder concrete, bio-concrete and geopolymer concrete.
4. To understand the concept of Self Compacting Concrete (SCC), mix design of SCC and properties of SCC.
5. To expose students to better understanding of durability and serviceability conditions of HPC and SCC.

Course Content
High Performance Concrete (HPC) - Introduction – Principles of HPC – Ingredients used for HPC – Production of HPC – Curing of HPC – Mechanism of HPC – Properties of HPC during the fresh and hardened state.


Self-Compacting Concrete - Introduction – Principles of SCC – Ingredients used for SCC – Mix design methods – Production and curing of SCC – Behavior of SCC under fresh and hardened state. Various Case Histories on HPC and SCC.

Reference Books

Course outcomes
At the end of the course student will be able
1. To select an apt concrete for specialized construction viz. in high-rise buildings, arches, shells, long-span bridges, containment structures etc.
2. To get a thorough knowledge in the sequence of concreting techniques under different conditions.
3. To understand High Performance Concrete (HPC), fresh and hardened properties of HPC, mix design of HPC, properties of Ultra HPC, Special HPC.
4. To be familiar in reactive powder concrete, bio-concrete and geo-polymer concrete.
5. To understand the concept of Self Compacting Concrete (SCC), mix design of SCC and properties of SCC, durability and serviceability conditions of HPC and SCC.
Course Code : CE682
Course Title : Hydraulic Structures
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand preliminary investigations for hydraulic structures.
2. To understand geological and hydrological investigations for hydraulic structures.
3. To get exposed to analysis and design of dams.
4. To familiarize students with construction of dams and foundation for dams.
5. To learn design of weirs on permeable foundation.

Course Content
Investigation and Planning - Preliminary investigations and preparation of reports, Layout of projects, Geological and hydrological investigations.

Analysis and Design of Dams - Earthen Dam and Gravity Dam.

Analysis and Design of Arch Dam, Infiltration Gallery, Collector wells.

Construction of Dams - Masonry, Concrete and Earthen Dams, Foundation for Dams-Principles of Foundation treatment, grouting methods.

Design of Weirs on Permeable foundation - Creep theory, Potential theory, Flownets, design of weirs - Khosla's theory.

Reference Books
2. Kushalani, K. B., Irrigation (Practice and Design) Vol. III and IV.

Course outcomes
At the end of the course student will be able
1. To carry out investigation and planning of hydraulic structures.
2. To analyse and design different types of dams.
3. To understand construction of different types of dams.
4. To be familiar with foundation treatment for dams.
5. To design weirs on permeable foundation.
Course Code : CE683
Course Title : Design of Bridges
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To learn the components of bridges, classification of bridges, importance of bridges.
2. To understand the investigation for bridges, subsoil exploration, choice of bridge type.
3. To study the specification of road bridges, loads to be considered.
4. To familiarize students with various types of bridges such as slab-bridge, T-beam bridge, pre-stressed concrete bridge, continuous bridge, arch bridge, box girder bridge decks.
5. To get exposure to evaluation of sub structures, type of foundations, importance of bearings, lessons from bridge failures.

Course Content
Components of Bridges – Classification – Importance of Bridges – Investigation for Bridges – Selection of Bridge site – Economical span – Location of piers and abutments – Subsoil exploration – Scour depth – Traffic projection – Choice of bridge type.


General design considerations – Slab Bridge – Design of T-beam bridge – Prestressed concrete bridge – continuous bridge – Arch Bridge – Box girder bridge decks.

Evaluation of sub structures – Pier and abutments caps – Design of pier – Abutments – Type of foundations.


Reference Books

**Course outcomes**
At the end of the course student will be able
1. To be familiar with the components of bridges, classification of bridges, importance of bridges.
2. To understand the investigation for bridges, subsoil exploration, choice of bridge type.
3. To understand the specification of road bridges, loads to be considered.
4. To be familiar with various types of bridges such as slab-bridge, T-beam bridge, pre-stressed concrete bridge, continuous bridge, arch bridge, box girder bridge decks.
5. To get exposed to evaluation of sub structures, type of foundations, importance of bearings, lessons from bridge failures.
Course Code : CE684
Course Title : Health, Safety and Environmental Management (HSE) Practices
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand safety, health and environmental management.
2. To be familiar with hazard classification and assessment, hazard evaluation and hazard control, environmental issues and management.
3. To get exposed to accidents modeling, accident investigation and reporting, concepts of HAZOP and PHA.
4. To be familiar with safety measures in design and process operations.
5. To get exposed to risk assessment and management, principles and methods.

Course Content
Introduction to safety, health and environmental management - Basic terms and their definitions - Importance of safety - safety assurance and assessment - safety in design and operation - organizing for safety.

Hazard classification and assessment - hazard evaluation and hazard control.

Environmental issues and Management - atmospheric pollution - flaring and fugitive release - water pollution - Environmental monitoring - environmental management.

Accidents modeling - release modeling - fire and explosion modeling - toxic release and dispersion modeling - accident investigation and reporting - concepts of HAZOP and PHA.

Safety measures in design and process operations - inerting, explosion, fire prevention, sprinkler systems.


Reference Books


**Course outcomes**

At the end of the course student will be able

1. To understand safety, health and environmental management.

2. To be familiar with hazard classification and assessment, hazard evaluation and hazard control, environmental issues and management.

3. To get exposed to accidents modelling, accident investigation and reporting, concepts of HAZOP and PHA.

4. To be familiar with safety measures in design and process operations.

5. To get exposed to risk assessment and management, principles and methods.
Course Code : CE685
Course Title : Design of Offshore Structures
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To understand the demand for coastal and offshore structures, overview of different types of ocean structures.
2. To get exposed to structural geometry, analysis methods, design techniques, construction practice, different types of material, guidelines associated with selection of materials for marine environment.
3. To learn various types of structural systems/forms, brief overview of various environmental loads.
4. To be familiar with the problems associated with the material behavior in marine environment and various protection methods.
5. To understand the inspection and testing methods, repair and rehabilitation processes.

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

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

Different types of offshore structures, foundation modelling, fixed jacket platform structural modelling.

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

Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipelines.

Reference Books
Course outcomes
At the end of the course student will be able
1. To understand different types of ocean structures, different structural systems of ocean structures and types of environmental loads.
2. To be familiar with structural action of ocean structures, planning guidelines and design principles and regulations and codes of practice.
3. To understand the concepts of foundation of ocean structures, sea bed anchors, dredging methods and equipment.
4. To get exposed to materials for marine applications, deterioration of materials, inspection and testing of marine structures.
5. To be familiar with non-destructive techniques, repair and rehabilitation of marine structures and structural health monitoring of marine structures.
Course Code : CE686

Course Title : Non-Linear Analysis

Number of Credits : 3

Course Type : Elective

Course Learning Objectives
1. To provide an understanding of the nonlinear behaviour of structures
2. To study the methods for analysing nonlinear response of framed structures
3. To study the Basic equations for continuum; Beams, plates and shells
4. To study the Analytical and discrete numerical solution techniques
5. To learn the Applications of finite element method

Course content
Geometrical and material non-linear problems; Basic equations for continuum; Beams, plates and shells, Analytical and discrete numerical solution techniques; Applications of finite element method.

Reference Books

Course outcomes
At the end of the course, student will be able to
1. Analyse the Frames including the Material nonlinearity
2. Analyse the Frames including the Geometry nonlinearity
3. Analyse frames using the elastic-plastic approach
4. Analyse frames using numerical solution techniques
5. Apply the Finite element method to solve nonlinear problems
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<tr>
<td>Course Title</td>
<td>Ground Improvement Techniques</td>
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<td>Number of Credits</td>
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**Course Learning Objectives**

1. To understand the engineering properties of soil and problems associated with weak deposit.
2. To understand the need for ground improvements.
3. To study the concept of soil stabilization.
4. To familiarize students in recent ground improvement techniques.
5. To get exposure to soil reinforcement techniques and geo-synthetics.

**Course Content**


Reference Books


Course outcomes

At the end of the course student will be able

1. To understand the engineering properties of soil and problems associated with weak deposit.
2. To understand the need for ground improvements.
3. To be familiar with the concept of soil stabilization.
4. To be familiar in recent ground improvement techniques.
5. To be exposed to soil reinforcement techniques and geo-synthetics.
Course Code : CE816
Course Title : Analysis of Deep Foundation
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To gain familiarity with different types of foundation, deep foundation and its importance, design of deep foundations.
2. To explain how pile classification is done based on its functions and how to estimate pile capacity based on static and dynamic approach as per codes.
3. To explain how to select soil design parameters for pile capacity analysis and role of geotechnical investigation in the pile capacity analysis.
4. To explain pile group failures under varies conditions and the importance of group action in pile group capacity.
5. To explain how lateral pile capacity analysis is done under various pile failure mode.

Course Content
Functions and requisites of a foundation - Different types - Choice of foundation type – Types of deep foundation – Types of pile foundations - Factor governing choice of type of pile – Choice of pile materials.

Load carrying capacity of piles by static formulae - Introduction: IS code method - API method - Piles in cohesive and cohesionless soils – Piles in layered cohesive and cohesionless soils – Settlement of single pile – Piles bearing on rock – Piles in fill and Negative skin friction.

Load carrying capacity of piles by dynamic formulae: Introduction - Pile driving formulae - selection of pile hammers - Determination of temporary elastic compression - Driving stresses in piles - Field measurement - Wave equation analysis.


Reference Books


Course outcomes

At the end of the course student will be able

1. To select appropriate foundation type based on available soil conditions.
2. To determine the load carrying capacity of pile foundation.
3. To gain thorough knowledge about the design of pile foundations.
4. To understand the importance of deep foundation in civil engineering construction field and they could able to select appropriate pile system based on the site conditions.
5. To do pile capacity (static, dynamic, lateral and group capacity) analysis as per code and they will understand the complete physics of pile and pile group failure mode under various circumstances.
Course Code : HM712
Course Title : Human Resource Management
Number of Credits : 3
Course Type : Elective

Course Learning Objectives
1. To introduce human resource management and its importance.
2. To understand human relations concepts and human resources accounting.
3. To understand the efficiency and effectiveness of the human resources in an industrial organization.
4. To get exposure to job design and performance appraisal methods.
5. To familiarize students in human resource planning and industrial relations.

Course Content


Reference Books

Course outcomes
At the end of the course student will be able
1. To understand human resource management and its importance.
2. To understand human relations concepts and human resources accounting.
3. To understand the efficiency and effectiveness of the human resources in an industrial organization.
4. To get exposure to job design and performance appraisal methods.
5. To be familiar in human resource planning and industrial relations.