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**ADITYA INSTITUTE OF TECHNOLOGY**

**AND MANAGEMENT (AITAM)**

**AR-16**

**M.TECH**

**(STRUCTURAL ENGINEERING SYLLABUS)**

**DEPT. OF CIVIL ENGINEERING**

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| **M.Tech (STRUCTURAL ENGINEERING) - I Semester** | | | | | | | |
| **S. No.** | **Codes** | **Theory / Labs** | **L** | **P** | **C** | **Marks** | |
| **Int** | **Ext** |
| **1** | **16MSE1001** | Advanced Mathematics | 4 |  | 3 | 40 | 60 |
| **2** | **16MSE1002** | Theory of Elasticity and Plasticity | 4 |  | 3 | 40 | 60 |
| **3** | **16MSE1003** | Matrix Analysis of Structures | 4 |  | 3 | 40 | 60 |
| **4** | **16MSE1004** | Theory of Plates and Shells | 4 |  | 3 | 40 | 60 |
| **5** |  | Elective –I |  |  |  |  |  |
|  | **16MSE1005** | a) Experimental Stress Analysis | 4 |  | 3 | 40 | 60 |
|  | **16MSE1006** | b) Foundation Engineering |
|  | **16MSE1007** | c) Optimization in Structural Design. |
| **6** |  | Elective – II |  |  |  |  |  |
|  | **16MSE1008** | a) Advanced Concrete Technology | 4 |  | 3 | 40 | 60 |
|  | **16MSE1009** | b) Offshore structures |
|  | **16MSE1010** | c) Plastic Analysis and Design |
| **7** | **16MSE1101** | Advanced Concrete Lab |  | 4 | 2 | 40 | 60 |
| Total | | | | | 20 | 280 | 420 |

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| **M.Tech (STRUCTURAL ENGINEERING - II Semester** | | | | | | | |
| **S. No.** | **codes** | **Theory / Labs** | **L** | **P** | **C** | **Marks** | |
| **INT** | **EXT** |
| **1** | **16MSE1011** | Finite Element Method in Structural Engineering | 4 |  | 3 | 40 | 60 |
| **2** | **16MSE1012** | Computer Applications and CAD | 4 |  | 3 | 40 | 60 |
| **3** | **16MSE1013** | Stability of Structures | 4 |  | 3 | 40 | 60 |
| **4** | **16MSE1014** | Structural Dynamics and Earthquake Resistant Design. | 4 |  | 3 | 40 | 60 |
| **5** |  | Elective - III |  |  |  |  |  |
|  | **16MSE1015** | a) Pre-stressed Concrete | 4 |  | 3 | 40 | 60 |
| **16MSE1016** | b) Composite Materials. |
| **16MSE1017** | c) Fracture Mechanics |
| **6** |  | Elective – IV |  |  |  |  |  |
|  | **16MSE1018** | 1. a) Industrial steel structures | 4 |  | 3 | 40 | 60 |
| **16MSE1019** | 1. b) Bridge Engineering |
| **16MSE1020** | 1. c) Design of substructures |
| **7** | **16MSE1102** | CAD Lab |  | 4 | 2 | 40 | 60 |
| Total | | | | | 20 | 280 | 420 |

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| **M.Tech (STRUCTURAL ENGINEERING) - III Semester** | | | | | | | |
| **S. No.** | **codes** | **Theory / Labs** | **L** | **P** | **C** | **Marks** | |
| **INT** | **EXT** |
| **1** | **16MSE2201** | Technical Seminar | - | - | 2 | 100 | - |
| **2** | **16MSE2202** | Project work phase - 1 | - | - | 18 | - | - |
| Total | | | | | 20 |  |  |

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| **M.Tech (STRUCTURAL ENGINEERING) - IV Semester** | | | | | | | |
| **S. No.** | **codes** | **Theory / Labs** | **L** | **P** | **C** | **Marks** | |
| **INT** | **EXT** |
| **1** | **16MSE2203** | Project work phase - 2 | - | - | 20 | - | - |
| Total | | | | | 20 |  |  |

**ADVANCED MATHEMATICS**

**(For CIVIL Branch)**

**Subject Code: 16MSE1001 External Marks: 60**

**Course: M.Tech Ist Year I Semester. Credits: 4 Internal Marks: 40**

**COURSE OBJECTIVES:**

* To study the process of solving and identifying a One-dimensional Heat equation, two-dimensional, three-dimensional Laplace Equation in Cartesian and polar coordinates.
* To calculate Numerical solutions of Heat and Laplace Equations in Cartesian coordinates using finite differences.
* To Estimate point estimation, interval estimation for large and small samples.
* To Test the hypothesis for large and small samples
* To understand regression, correlation concepts and fitting a curve using method of Least squares and acquire knowledge of multiple, partial correlation and regression Coefficients, tests of significance, F-test for regression and multiple correlation coefficients.
* To solve boundary value and eigen value problems by different methods.

**COURSE OUTCOMES:**

**On completion of this course, student should be able to:**

* Solve One-dimensional Heat equation, two-dimensional, three-dimensional Laplace Equation in Cartesian and polar coordinates.
* Estimate Numerical solutions to Heat and Laplace Equations in Cartesian coordinates using different methods.
* Estimate point estimation, interval estimation for large and small samples.
* Test the hypothesis for large and small samples.
* Estimate regression, correlation coefficients for a given data, fit a curve to a given data using method of least squares. And Calculate partial regression coefficients, identify suitable test of significance for a given problem and perform analysis of variance for a given data.
* Evaluate boundary value and eigen value problems by Shooting method, Finite difference method, Polynomial method and Power method.

**UNIT-I**

Applied partial differential equations

Solution by separation of variables- One dimensional Heat equation, Laplace equation in two-dimension- Cartesian and polar coordinates. Laplace equation in three dimension- Cartesian, spherical and cylindrical coordinates( problems having axis-symmetry).

**UNIT-II**

Numerical solutions of partial differential equations

Numerical Solution -Laplace equation by Gauss seidal, Jacobi and SOR Method- Poisson’s equation by Gauss Seidal Method- Heat equation by Bender Schmidt recurrence relation, Crank and Nicolson Method and Iterative methods.

**UNIT-III**

Theroy of Estimation

Introduction to Population-sample-parameter-statistic-sampling distribution of a statistic-standard error. Point estimation, Interval estimation for single mean and difference of means for both small and large sample tests.

**UNIT-IV**

Testing of Hypothesis

Introduction to testing of hypothesis -Large sample tests (mean and proportion tests)-student t-Test(single mean & difference of means)- Chi-Square test for independence of attributes and goodness of fit.

**UNIT-V**

Multivariate Regression Analysis

Multiple – Correlation & Regression, coefficient of determination, Partial-Correlation& Regression –Coefficient. Test of significance- F- test for linear regression and multiple correlation coefficient. Analysis of variance

**UNIT-VI**

Boundary values and eigen value problems

Shooting method, Finite difference method, solving Eigen value problems, Polynomial method and Power method.

**Text Books:**

1. Higher Engineering Mathematics, 42nd edition, 2012 - B. S. Grewal, Khanna Publishers, New Delhi
2. Advanced Engineering Mathematics, 8th edition, 2009, Erwin Kreyszig- Shree Maitrey Printech Pvt.Ltd, Noida.
3. Numerical Methods by E. Balaguru swamy, Tata Mc grewal

**Reference Books:**

1. Basic Statistics – Agerwal, B.L, Wiley 1991, 2ndEdition.
2. Introductory Methods of Numerical Analysis- Sastry, S.S, Prentice-Hall, 2nd Edition, 1992.
3. Solutions of partial differential eqution - Dean G. Duffy, CBS publishers, 1988.
4. Numerical Algorithm – Krishnamurty & Sen, Affiliated East-West Press, 1991, 2nd Edition.
5. Matrices-Ayres,F., TMH-1973.

**THEORY OF ELASTICITY AND PLASTICITY**

**SUBJECT CODE: 16MSE1002**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

* To study Elasticity, Components of Stresses, Strain, Hooke’s Law, Plane Stress and Plane Strain analysis, Differential Equations of equilibrium, Compatibility.
* To study Two Dimensional Problems in Rectangular Co-Ordinates, Solution by polynomials, Saint – Venant’s Principle, Bending of Simple beams – Application of Fourier Series.
* To study Two Dimensional problems in Polar Co-ordinates General Equations in polar Co-ordinates, Pure bending of curved bars, Strain Components, Circular discs, Stresses on plates with circular holes
* To study Analysis of Stress and Strain in Three Dimension Principal Stress, Stress Ellipsoid, Homogeneous Torsion of Prismatic Bars, Membrance Analogy , Torsion of Rectangular Bars
* To study General Theorems: Differential equations of equilibrium, Conditions of Compatibility, equations of Equilibrium in Terms of Displacements, Principle of Superposition theorem.

**COURSE OUTCOMES:**

**Students will get ability**

* To learn Elasticity, Components of Stresses, Strain, Hooke’s Law, Plane Stress and Plane Strain analysis, Differential Equations of equilibrium, Compatibility.
* To learn Two Dimensional Problems in Rectangular Co-Ordinates, Solution by polynomials, Saint – Venant’s Principle, Bending of Simple beams – Application of Fourier Series.
* To learn Two Dimensional problems in Polar Co-ordinates General Equations in polar Co-ordinates, Pure bending of curved bars, Strain Components, Circular discs, Stresses on plates with circular holes
* To learn Analysis of Stress and Strain in Three Dimension Principal Stress, Stress Ellipsoid, Homogeneous Torsion of Prismatic Bars, Membrance Analogy , Torsion of Rectangular Bars
* To learn Theory of plasticity concepts in and plasticity assumption in this theory.

**SYLLABUS:**

1. Elasticity – Notation for Forces and Stresses – Components of Stresses – Components of Strain – Hooke’s Law. Plane Stress and Plane Strain analysis – Plane Stress – Plane strain – Differential Equations of equilibrium – Boundary conditions – Compatibility equations - Stress function – Boundary Conditions.
2. Two Dimensional Problems in Rectangular Co-Ordinates – Solution by polynomials – Saint – Venant’s Principle – Determination of Displacements – Bending of Simple beams – Application of Fourier Series for two dimensional problems for gravity Loading
3. Two Dimensional problems in Polar Co-ordinates General Equations in polar Co-ordinates – Stress Distribution Symmetrical about an axis – Pure bending of curved bars - Strain Components in Polar Co-ordinates – Displacements for Symmetrical stress Distributions – Circular discs- Stresses on plates with circular holes
4. Analysis of Stress and Strain in Three Dimension Principal Stress – Stress Ellipsoid and stress director surface – Determination of Principal stresses Maximum shear stresses – Homogeneous Deformation – Principle Axes of Strain. Torsion of Prismatical Bars – Bars with Elliptical Cross Section – Other elementary Solution – Membrance Analogy – Torsion of Rectangular Bars
5. Theory of plasticity interdiction – Theory of plasticity – concepts and assumption - yield criterions.
6. Torsion: Torsion of straight bars – St.-Venant solution – Stress function, Warp function – Elliptic cross section – Membrane analogy torsion of bar of narrow rectangular cross section

**REFERENCE:**

1. Theory of Elasticity- Timoshenko & Goodier

2. Theory of Elasticity – Sadhu Singh

**MATRIX ANALYSIS OF STRUCTURES**

**SUBJECT CODE: 16MSE1003**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Introduction of matrix methods of analysis, Static Indeterminacy and kinematic indeterminacy, Degree of freedom co-ordinate system, Structure idealization stiffness.
* To study Element stiffness matrix for truss element, beam element and Torsional element, Element force displacement equations Element flexibility matrix, Truss, Beam, frame, Flexibility method.
* To study Stiffness method, member and global stiffness equation, coordinate transformation structure stiffness matrix equation, analysis of simple pin jointed trusses, continuous beams.
* To study Stiffness method, development of grid elemental stiffness matrix, coordinate transformation, idealizing the beam stiffness solutions, curved beam element stiffness matrix.
* To study Multi-storied frames, shear walls necessity, structural behavior of large frames with and without shear wall, approximate methods of analysis of shear walls, tall structures

**COURSE OUTCOMES:**

Students will get ability

* To learn Introduction of matrix methods of analysis, Static Indeterminacy and kinematic indeterminacy, of freedom co-ordinate system, Structure idealization stiffness.
* To learn Element stiffness matrix for truss element, beam element and Torsional element, Element force displacement equations Element flexibility matrix, Truss, Beam, frame, Flexibility method.
* To learn Stiffness method, member and global stiffness equation, coordinate transformation structure stiffness matrix equation, analysis of simple pin jointed trusses, continuous beams.
* To learn Stiffness method, development of grid elemental stiffness matrix, coordinate transformation, idealizing the beam stiffness solutions, curved beam element stiffness matrix.
* To learn Multi-storied frames, shear walls necessity, structural behavior of large frames with and without shear wall, approximate methods of analysis of shear walls, tall structures

**SYLLABUS:**

1. Introduction of matrix methods of analysis – Static Indeterminacy and kinematic indeterminacy – Degree of freedom co-ordinate system – Structure idealization stiffness and flexibility matrices – Suitability
2. Element stiffness matrix for truss element, beam element and Torsional element - element force - displacement equations,
3. Element flexibility matrix – Truss, Beam,and frame – force Displacement equations. Flexibility method
4. Stiffness method – member and global stiffness equation – coordinate transformation and global assembly – structure stiffness matrix equation – analysis of simple pin jointed trusses – continuous beams – rigid jointed plane frames Direct stiffness method for continuous beams and simple frames.
5. Stiffness method – development of grid elemental stiffness matrix – coordinate transformation. Examples of grid problems – tapered and curved beams – idealizing the beam stiffness solutions – curved beam element stiffness matrix.
6. Multi-storied frames – shear walls necessity – structural behavior of large frames with and with out shear wall – approximate methods of analysis of shear walls – tall structures.

**REFERENCES:**

1. Matrix analysis of structures- Robert E Sennet- Prentice Hall- Englewood cliffs-New Jercy
2. Advanced structural analysis-Dr. P. Dayaratnam- Tata McGraw hill publishing company limited.
3. Indeterminate Structural analysis- C K Wang
4. Matrix methods of structural Analysis – Dr. A.S. Meghre& S.K. Deshmukh – Charotar publishing hour.
5. Analysis of tall buildings by force – displacement – Method M.Smolira – Mc. Graw Hill.

**THEORY OF PLATES AND SHELLS**

**SUBJECT CODE: 16MSE1004**

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| --- | --- | --- | --- | --- |
| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Derivation of plate equation for -in plane bending and transverse bending effects, Rectangular Plates.
* Plates under various loading conditions like sinusoidal loading, uniformly distributed load and hydrostatic pressure.
* To study Circular plates, symmetrically loaded, circular plates under various loading conditions, annular plates.
* To study Equations of Equilibrium, Derivation of stress resultants, Principles of membrane theory and bending theory.
* To study Cylindrical Shells, Derivation of the governing DKJ equation for bending theory, details of Schorer’s theory. Application to the analysis and design of short and long shells.
* To study Introduction to the shells of double curvatures: Geometry analysis and design of elliptic Paraboloid, Conoidal and Hyperbolic Paraboloid shapes by membrane theory.

**COURSE OUTCOMES:**

Students will get ability

* To study Derivation of plate equation for -in plane bending and transverse bending effects, Rectangular Plates,
* Plates under various loading conditions like sinusoidal loading, uniformly distributed load and hydrostatic pressure.
* To study Circular plates, symmetrically loaded, circular plates under various loading conditions, annular plates.
* To study Equations of Equilibrium, Derivation of stress resultants, Principles of membrane theory and bending theory.
* To study Cylindrical Shells, Derivation of the governing DKJ equation for bending theory, details of Schorer’s theory. Application to the analysis and design of short and long shells.
* To study Introduction to the shells of double curvatures: Geometry analysis and design of elliptic Paraboloid, Conoidal and Hyperbolic Paraboloid shapes by membrane theory.

**SYLLABUS:**

1. Derivation of plate equation for cylindrical bending of rectangular plates – analysis of UDL rectangular plates with simply supported edges and fixed edges – stain Energy in pure bending.

2. Small Deflection theory thin Rectangular Plates: Plates under various loading conditions

like sinusoidal loading, uniformly distributed load Navier and Levy’s type of solutions for

various boundary conditions and hydrostatic pressure.

1. Circular plates: Symmetrically loaded, circular plates under various loading conditions, Annular plates.
2. Equations of Equilibrium: Derivation of stress resultants, Principles of membrane theory and bending theory.
3. Cylindrical Shells: Derivation of the governing DKJ equation for bending theory, details of Schorer’s theory. Application to the analysis and design of short and long shells. Use of ASCE Manual coefficients for the design.
4. Introduction to the shells of double curvatures: Geometry analysis and design of elliptic Paraboloid, Conoidal and Hyperbolic Paraboloid shapes by membrane theory.

**REFERENCES:**

1. Theory of plates and shells – Timoshenko and Krieger, McGraw-Hill book company, INC, New Yark.
2. A Text Book of Plate Analysis – Bairagi, K, Khanna Publisher, New Delhi.
3. Design and Construction of Concrete Shell Roofs – Ramaswamy, G.S, Mc Graw – Hill, New Yark.

##### EXPERIMENTAL STRESS ANALYSIS

**(Elective I)**

**SUBJECT CODE: 16MSE1005**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

# To study Strain measurement methods Definition of strain and its relation to experimental determinations, properties of strain, Gauge systems – Mechanical, Optical, Acoustic and Pneumatic types.

* To study Analysis of strain gauge data- The three element rectangular rosette, the delta rosette, correction for transverse sensitivity.

## To study Non – destructive testing, Ultrasonic pulse velocity method, Rebound Hardness method, application to assessment of concrete quality.

* To study Brittle coating methods, coating stresses – failure theories – brittle coating crack patterns, types of brittle coatings, test procedures for brittle coating analysis, analysis of brittle coating.
* To study Theory of photo elasticity, temporary double refraction, Index ellipsoid and stress ellipsoid, the stress optic law, effects of stressed model in a polar scope for various arrangements.
* To study Two Dimensional Photo Elasticity, Is chromatic Fringe patterns - Isoclinic fringe patterns, passage of light through plane Polaris cope and circular Polaris cope.

**COURSE OUTCOMES:**

Students will get ability

# To learn Strain measurement methods Definition of strain and its relation to experimental determinations, properties of strain, Gauge systems – Mechanical, Optical, Acoustic and Pneumatic types.

* To learn Analysis of strain gauge data- The three element rectangular rosette, the delta rosette, correction for transverse sensitivity.

## To learn Non – destructive testing, Ultrasonic pulse velocity method, Rebound Hardness method, application to assessment of concrete quality.

* To learn Brittle coating methods, coating stresses – failure theories – brittle coating crack patterns, types of brittle coatings, test procedures for brittle coating analysis, analysis of brittle coating.
* To learn Theory of photo elasticity, temporary double refraction, Index ellipsoid and stress ellipsoid, the stress optic law, effects of stressed model in a polar scope for various arrangements.

**SYLLABUS:**

# Strain measurement methods:

Definition of strain and its relation to experimental determinations - properties of strain – Gauge systems – Mechanical, Optical, Acoustic and Pneumatic types. Electrical resistance strain gages:

Introduction – gauge construction – strain gauge adhesives - mounting methods – gauge sensitivities and gage factor – performance characteristics of wire and foil strain gauges – environmental effects.

1. Analysis of strain gauge data:

Introduction – the three element rectangular rosette – the delta rosette – correction for transverse sensitivity.

## Non – destructive testing:

Introduction – objective of non destructive testing.

Ultrasonic pulse velocity method – Rebound Hardness method (Concrete hammer) – application to assessment of concrete quality.

1. Brittle coating methods:

Introduction – coating stresses – failure theories – brittle coating crack patterns – crack detection – types of brittle coatings – test procedures for brittle coating analysis – calibration procedures – analysis of brittle coating, data interpretation.

1. Theory of photo elasticity:

Introduction – temporary double refraction – Index ellipsoid and stress ellipsoid – the stress optic law – effects of stressed model in a polar scope for various arrangements - fringe sharpening.

1. Two Dimensional Photo Elasticity: Introduction, Is chromatic Fringe patterns - Isoclinic fringe patterns, passage of light through plane Polaris cope and circular Polaris cope, Isoclinic fringe pattern - Compensation techniques - calibration methods, separation methods.

**REFERENCES:**

1. Experimental Stress Analysis- Riley and Dally
2. Experimental Stress Analysis – Lee
3. Experimental Stress Analysis- Sadhu Singh

**FOUNDATION ENGINEERING**

**(Elective – I)**

**SUBJECT CODE: 16MSE1006**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study about soil exploration geo physical methods borings, location spacing and depth of bore holes stabilization of bore holes, various sampling methods, samplers, cleaning of bore holes and boring records.
* To study Shallow Foundations, Bearing capacity, General bearing capacity equation, Meyerhof’s, Hansen’s and Vesic’s bearing capacity factors, bearing capacity of stratified soils.
* To study Types and choice of type, Design considerations including location and depth, Proportioning of shallow foundations, isolated and combined footings and mats, Design procedure for mats.
* To study Pile foundations-Classification of piles-factors influencing choice, sands using static pile formulae- α - β - and λ - methods, Monotonic and cyclic pile load tests, Under reamed piles.
* To study about types and components of well foundations and design approach

**COURSE OUTCOMES:**

Students will get ability

* To learn about soil exploration geo physical methods borings, location spacing and depth of bore holes stabilization of bore holes, various sampling methods, samplers, cleaning of bore holes and boring records.
* To learn Shallow Foundations, Bearing capacity, General bearing capacity equation, Meyerhof’s, Hansen’s and Vesic’s bearing capacity factors, bearing capacity of stratified soils.
* To learn Types and choice of type, Design considerations including location and depth, Proportioning of shallow foundations, isolated and combined footings and mats, Design procedure for mats.
* To learn Pile foundations-Classification of piles-factors influencing choice, sands using static pile formulae- α - β - and λ - methods, Monotonic and cyclic pile load tests, Under reamed piles.
* To get an idea regarding construction and design of well foundations.

**SYLLABUS:**

1. Soil Exploration – Importance, Terminology, and planning - Geophysical methods. Borings, location, spacing and depth, methods of boring including drilling, stabilization of boreholes, boring records. Soil sampling – Methods of sampling -Types of samples and samplers- cleaning of bore holes, preservation, labeling and shipment of samples - Design considerations of open drive samplers.
2. Types and choice of type.Design considerations including location and depth,Settlement and Shear failure criteria.Shallow Foundations –Bearing capacity – General Bearing Capacity equation, Meyerhof’s, Hansen’s and Vesic’s Bearing Capacity factors.Safe Bearing Capacity and allowable bearing pressure. (Ref: IS -2131 & IS 6403).
3. Bearing capacity based on penetration resistance- Isolated and combined footings and mats - Design procedure for mats. Floating foundation- Fundamentals of beams on Elastic foundations. .(Ref: IS -456 & N.B.C. relevant volume)
4. Settlement of shallow foundations, types of settlement,proportioning of Footings.
5. Pile foundations-Classification of piles-factors influencing choice-Load -carrying capacity of single piles in clays and sands using static pile formulae- α - β - and λ - methods –Dynamic pile formulae-limitations- Monotonic and cyclic pile load tests
6. Soil structure interaction, Design approach and suitability criteria of piled raft foundation.Under Reamed piles and Negative Skin Friction.

**REFERENCES:**

1. Principles of Foundation Engineering by Braja M. Das.
2. Soil Mechanics in Engineering Practice by Terzagi and Peck
3. Foundation Design by Wayne C. Teng, John Wiley & Co.,
4. Foundation Analysis and Design by J.E. Bowles McGraw Hill Publishing Co.,
5. Analysis and Design of sub structures by Swami Saran
6. Design Aids in Soil Mechanics and Foundation Engineering by Shanbaga

R. Kaniraj,Tata Mc. Graw Hill.

1. Foundation Design and Construction by MJ Tomlinson – Longman Scientific
2. A short course in Foundation Engineering by Simmons and Menzes – ELBS
3. Foundation Engineering by V.N.S Murthy

# OPTIMIZATION IN STRUCTURAL DESIGN

**(Elective -1)**

**SUBJECT CODE: 16MSE1007**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study, Need and scope for optimization, Historical development, Objective function and its surface design variables, constraints and constraint surface, Classification of optimization problems.
* To study Classical optimization techniques, multi variable optimization by method of constrained variation and Lagrange multipliers, Khun-Tucker conditions of optimality
* To study Fully stressed design and optimality criterion based algorithms of fully stressed design theoretical basis with examples.
* To study Non-Liner programming, Fibonacci, Quadratic and cubic interpolation methods for a one dimensional minimization and univariate method, Powel’s method, Newton’s method, Davidon Fletcher Powell’s method for multivariable optimization, Zoutendjik’s method
* To study Linear programming, Definitions and theorems, Simplex method, Duality in Linear programming, Plastic analysis and Minimum weight design and rigid frame
* To study Introduction to quadratic programming, Geometric programming and Dynamic programming. Design of beams and frame using dynamic programming technique.

**COURSE OUTCOMES:**

Students will get ability

* To learn, Need and scope for optimization, Historical development, Objective function and its surface design variables, constraints and constraint surface, Classification of optimization problems.
* To learn Classical optimization techniques, multi variable optimization by method of constrained variation and Lagrange multipliers, Khun-Tucker conditions of optimality
* To learn Fully stressed design and optimality criterion based algorithms of fully stressed design theoretical basis with examples.
* To learn Non-Liner programming, Fibonacci, Quadratic and cubic interpolation methods for a one dimensional minimization and univariate method, Powel’s method, Newton’s method, Davidon Fletcher Powell’s method for multivariable optimization, Zoutendjik’s method
* To learn Linear programming, Definitions and theorems, Simplex method, Duality in Linear programming, Plastic analysis and Minimum weight design and rigid frame.
* To learn Introduction to quadratic programming, Geometric programming and Dynamic programming. Design of beams and frame using dynamic programming technique.

**SYLLABUS:**

1. Introduction: Need and scope for optimization- Historical development – statements of optimization problems- Objective function and its surface design variables- constraints and constraint surface- Classification of optimization problems (various functions continuous, discontinuous and discrete) and function behavior (monotonic and unimodal)
2. Classical optimization techniques: Differential calculus method, multi variable optimization by method of constrained variation and Lagrange multipliers (generalized problem) Khun-Tucker conditions of optimality
3. Fully stressed design and optimality criterion based algorithms- introduction, characteristics of fully stressed design theoretical basis- examples
4. Non-Liner programming: Unconstrained minimization- Fibonacci, golden search, Quadratic and cubic interpolation methods for a one dimensional minimization and univariate method, Powel’s method, Newton’s method and Davidon Fletcher Powell’s method for multivariable optimization- Constrained minimization- Cutting plane method- Zoutendjik’s method- penalty function methods
5. Linear programming: Definitions and theorems- Simplex method- Duality in Linear programming- Plastic analysis and Minimum weight design and rigid frame .
6. Introduction to quadratic programming, Geometric programming and Dynamic programming. Design of beams and frame using dynamic programming technique.

**REFERENCES:**

1. Optimization Theory and Applications – S.S. Rao, Wiley Eastern Limited, New Delhi
2. Optimum structural design- Theory and applications- R H Gallergher and O C Zienkiewiez

# ADVANCED CONCRETE TECHNOLOGY

**(Elective -II)**

**SUBJECT CODE: 16MSE1008**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Materials- Cement, Aggregates, mixing water soundness of aggregate, Fresh and hardened concrete, Admixtures, types of admixtures, purposes of using admixtures- chemical composition.
* To study Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms, Acoustical emission methods- Corrosion activity measurement, Impact echo methods- Ultrasound pulse velocity methods
* To study Repair and rehabilitation of structural elements, Analysis, and design, Material requirement, Surface preparation- Reinforcing steel cleaning, repair and protection
* To study Strengthening and stabilization, design considerations, Beam shear capacity strengthening- Shear Transfer strengthening, Column strengthening, flexural strengthening.
* To study Fibre reinforced concrete, Properties of constituent materials, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes.
* To study Light weight concrete, properties of light weight concrete, design of light weight concrete, High performance concretes, Development of high performance concretes, Materials of high performance concretes, Properties of high performance concretes.

**COURSE OUTCOMES:**

Students will get ability

* To learn Materials- Cement, Aggregates, mixing water soundness of aggregate, Fresh and hardened concrete, Admixtures, types of admixtures, purposes of using admixtures- chemical composition.
* To learn Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms, Acoustical emission methods- Corrosion activity measurement, Impact echo methods- Ultrasound pulse velocity methods
* To learn Repair and rehabilitation of structural elements, Analysis, and design, Material requirement, Surface preparation- Reinforcing steel cleaning, repair and protection
* To learn Strengthening and stabilization, design considerations, Beam shear capacity strengthening- Shear Transfer strengthening, Column strengthening, flexural strengthening.
* To learn Fibre reinforced concrete, Properties of constituent materials, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes.
* To learn Light weight concrete, properties of light weight concrete, design of light weight concrete, High performance concretes, Development of high performance concretes, Materials of high performance concretes, Properties of high performance concretes.

**SYLLABUS:**

1. Materials- Cement, Aggregates, mixing water soundness of aggregate- Fresh and hardened concrete: Admixtures- types of admixtures- purposes of using admixtures- chemical composition- effect of admixtures on fresh and hardened concretes- Natural admixtures.
2. Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods- Corrosion activity measurement- chloride content – Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests
3. Repair and rehabilitation of structural elements: Analysis, strategy and design- Material requirement- Material selection- Surface preparation- Reinforcing steel cleaning, repair and protection- Bonding repair materials to existing concrete- placement methods-
4. Strengthening and stabilization- Techniques- design considerations- Beam shear capacity strengthening- Shear Transfer strengthening- stress reduction techniques- Column strengthening-flexural strengthening- Connection stabilization and strengthening Crack stabilization
5. Fibre reinforced concrete- Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes
6. Light weight concrete- Introduction- properties of light weight concrete- No fines concrete- design of light weight concrete. High performance concretes- Introduction- Development of high performance concretes- Materials of high performance concretes- Properties of high performance concretes.

**REFERENCE:**

1. Concrete technology- Neville & Brooks
2. Special Structural concrete- Rafat Siddique
3. Concrete repair and maintenance illustrated- Peter H Emmons
4. Concrete technology-M S Shetty

# OFFSHORE STRUCTURES

**(Elective - II)**

**SUBJECT CODE: 16MSE1009**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Physical Environmental aspects of Marine and offshore construction, Materials and offshore construction equipment, Marine operations, Sea floor modification and improvements.
* To study Marine and Offshore construction equipment, Buoyancy, Draft and freeboard, Barges, Crane, offshore Derrick, Catamaran and Semi submersible Barges, Jack up Barges, offshore Dredges.
* To study Installation of Piles in marine and offshore Structures, Fabrication of tubular steel piles, Inserting and anchoring into rock and hardpan- Prestresses concrete piles for marine construction.
* To study Offshore Platforms, Steel Jackets and Pin piles- Fabrication- Land out, tie down and transportation- Removal of jacket from transportation barge – Lifting – launching-Installation at Sea floor- Pile and conductor Installation- Deck Installation, Construction stages- Sub base construction
* To study Submarine Pipelines- Types of barges- Controlled underwater floating- Bundles pipes- Directional drilling- protection of pipelines- burial and covering with rock- support of pipelines
* To study Underwater repairs, Repairs to steel Jacket, type structures, Repairs to steel piling, Repairs to Concrete offshore structures, repairs to foundations, Fie damage, Pipeline repairs.

**COURSE OUTCOMES:**

Students will get ability

* To learn Physical Environmental aspects of Marine and offshore construction, Materials and offshore construction equipment, Marine operations, Sea floor modification and improvements.
* To learn Marine and Offshore construction equipment, Buoyancy, Draft and freeboard, Barges, Crane, offshore Derrick, Catamaran and Semi submersible Barges, Jack up Barges, offshore Dredges.
* To learn Installation of Piles in marine and offshore Structures, Fabrication of tubular steel piles, Inserting and anchoring into rock and hardpan- Prestresses concrete piles for marine construction.
* To learn Offshore Platforms, Steel Jackets and Pin piles- Fabrication- Land out, tie down and transportation- Removal of jacket from transportation barge – Lifting – launching-Installation at Sea floor- Pile and conductor Installation- Deck Installation, Construction stages- Sub base construction
* To learn Submarine Pipelines- Types of barges- Controlled underwater floating- Bundles pipes- Directional drilling- protection of pipelines- burial and covering with rock- support of pipelines.
* To learn Underwater repairs, Repairs to steel Jacket, type structures, Repairs to steel piling, Repairs to Concrete offshore structures- repairs to foundations, Fie damage, Pipeline repairs.

**SYLLABUS:**

1. Introduction- Physical Environmental aspects of Marine and offshore construction- Materials and offshore construction equipment – Marine operations – Sea floor modification and improvements
2. Marine and Offshore construction equipment- Basic motions in sea- Buoyancy, Draft and freeboard- Stability- Damage control- Barges - Crane - offshore Derrick – Catamaran and Semi submersible Barges- Jack up Barges- launch barges- offshore Dredges- Floating Concrete Plant .
3. Installation of Piles in marine and offshore Structures- Fabrication of tubular steel piles- Transportation- Installation- Methods of increasing penetration – Inserting and anchoring into rock and hardpan- Prestresses concrete piles for marine construction- Handling and Positioning of Piles Review of Basic Concepts
4. Offshore Platforms: Steel Jackets and Pin piles- Fabrication- Land out, tie down and transportation- Removal of jacket from transportation barge – Lifting – launching-Installation at Sea floor- Pile and conductor Installation- Deck Installation- Concrete Platforms- Construction stages- Sub base construction
5. Submarine Pipelines- Types of barges- Controlled underwater floating- Bundles pipes- Directional drilling- protection of pipelines- burial and covering with rock- support of pipelines
6. Underwater repairs- Repairs to steel Jacket- type structures- Repairs to steel piling- Repairs to Concrete offshore structures- repairs to foundations- Fie damage- Pipeline repairs.

**REFERENCES:**

1. Construction of Marine and offshore Structures- 2e- Ben-C. Gerwick, Jr CRC press
2. Basic Coastal Engineering by R. M. Sorensen, published by Chapman & Hall, 1997
3. Port and Marine Structure Quin.

# PLASTIC ANALYSIS AND DESIGN

**(Elective -II)**

**SUBJECT CODE: 16MSE1010**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Introduction and basic hypothesis, relation of steel Moment curvature relation- basic difference between elastic and plastic analysis Yield condition, Virtual work in the elastic-plastic state.
* To study Method of Limit Analysis, Introduction to limit analysis of simply supported fixed beams and continuous beams, basic theorems of limit analysis, rectangular portal frames, gable frames, grids.
* To study Limit design Principles, Basic principles, limit design theorems, trial and error method, method of combining mechanisms, plastic moment distribution method, load replacement method.
* To study Deflection in Plastic beams and frames, Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.
* To study Design of beam to column Moment resisting connections. End plate: Flush & extended, T-Stub connections. Combined tension & shear considerations in welded & bolted connection.
* To study Minimum weight Design: Introduction to minimum Weight and linear Weight functions, Foulkes theorems and its geometrical analogue and absolute minimum weight design.

**COURSE OUTCOMES:**

Students will get ability

* To learn Introduction and basic hypothesis, relation of steel Moment curvature relation- basic difference between elastic and plastic analysis Yield condition, Virtual work in the elastic-plastic state.
* To learn Method of Limit Analysis, Introduction to limit analysis of simply supported fixed beams and continuous beams, basic theorems of limit analysis, rectangular portal frames, gable frames, grids.
* To learn Limit design Principles, Basic principles, limit design theorems, trial and error method, method of combining mechanisms, plastic moment distribution method, load replacement method.
* To learn Deflection in Plastic beams and frames, Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.
* To learn Design of beam to column Moment resisting connections. End plate: Flush & extended, T-Stub connections. Combined tension & shear considerations in welded & bolted connection.
* To learn Minimum weight Design: Introduction to minimum Weight and linear Weight functions, Foulkes theorems and its geometrical analogue and absolute minimum weight design.

**SYLLABUS:**

1. Introduction and basic hypothesis: Concepts of stress and strain – relation of steel Moment curvature relation- basic difference between elastic and plastic analysis with examples- Yield condition, idealizations, collapse criteria- Virtual work in the elastic-plastic state- Evaluation of fully plastic moment and shape factors for the various practical sections.
2. Method of Limit Analysis: Introduction to limit analysis of simply supported fixed beams and continuous beams, Effect of partially fixity and end, invariance of collapse loads, basic theorems of limit analysis, rectangular portal frames, gable frames, grids, superposition of mechanisms, drawing statistical bending moment diagrams for checks.
3. Limit design Principles: Basic principles, limit design theorems, application of limit design theorems, trial and error method, method of combining mechanisms, plastic moment distribution method, load replacement method, continuous beams and simple frames designs using above principles.
4. Deflection in Plastic beams and frames: Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.
5. Design of beam to column Moment resisting connections. End plate: Flush & extended, T-Stub connections. Combined tension & shear considerations in welded & bolted connection.
6. Minimum weight Design: Introduction to minimum Weight and linear Weight functions- Foulkes theorems and its geometrical analogue and absolute minimum weight design.

**REFERENCES:**

1. Plastic Methods of Structural analysis- B G Neal, Chapman and Rall publications
2. Plastic analysis and Design – C E Messennet, M A Seve

3) “Limit state Design of Steel Structures”, S K Duggal , McGraw Hill education, 2010

4) “Limit State Design of Steel Structures”, Dr. M R Shiyekar, PHI Publication, 3rd Print.

5) A.S. Arya and J.L. Ajmani – Design of Steel Structures, Nemchand& Bros., Roorkee

6) Ramchandra – Design of Steel Structures Vol – II, Standard Book House, Delhi

7) B.G. Neal – Plastic Method of Structural Analysis, Chapman & Hall

**ADVANCED CONCRETE LABORATORY**

**SUBJECT CODE: 16MSE1101**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **0** | **4** | **2** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To practice Tests on cement - Consistency, Setting times, Soundness, Compressive Strength, Gradation Charts of Aggregates, Bulking of fine Aggregate.
* To practice Aggregate Crushing and Impact value, Workability Tests on Fresh self compacting concrete, Air Entrainment Test on fresh concrete.
* To practice Marsh cone test, Permeability of Concrete.
* To practice Non Destructive Testing of Concrete, Accelerated Curing of Concrete.
* To practice Influence of W/C ratio on strength and Aggregate / Cement ratio on workability and Strength, Influence of Different Chemical Admixtures on concrete.

**COURSE OUTCOMES:**

Students will get ability

* To practice Tests on cement - Consistency, Setting times, Soundness, Compressive Strength, Gradation Charts of Aggregates, Bulking of fine Aggregate.
* To practice Aggregate Crushing and Impact value, Workability Tests on Fresh self compacting concrete, Air Entrainment Test on fresh concrete.
* To practice Marsh cone test, Permeability of Concrete.
* To practice Non Destructive Testing of Concrete, Accelerated Curing of Concrete.
* To practice Influence of W/C ratio on strength and Aggregate / Cement ratio on workability and Strength, Influence of Different Chemical Admixtures on concrete.

**SYLLABUS:**

1. Tests on cement - Consistency, Setting times, Soundness, Compressive Strength.
2. Gradation Charts of Aggregates.
3. Bulking of fine Aggregate.
4. Aggregate Crushing and Impact value
5. Workability Tests on Fresh self compacting concrete
6. Air Entrainment Test on fresh concrete.
7. Marsh cone test.
8. Permeability of Concrete.
9. Non Destructive Testing of Concrete.
10. Accelerated Curing of Concrete.
11. Influence of W/C ratio on strength and Aggregate / Cement ratio on workability and

Strength

1. Influence of Different Chemical Admixtures on concrete.

**SEMESTER II**

**FINITE ELEMENT METHOD**

**SUBJECT CODE: 16MSE1011**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study A brief history of F.E.M. Need of the method, Review of basic principles of solidmechanics, Equations of equilibrium, Compatibility, Strain displacement relations.
* To study Theory relating to the formulation of the finite element method, Coordinate system (local and global),Basic component – A single element.
* To study Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions – All with reference to trusses under axial forces.
* To study Concept of element, Discretisation of a structure, Mesh refinement Vs Higher order element, Inter connections at nodes of displacement models on inter element compatibility.
* To study Three dimensional analysis, Various elements used, Tetra-hadrons, Hex-hedrons. Requirements onRepresentation of element behaviour functions, Polynomial series.

**COURSE OUTCOMES:**

Students will get ability

* To learn A brief history of F.E.M. Need of the method, Review of basic principles of solidmechanics, Equations of equilibrium, Compatibility, Strain displacement relations.
* To learn Theory relating to the formulation of the finite element method, Coordinate system (local and global),Basic component – A single element.
* To learn Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions – All with reference to trusses under axial forces.
* To learn Concept of element, Discretisation of a structure, Mesh refinement Vs Higher order element, Inter connections at nodes of displacement models on inter element compatibility.
* To learn Three dimensional analysis, Various elements used, Tetra-hadrons, Hex-hedrons. Requirements onRepresentation of element behavior functions, Polynomial series.

**SYLLABUS:**

1. Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid

mechanics, Equations of equilibrium, Boundary conditions, Compatibility.

1. Theory relating to the formulation of the finite element method, Coordinate system (local and global),Basic component – A single element.
2. Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions – All with reference to trusses under axial forces.
3. Concept of element, Various element shapes, Triangular element. Discretization of a structure, Mesh refinement Vs. Higher order element, Inter connections at nodes of displacement models on inter element compatibility.
4. Two dimensional analysis –Stiffness Matrix for a two noded Truss Element ,Threenoded Truss element and Two noded Beam element in Local and Global (2D).
5. Three dimensional analysis – Various elements used, Tetra-hedrons, Hex-hedrons. Requirements onRepresentation of element behavior functions.

**REFERENCES:**

1. “The Finite Element Method in Engineering Science” by Zienkiewicz, P., McGraw Hill, 1971.

2. “Finite Element Analysis Fundamentals” by Richard H. Gallagher, Prentice Hall, 1975.

3. “Introduction to Finite Element Method” by Desai, C.S. and Abela, J.F., Van Nostrand, 1972.

4. “Finite Element Methods for Engineers” by Reger, T. Fenuer, The Macmillan Ltd., London, 1975.

5. “Fundamentals of Finite Element Techniques for Structural Engineers” by Drabbia, C.A. and

Conner, J.J., John Wiley and Sons, 1971.

6. **“**Numerical Methods in Finite Element Analysis” by Klaus Jurgen and Edward, L., Wilson,

Prentice Hall of India, New Delhi, 1978.

**COMPUTER APPLICATIONS AND CAD**

**SUBJECT CODE: 16MSE1012**

|  |  |  |  |  |
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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study the introduction to CA, tasks and benefits in CAD, difference between the Conventional and CAD Design, capabilities of designer versus computer ,computer organization, CPU, input devises, cursor controlled devises, plotters, printers and other output devices, memory.
* To study the CAD software and hardware, work station, graphics terminals, data base structure- Screen management- Menu handling- Dialogue boxes- soft key commands- Window and view port- Solid modeling-wire modeling.
* To study the computer graphics, graphic devices, representation of images in computers, transformation, segmentation, geometric modeling, graphics programming, computer aided drafting.
* To study algorithm and STAAD Pro (or Equivalent) program for analysis of simply supported beam with point load and uniform distributed load at different positions and different combinations.
* To study algorithm and STAAD Pro (or Equivalent) program for analysis of cantilever beam with point load and uniform distributed load at different positions and different combinations.
* To study Displacement Method, Stiffness properties of members, element and structure stiffness formulation co-ordinate transformation and global assembly, Boundary conditions, Application to plane pin – jointed trusses and rigid jointed plane frames.

**COURSE OUTCOMES:**

Students will get ability

* To understand the introduction to CA, tasks and benefits in CAD, difference between the Conventional and CAD Design, capabilities of designer versus computer ,computer organization, CPU, input devises, cursor controlled devises, plotters, printers and other output devices, memory.
* To learn the CAD software and hardware, work station, graphics terminals, data base structure- Screen management- Menu handling- Dialogue boxes- soft key commands- Window and view port- Solid modeling-wire modeling.
* To understand the computer graphics, graphic devices, representation of images in computers, transformation, segmentation, geometric modeling, graphics programming, computer aided drafting.
* To learn algorithm and STAAD Pro (or Equivalent) program for analysis of simply supported beam with point load and uniform distributed load at different positions and different combinations.
* To learn algorithm and STAAD Pro (or Equivalent) program for analysis of cantilever beam with point load and uniform distributed load at different positions and different combinations.
* To learn Displacement Method, Stiffness properties of members, element and structure stiffness formulation co-ordinate transformation and global assembly, Boundary conditions, Application to plane pin – jointed trusses and rigid jointed plane frames.

**SYLLABUS:**

1. Introduction to CAD - Tasks and benefits in CAD – Difference between the Conventional and CAD Design – Capabilities of Designer versus Computer -computer Organization – CPU - Input devises- Cursor controlled devises- Plotters, Printers and other output devices – memory.
2. CAD software and hardware- Work station- graphics terminals- Data base structure- Screen management- Menu handling- Dialogue boxes- soft key commands- Window and view port- Solid modeling-wire modeling.
3. Computer graphics- Graphic devices- Representation of images in computers- Transformation- Segmentation- Geometric modeling- Graphics programming- Computer aided drafting.
4. Algorithm and STAAD Pro (or Equivalent) program for analysis of simply supported beam with point load and uniform distributed load at different positions and different combinations.
5. Algorithm and STAAD Pro (or Equivalent) program for analysis of cantilever beam with point load and uniform distributed load at different positions and different combinations.
6. Displacement Method: Stiffness properties of members, element and structure stiffness formulation co-ordinate transformation and global assembly – Boundary conditions. Application to plane pin – jointed trusses and rigid jointed plane frames.

**PERQUISITE SUBJECTS:**

* Structural analysis I & II
* STADD Pro (or equivalent) software

**REFERENCES:**

* 1. Computer Aided Design and Manufacturing : Mikel P. Groover & C.W. Zimers Jr.
  2. Computer Aided Design: C.S. Krishna Murthy & S. Rawer.
  3. Rajput, R.K. Strength of Materials (2007), S Chand & Co Ltd, Page No. 310-312
  4. STAAD.Pro V8i Reference Guide
  5. Computer Programming and Engineering Analysis. I. C. Syal & S.P Gupta
  6. Computer Graphics by Donald Hearn & Pauline and Baker

**STABILITY OF STRUCTURES**

**SUBJECT CODE: 16MSE1013**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Beam columns, Differential equation for beam columns, Beams column with concentrated loads continuous lateral load, Beam column with built in ends, continuous beams with axial load.
* To study Elastic buckling of bars, Elastic buckling of straight columns, Sway & Non Sway mode, Energy methods.
* To study Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads, Effect of shear force on critical load Buckling of frames.
* To study Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling.
* To study Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.
* To study Lateral Buckling of simply supported Beams: Beams of rectangular cross section subjected for pure bending, Buckling of I Section subjected to pure bending.

**COURSE OUTCOMES:**

Students will get ability

* To learn Beam columns, Differential equation for beam columns, Beams column with concentrated loads continuous lateral load, Beam column with built in ends, continuous beams with axial load.
* To learn Elastic buckling of bars, Elastic buckling of straight columns, Sway & Non Sway mode, Energy methods.
* To learn Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads, Effect of shear force on critical load Buckling of frames
* To learn Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling.
* To learn Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.
* To learn Lateral Buckling of simply supported Beams: Beams of rectangular cross section subjected for pure bending, Buckling of I Section subjected to pure bending.

**SYLLABUS:**

1. Beam columns: Differential equation for beam columns – Beams column with concentrated loads – continuous lateral load – couples – Beam column with built in ends – continuous beams with axial load – application of Trigonometric series – Determination of allowable stresses.
2. Elastic buckling of bars : Elastic buckling of straight columns – Effect of shear stress on buckling – Eccentrically and laterally loaded columns –Sway & Non Sway mode - Energy methods .
3. Buckling of a bar on elastic foundation – Buckling of bar with intermediate compressive forces and distributed axial loads – Buckling of bars with change in cross section – Effect of shear force on critical load – Built up columns – Effect of Initial curvature on bars – Buckling of frames – Sway & Non Sway mode.
4. Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae of design – various end conditions – Design of columns based on buckling.
5. Mathematical Treatment of stability problems: Buckling problem orthogonality relation – Ritz method – Timeshinko method, Galerkin method.
6. Lateral Buckling of simply supported Beams: Beams of rectangular cross section subjected for pure bending, Buckling of I Section subjected to pure bending.

**REFERENCES:**

1. Theory of Elastic stability by Timshenko & Gere-Mc Graw Hill
2. Stability of Metal Structures by Bleinch – Mc Graw Hill
3. Theory of beam columns Vol I by Chem. & Atsute Mc. Graw Hill.
4. Theory of Stability of Structures by Alexander Chases.

**STRUCTURAL DYNAMICS AND EARTHQUAKE RESISTANT DESIGN**

**SUBJECT CODE: 16MSE1014**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study earthquake phenomenon , types of waves generated during earthquake, engineering seismology
* To study Introduction to Structural Dynamics, Fundamental objective of Dynamic analysis, Types of prescribed loadings, methods of Discretization, Formulation of the Equations of Motion.
* To study Theory of Vibrations, Elements of a Vibratory system, Oscillatory motion, Simple Harmonic Motion, Free Vibrations of Single Degree of Freedom systems, Undamped and Damped.
* To study Single Degree of Freedom System, Formulation and Solution of the equation of Motion, Free vibration response, Response to Harmonic, Periodic, Impulsive and general dynamic.
* To study Multi Degree of Freedom System, Selection of the Degrees of Freedom, Evaluation of Structural Property Matrices, Formulation of the MDOF equations of motion, Undamped free vibrations.
* To study Introduction to Earthquake Analysis, Excitation by rigid base translation, Lumped mass approach of SDOF and MDOF systems, I.S. Code methods of analysis, Multistoried buildings, Bridges Dams and Embankments, Retaining walls.

**COURSE OUTCOMES:**

Students will get ability

* To study earthquake phenomenon , types of waves generated during earthquake, engineering seismology
* To learn Introduction to Structural Dynamics, Fundamental objective of Dynamic analysis, Types of prescribed loadings, methods of Discretization, Formulation of the Equations of Motion.
* To learn Theory of Vibrations, Elements of a Vibratory system, Oscillatory motion, Simple Harmonic Motion, Free Vibrations of Single Degree of Freedom systems, Undamped and Damped.
* To learn Single Degree of Freedom System, Formulation and Solution of the equation of Motion, Free vibration response, Response to Harmonic, Periodic, Impulsive and general dynamic.
* To learn Multi Degree of Freedom System, Selection of the Degrees of Freedom, Evaluation of Structural Property Matrices, Formulation of the MDOF equations of motion, Undamped free vibrations.
* To learn Introduction to Earthquake Analysis, Excitation by rigid base translation, Lumped mass approach of SDOF and MDOF systems, I.S. Code methods of analysis, Multistoried buildings, Bridges Dams and Embankments, Retaining walls.

**SYLLABUS:**

1. **Earthquake Engineering** : - Engineering Seismology – Earthquake phenomenon – Causes and effects of earthquakes – Faults – Structure of earth – Plate Tectonics – Elastic Rebound Theory – Earthquake Terminology – Source, Focus, Epicenter etc - Earthquake size – Magnitude and intensity of earthquakes – Classification of earthquakes – Seismic waves – Seismic zones – Seismic Zoning Map of India – Seismograms and Accelegrams.
2. **Introduction to Structural Dynamics**: Fundamental objective of Dynamic analysis – Types of prescribed loadings – methods of Discretization – Formulation of the Equations of Motion.

**Theory of Vibrations**: Introduction – Elements of a Vibratory system – Degrees of Freedom of continuous systems - Oscillatory motion – Simple Harmonic Motion – Free Vibrations of Single Degree of Freedom (SDOF) systems – Undamped and Damped – Critical damping – Logarithmic decrement – Forced vibrations of SDOF systems – Harmonic excitation – Dynamic magnification factor – Band width.

1. **Single Degree of Freedom System**: Formulation and Solution of the equation of Motion – Free vibration response – Response to Harmonic, Periodic, Impulsive and general dynamic loadings – Duhamel integral.
2. **Multi Degree of Freedom System**: Selection of the Degrees of Freedom – Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion - Undamped free vibrations – Solution of Eigen value problem for natural frequencies and mode shapes – Analysis of dynamic response - Normal coordinates –
3. **Introduction to Earthquake Analysis:** Introduction – Excitation by rigid base translation – Lumped mass approach of SDOF and MDOF systems – I.S. Code methods of analysis. Terminology- general principles of design criteria- Seismic coefficient method- Design criteria for various applications- Multistoried buildings- Bridges - Dams and Embankments- Retaining walls
4. **Ductile Detailing Provisions** : - Review of the latest Indian Seismic codes IS:4326 and IS:13920 provisions for ductile detailing of R.C buildings – Beam, column and joints

**REFERENCES:**

1. Dynamics of Structures by Claugh & Penzien.
2. Structural Dynamics A K Chopra
3. Earth quake resistant Design of Structure – P.Agarwal, M.Shikhande
4. IS:1983-1984 Code of Practice for Earthquake Resistant Design of Structure
5. IS:13920-1993 Code for ductile detailing of R.C. buildings

# PRESTRESSED CONCRETE

**(Elective –III)**

**SUBJECT CODE: 16MSE1015**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Introduction General principles of Pre-stressing, Pre-tensioning and Post tensioning Advantages and limitations of Pre-stressing concrete, Materials, Methods and systems of Pres-stressing.
* To study Analysis of prestress and Bending stresses, Analysis of prestress, Resultant, stress at a section, pressure line, concept of load balancing, stresses in tendons.
* To study Losses of Pre-stressing, Loss of Pre-stress in pre-tensioned and post tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, Relaxation of steel.
* To study Deflections of pre-stressed concrete beams: Importance of control of deflections, short term deflections of un cracked member, prediction of long term deflections
* To study Flexural, shear, torsional resistance and design of Prestressed concrete section, Types of flexural failure, code procedures-shear and principal stresses, Prestressed concrete members in torsion, Analysis of end blocks: By Guyon’s method and Magnel’s method.
* To learn Composite sections, Analysis for stresses, differential shrinkage, general design considerations

**COURSE OUTCOMES:**

Students will get ability

* To learn Introduction General principles of Pre-stressing, Pre-tensioning and Post tensioning Advantages and limitations of Pre-stressing concrete, Materials, High strength concrete and high tensile steel and their characteristics, I S codal provisions, Methods and systems of Pres-stressing.
* To learn Analysis of prestress and Bending stresses, Analysis of prestress, Resultant, stress at a section, pressure line, concept of load balancing, stresses in tendons.
* To learn Losses of Pre-stressing, Loss of Pre-stress in pre-tensioned and post tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, Relaxation of steel.
* To learn Deflections of pre-stressed concrete beams: Importance of control of deflections, short term deflections of un cracked member, prediction of long term deflections.
* To learn Flexural, shear, torsional resistance and design of Prestressed concrete section, Types of flexural failure, code procedures-shear and principal stresses, Prestressed concrete members in torsion, Analysis of end blocks: By Guyon’s method and Magnel’s method.
* To learn Composite sections, Analysis for stresses, differential shrinkage, general design considerations

**SYLLABUS:**

1. Introduction to Historic development- General principles of Pre-stressing- Pre-tensioning and Post tensioning- Advantages and limitations of Pre-stressing concrete- Materials- Methods and systems of Pres-stressing- Pre tensioning and Post tensioning methods- Different systems of Pre-stressing like Hoyer systems- Magnel systems, Freyssinet system and Gifford Udall system.
2. Analysis of prestress and Bending stresses:

Assumptions – Analysis of prestress – Resultant – stress at a section – pressure line – concept of load balancing – stresses in tendons.

1. Losses of Pre-stressing- Loss of Pre-stress in pre-tensioned and post tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, Relaxation of steel, slip in anchorage.
2. Deflections of pre-stressed concrete beams: Importance of control of deflections- factors influencing deflections- short term deflections of un cracked member – prediction of long term deflections
3. Flexural, shear; tensional resistance and design of Prestressed concrete section. Types of flexural failure – code procedures-shear and principal stresses – Prestressed concrete members in torsion – Design of sections for flexure, Axial Tension, Compression and bending, shear.

Analysis of end blocks: By Guyon’s method and Magnel’s method

6. Composite sections: Introduction-Analysis for stresses- differential shrinkage- general design considerations

**REFERENCES:**

1. Prestressed Concrete- N. Krishna Raju
2. Prestressed Concrete- S. Ramamrutham
3. Prestressed Concrete- P. Dayaratnam

# COMPOSITE MATERIALS

**(Elective-III)**

**SUBJECT CODE: 16MSE1016**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Classification of Composite materials. Introduction to composite materials, including fabrication processes, properties, design concepts, assembly, and applications.
* To study Polymer Matrix Composites (PMC’s) Metal Matrix Composites (MMC’s) Ceramic Matrix Composites (CMC’s)
* To study Elastic properties and stress-strain relations, fracture behavior, Dispersion strengthened particle reinforced and fiber reinforced composite laminates, elastic an isotopic properties.
* To study Properties of matrix and reinforced materials, orthotropic coefficients needed for design activities, the Hill-Tsai failure criterion,
* To study Bending and torsion of composite beams, and the bending of thick composite plates. Micromechanics and principles of strengthening

**COURSE OUTCOMES:**

Students will get ability

* To learn Classification of Composite materials. Introduction to composite materials, including fabrication processes, properties, design concepts, assembly, and applications.
* To learn Polymer Matrix Composites (PMC’s) Metal Matrix Composites (MMC’s) Ceramic Matrix Composites (CMC’s)
* To learnv Elastic properties and stress-strain relations, fracture behavior, Dispersion strengthened particle reinforced and fiber reinforced composite laminates, elastic an isotopic properties.
* To learn Properties of matrix and reinforced materials, orthotropic coefficients needed for design activities, the Hill-Tsai failure criterion,
* To learn Bending and torsion of composite beams, and the bending of thick composite plates. Micromechanics and principles of strengthening

**SYLLABUS:**

1. Definition of fiber reinforced composite, types, Application
2. Classification of Composite materials. Introduction to composite materials, including fabrication processes, properties, design concepts, assembly, and applications.
3. Polymer Matrix Composites (PMC’s) Metal Matrix Composites (MMC’s) Ceramic Matrix Composites (CMC’s)
4. Elastic properties and stress-strain relations –fracture behavior -Dispersion strengthened particle reinforced laminates - elastic anisotopic properties, the directional dependence of different properties, and the mechanical properties of thin laminates.
5. Properties of matrix and reinforced materials-orthotropic coefficients needed for design activities, the Hill-Tsai failure criterion,
6. Bending and torsion of composite beams, and the bending of thick composite plates. Micromechanics and principles of strengthening

**REFERENCES:**

1. Engineering Mechanics of composite materials by Isaac M. Daniel and H. Thomas Hahn
2. An introduction to composite materials by by D. Hull and T.W. Clyne
3. The Theory of Composites - Graeme W. Milton- Cambridge

**FRACTURE MECHANICS**

**(Elective-III)**

**SUBJECT CODE: 16MSE1017**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study, Fundamentals of elastic and plastic behaviour of materials- stresses in a plate with a hole, Stress Concentration factor, Brittle fracture and ductile fracture- history of fracture mechanics.
* To study Principles of Linear Elastic Fracture Mechanics, SOM vs Fracture Mechanics, Stress Intensity Factors- KI, KII and KIII, Critical stress Intensity Factors, KIc KIIc and KIIc, crack tip plastic zone, Erwin’s plastic zone correction -Critical crack length.
* To study Griffith’s criteria, Criteria for crack propagation, Energy release rate , GI GII and GIII - Critical energy release rate GIc , GIIc and GIIIc – surface energy, R curves, compliance, J-Integrals.
* To study Geometric features of photo elastic fringes observed near the crack-tip. Crack growth and fracture mechanisms. Shear-lip in necking. Fatigue crack growth model.
* To study Material characterisation by Crack Tip Opening Displacements, Crack Mouth Opening Displacement, Critical crack tip opening displacement, critical Crack Mouth Opening Displacement
* To study Experimental determination of fracture parameters- KIc , GIc, CTODc and critical J-Integral.-for brittle and quasi brittle materials like concrete and rock- Specimen geometry .

**COURSE OUTCOMES:**

Students will get ability

* To learn, Fundamentals of elastic and plastic behaviour of materials- stresses in a plate with a hole, Stress Concentration factor, Brittle fracture and ductile fracture- history of fracture mechanics.
* To learn vPrinciples of Linear Elastic Fracture Mechanics, SOM vs Fracture Mechanics, Stress Intensity Factors- KI, KII and KIII, Critical stress Intensity Factors, KIc KIIc and KIIc, crack tip plastic zone, Erwin’s plastic zone correction -Critical crack length.
* To learn Griffith’s criteria, Criteria for crack propagation, Energy release rate , GI GII and GIII - Critical energy release rate GIc , GIIc and GIIIc – surface energy, R curves, compliance, J-Integrals.
* To learn Geometric features of photo elastic fringes observed near the crack-tip. Crack growth and fracture mechanisms. Shear-lip in necking. Fatigue crack growth model.
* To learn Material characterisation by Crack Tip Opening Displacements, Crack Mouth Opening Displacement, Critical crack tip opening displacement, critical Crack Mouth Opening Displacement
* To learn Experimental determination of fracture parameters- KIc , GIc, CTODc and critical J-Integral.-for brittle and quasi brittle materials like concrete and rock- Specimen geometry .

**SYLLABUS:**

1. Introduction: Fundamentals of elastic and plastic behaviour of materials- stresses in a plate with a hole – Stress Concentration factor- modes of failure- Brittle fracture and ductile fracture- history of fracture mechanics-Griffiths criteria of cracks- mode I, mode II and mode III failure.
2. Principles of Linear Elastic Fracture Mechanics: SOM vs Fracture Mechanics -stressed based Criteria for fracture- Stress Intensity Factors- KI KII and KIII – Critical stress Intensity Factors, KIc KIIc and KIIc – crack tip plastic zone – Erwin’s plastic zone correction -Critical crack length-Load carrying capacity of a cracked component- Design of components based on fracture mechanics.
3. Geometric features of photo elastic fringes observed near the crack-tip. Crack growth and fracture mechanisms. Shear-lip in necking. Fatigue crack growth model.
4. Griffith’s criteria- Criteria for crack propagation -Energy release rate , GI GII and GIII - Critical energy release rate GIc , GIIc and GIIIc – surface energy - R curves – compliance- J-Integrals:
5. Material characterisation by Crack Tip Opening Displacements (CTOD)- Crack Mouth Opening Displacement (CMOD)- Critical crack tip opening displacement (CTODc) –critical Crack Mouth Opening Displacement (CMODc)-Determination of fracture parameters.
6. Experimental determination of fracture parameters- KIc , GIc, CTODc and critical J-Integral.-for brittle and quasi brittle materials like concrete and rock- Specimen geometry .

**REFERENCES:**

1. Engineering Fracture Mechanics- S.A. Meguid, Elsevier Applied Science Publications.
2. Elementary engineering fracture mechanics – David Broek – Sijthoff & Noordhoff – Alphenaan den Rijn – Netherlands.
3. Elements of Fracture Mechanics – Prasanth Kumar, wiley Eastern Publications
4. Fracture Mechanics: Fundamentals and applications – T. L. Andrason, PhD, CRC publications
5. Fracture Mechanics of Concrete: Applications of fracture mechanics to concrete, Rock, and other quasi-brittle materials, Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang, John Wiley & Son publications.
6. Fracture mechanics of concrete structures – Theory and applications – Rilem Report – Edited by L. Elfgreen – Chapman and Hall – 1989.

Fracture mechanics – applications to concrete – Edite

**INDUSTRIAL STEEL STRUCTURES**

**SUBJECT CODE: 16MSE1018**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Upper lower bound theorems. Redistribution of moments.
* To study Portal frame, Mechanisms, Combination of mechanisms, Instantaneous Centre, The rigid frame, The instantaneous center of rotation, Multistorey Frames, Combination of mechanisms.
* To study Light gauge steel structures, Local buckling of thin sections, Light gauge steel columns and compression members, Form factor for columns and compression members,
* To study the analysis of Stiffened compression elements, Multiple stiffened compression elements.
* To study Design of Steel Towers, Trestles and Masts, Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Stress in trestle due to vertical loads, Stress in trestles due to horizontal loads, Design of members in towers.
* To study Analysis of Mill Bents, Types of mill bents, Loads on mill bents, Assumption made in mill bent analysis, Analysis for wind loads, For various edge conditions of mill bents.

**COURSE OUTCOMES:**

Students will get ability

* To learn Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Upper lower bound theorems. Redistribution of moments.
* To learn Portal frame, Mechanisms, Combination of mechanisms, Instantaneous Centre, The rigid frame, The instantaneous center of rotation, Multistorey Frames, Combination of mechanisms.
* To learn Light gauge steel structures, Local buckling of thin sections, Light gauge steel columns and compression members, Form factor for columns and compression members,
* To learn the analysis of Stiffened compression elements, Multiple stiffened compression elements.
* To learn Design of Steel Towers, Trestles and Masts, Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Stress in trestle due to vertical loads, Stress in trestles due to horizontal loads, Design of members in towers.
* To learn Analysis of Mill Bents, Types of mill bents, Loads on mill bents, Assumption made in mill bent analysis, Analysis for wind loads, For various edge conditions of mill bents.

**SYLLABUS:**

1. Introduction: Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Limit load, Coplanar load, Upper lower bound theorems. Redistribution of moments continuous beams: Relevant or irrelevant mechanisms, Types of mechanisms method for performing moment check.
2. Portal frame, Mechanisms, Combination of mechanisms, Moment check. Partial complete and over complete collapse. Instantaneous Centre: The rigid frame, The instantaneous center of rotation, Multistorey Frames: Combination of mechanisms.
3. Light gauge steel structures: Local buckling of thin sections, Post packing of thin elements, Light gauge steel columns and compression members, Form factor for columns and compression members.
4. Analysis of Stiffened compression elements, Multiple stiffened compression elements, Unstiffened compression elements effective length of light gauge steel compression members, Basic design stress, Allowable design stress.
5. Design of Steel Towers, Trestles and Masts: Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Analysis of towers (analysis as coplanar assembly of trestles), Mast, Trestle, Stress in trestle due to vertical loads, Stress in trestles due to horizontal loads, Design of members in towers,
6. Analysis of Mill Bents: Types of mill bents, Loads on mill bents, Assumption made in mill bent analysis, Analysis for wind loads, For various edge conditions of mill bents, Mill bents with double columns shear and moment diagrams, Wind loads analysis for two step columns.

**REFERENCES:**

1. “Plastic Analysis of Structures” by Beedle.

2. “Fundamentals of Structural Analysis” by Jakkula & Stephenson, Von Nostrand, East West Press.

3. “Design of Steel Structures” by Arya & Ajmani, Nemchand Publishers.

# BRIDGE ENGINEERING

**(Elective –IV)**

**SUBJECT CODE: 16MSE1019**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Hydraulic factors in bridge design and importance, Computation of peak flood flow, methods, small, mid size and large- river channels, Determination of peak discharge- Hydraulic geometry verses waterways, linear waterways- Economical spans-Afflux- Scour.
* To study Design loads on Minimum depth of foundation bridges, Dead load vehicle load live load, impact factor, centrifugal forces- Buoyancy water current forces- Thermal forces- Seismic forces.
* To study Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- Dimensioning of sub structures- Abutments pier and end connections.
* To study Pipe culvert- Flow pattern in pipe culvers- culvert alignment- culvert entrance structure- Hydraulic design and structural design of pipe culverts- reinforcements in pipes.
* To study Slab Bridge, effective width method, slabs supported on two edges, cantilever slabs- dispersion length, Pigeaud’s method, Guyon-Messonet method- Hendry Jaegar method.
* To study Design of prestressed concrete bridges - Preliminary dimensions - Flexural and torsional parameters - Courbon's theory - Distribution coefficient by exact analysis - Design of girder section - Maximum and minimum prestressing forces - Eccentricity - Live load and dead load shear forces - cable zone in girder –Check for stresses at various sections - Check for diagonal tension - Diaphragms - End block - Short term and long term deflections.

**COURSE OUTCOMES:**

Students will get ability

* To learn Hydraulic factors in bridge design and importance, Computation of peak flood flow, methods, small, mid size and large- river channels, Determination of peak discharge- Hydraulic geometry verses waterways, linear waterways- Economical spans-Afflux- Scour.
* To learn Design loads on Minimum depth of foundation bridges, Dead load vehicle load live load, impact factor, centrifugal forces- Buoyancy water current forces- Thermal forces- Seismic forces.
* To learn Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- Dimensioning of sub structures- Abutments pier and end connections.
* To learn Pipe culvert- Flow pattern in pipe culvers- culvert alignment- culvert entrance structure- Hydraulic design and structural design of pipe culverts- reinforcements in pipes.
* To learn Slab Bridge, effective width method, slabs supported on two edges, cantilever slabs- dispersion length, Pigeaud’s method, Guyon-Messonet method- Hendry Jaegar method.
* To learn Design of prestressed concrete bridges - Preliminary dimensions - Flexural and torsional parameters - Courbon's theory - Distribution coefficient by exact analysis - Design of girder section - Maximum and minimum prestressing forces - Eccentricity - Live load and dead load shear forces - cable zone in girder –Check for stresses at various sections - Check for diagonal tension - Diaphragms - End block - Short term and long term deflections.

**SYLLABUS:**

1. Introduction- Hydraulic factors in bridge design and importance- Computation of peak flood flow- methods- catchments – small- mid size and large- river channels- Determination of peak discharge- Hydraulic geometry verses waterways, linear waterways- Economical spans-Afflux- Scour (Ref: IRC-SP-13, IRC-5, IRC-78).
2. Design loads on Minimum depth of foundation bridges- Dead load vehicle load live load, impact factor, wind load, longitudinal form-centrifugal forces- Buoyancy water current forces- Thermal forces- deformation and horizontal forces- erection stresses- Seismic forces (Ref: IRC-6).
3. Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- Dimensioning of sub structures- Abutments pier and end connections.(Ref: IRC- SP-13)
4. Pipe culvert- Flow pattern in pipe culvers- culvert alignment- culvert entrance structure- Hydraulic design and structural design of pipe culverts- reinforcements in pipes .(Ref: IRC: SP-13)
5. SUPER STRUCTURE: Slab bridge- Wheel load on slab- effective width method- slabs supported on two edges- cantilever slabs- dispersion length- Design of interior panel of slab- Pigeaud’s method- design of longitudinal girders- Guyon-Messonet method- Hendry Jaegar method- Courbon’s theory. (Ref: IRC-21), voided slabs, T-Beam bridges.
6. Design of prestressed concrete bridges - Preliminary dimensions - Flexural and torsional parameters - Courbon's theory - Distribution coefficient by exact analysis - Design of girder section - Maximum and minimum prestressing forces - Eccentricity - Live load and dead load shear forces - cable zone in girder –Check for stresses at various sections - Check for diagonal tension - Diaphragms - End block - Short term and long term deflections.

**REFERENCES:**

1. Design of concrete bridges- Aswini, Vazirani, Ratwani
2. Essentials of bridge engineering- Jhonson Victor D
3. Design of bridges- Krishna Raju

# DESIGN OF SUBSTRUCTURES

**(Elective -IV)**

**SUBJECT CODE: 16MSE1020**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **4** | **0** | **3** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To study Substructure Design, Substructure, Definition and purpose, Role of foundation engineers, General requirements of substructure, Scope.
* To study marine structures and Types, Break waters, Wharves, Piers, Seawalls, Docks, Quay walls, Locks and moorings, Design loads, Combined loads, Wave action, Wave pressure on vertical walls, Ship impact on piled wharf structures, Design of breakwaters, Gravity wall and wharf structures.
* To study Sheet Piles, Type of sheet pile structures, Design of cantilever sheet piling wall, Design of anchored bulkheads, Design of braced sheeting in cuts, Design of cellular cofferdams.
* To study Foundations of Transmission Line Towers, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.
* To study Machine Foundations, Types of foundations, Design criteria, IS code previsions, Construction details of machine foundations vibration isolation.

**COURSE OUTCOMES:**

Students will get ability

* To learn Substructure Design, Substructure, Definition and purpose, Role of foundation engineers, General requirements of substructure, Scope.
* To learn marine structures and Types, Break waters, Wharves, Piers, Seawalls, Docks, Quay walls, Locks and moorings, Design loads, Combined loads, Wave action, Wave pressure on vertical walls, Ship impact on piled wharf structures, Design of breakwaters, Gravity wall and wharf structures.
* To learn Sheet Piles, Type of sheet pile structures, Design of cantilever sheet piling wall, Design of anchored bulkheads, Design of braced sheeting in cuts, Design of cellular cofferdams.
* To learn Foundations of Transmission Line Towers, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.
* To learn Machine Foundations, Types of foundations, Design criteria, IS code previsions, Construction details of machine foundations vibration isolation.

**SYLLABUS:**

1. **Substructure Design:** Introduction, Substructure – Definition and purpose, Role of foundation engineers, General requirements of substructure, Scope.
2. **Marine Substructures:** Introduction, Type of marine structures – Break waters, Wharves, Piers, Seawalls, Docks, Quay walls, Locks and moorings, Design loads, Combined loads, Wave action, Wave pressure on vertical walls.
3. **Design of break water:**Ship impact on piled wharf structures, Design of breakwaters, Rouble-Mound break waters, Wall type break water, Gravity wall and anchored bulk head wharf structures, Design of piled wharf structures.
4. **Sheet Piles:** Introduction, Type of sheet pile structures, Design of cantilever sheet piling wall, Design of anchored bulkheads, Anchorage methods, Design of braced sheeting in cuts, Design of cellular cofferdams.
5. **Foundations of Transmission Line Towers:** Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.
6. **Machine Foundations:** Types of foundations, Design criteria, IS code previsions, Construction details of machine foundations vibration isolation.

**REFERENCES:**

1. “Analysis and Design of Substructures Limit State Design” by Swami Saran, Oxford and IBH

Publishing Co. Pvt. Ltd., New Delhi.

2. **“**Dynamics of Bases and Foundations” by Barken**.**McGraw Hill Company.

**CAD LAB**

**SUBJECT CODE: 16MSE1102**

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| **L** | **P** | **C** | **INT** | **EXT** |
| **0** | **4** | **2** | **40** | **60** |

**COURSE OBJECTIVES:**

Students will have

* To practice Program using arrays and functions for matrix manipulation, Programs to draw bending moment.
* To practice shear force diagrams. Using graphic in C, Program for design of slabs. Using Excel.
* To practice Program for design of beams. Using Excel, Program for design of column and footing using excel.
* To practice Analysis of truss using STAAD Pro., Analysis of multistoried space frame, using STAAD Pro., Analysis of 2D frames STAAD Pro.
* To practice Analysis of beams, columns using STAAD Pro., Analysis of Bridge deck slab.

**COURSE OUTCOMES:**

Students will get ability

* To practice Program using arrays and functions for matrix manipulation, Programs to draw bending moment.
* To practice shear force diagrams. Using graphic in C, Program for design of slabs. Using Excel.
* To practice Program for design of beams. Using Excel, Program for design of column and footing using excel.
* To practice Analysis of truss using STAAD Pro., Analysis of multistoried space frame, using STAAD Pro., Analysis of 2D frames using STAAD Pro.
* To practice Analysis of beams, columns using STAAD Pro., Analysis of Bridge deck slab using STAAD.Pro.

**SYLLABUS:**

1. Program using arrays and functions for matrix manipulation.
2. Programs to draw bending moment and shear force diagrams. Using graphic in C
3. Program for design of slabs. Using Excel
4. Program for design of beams. Using Excel
5. Program for design of column and footing using excel
6. Analysis of truss using STAAD Pro. Or equivalent.
7. Analysis of 2D frames using STAAD Pro. Or equivalent.
8. Analysis of multistoried space frame, using STAAD Pro. Or equivalent.
9. Analysis of beams, columns using STAAD Pro., Or equivalent.
10. Analysis of Bridge deck slab using STAAD Pro. Or equivalent..