DEPARTMENT OF CIVIL ENGINEERING

COURSE STRUCTURE AND SYLLABUS

(1ST – 4TH SEMESTER)

FOR

M. TECH PROGRAMME

SPECIALISATION

IN

GEOTECHNICAL ENGINEERING

(EFFECTIVE FROM 2016-17)

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
(FORMLY, UNIVERSITY COLLEGE OF ENGINEERING)
BURLA – 768 018, SAMBALPUR, ODISHA

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA

DEPARTMENT OF CIVIL ENGINEERING

VISION

To emerge as an internationally acclaimed Civil Engineering Department for imparting futuristic technical education and creation of vibrant research enterprise to create quality civil engineering and researchers, truly world class leader and unleashes technological innovations to serve the global society and improve the quality of life.

MISSION

The Department of Civil Engineering, VSSUT, Burla strives to create values and ethics in its product by inculcating depth and intensity in its education standards and need based research throughout

- Participative learning in a cross-cultural environment that promotes the learning beyond the class room.
- Collaborative partnership with industries and academia within and outside the country in learning and research.
- Encouraging innovative research and consultancy through the active participation and involvement of all faculty members.
- Facilitating technology transfer, innovation and economic development to flow as natural results of research where ever appropriate.
- Expanding curricula to cater broader perspectives.
- Creation of service opportunities for upliftment of the society at large.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA

DEPARTMENT OF CIVIL ENGINEERING

M.TECH IN GEOTECHNICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEOs-I

1. The Programme will prepare graduates to perform analysis and design of various geotechnical structures.

PEOs-II

2. The Programme will prepare graduates to take up industrial project in the field of geotechnical engineering and allied area and also research work in the relevant domain

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA

DEPARTMENT OF CIVIL ENGINEERING

M.TECH IN GEOTECHNICAL ENGINEERING

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs.

These Graduate Attributes are identified by National Board of Accreditation.

a. Engineering Knowledge
b. Problem Analysis
c. Design & Development of Solutions
d. Investigation of Complex Problem
e. Modern Tools Usage
f. Engineer and Society
g. Environment & Sustainability
h. Ethics
i. Individual & Team work
j. Communication
k. Lifelong Learning
l. Project management & Finance

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA

DEPARTMENT OF CIVIL ENGINEERING

M.TECH IN GEOTECHNICAL ENGINEERING

PROGRAMME OUTCOMES (POs)

1. The graduates are expected to have an ability to apply knowledge of mathematics; science and engineering while analysis and design of geotechnical structure ant its components.

2. The graduates are expected to have ability to predict geotechnical problems and adopt innovative solutions.

3. The graduates are expected to solve complex geotechnical engineering problems and able to propose optimal, feasible and economical design solution.

4. The graduates are expected to have capability to take research projects in the field of geotechnical, geo-environment engineering and also able to develop modern solution using advanced technological concepts.

5. The graduates are expected to identify and use modern tools /equipments for analysis and design of components of geotechnical structures.

6 The graduates are expected to participate in collaborative and multidisciplinary work in order to contribute the overall development of the society.

7. The graduates are expected to participate in group projects and have ability to manage project competently through efficient and optimal use of resources.

8. The graduates are expected to communicate technical details effectively through oral presentation and written documents.

9. The graduates are expected to engage themselves in life-long learning and keep on updating themselves with technological advances.

10. The graduates are expected to understand and follow ethical practices in geotechnical engineering.

11. The graduates are expected to critically examine, judge and decide independently the outcome of work carried out.

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DEPARTMENT OF CIVIL ENGINEERING

M.TECH IN GEOTECHNICAL ENGINEERING

POs aligned to the Graduate Attributes prescribed by the NBA

GA (NBA) /POs	1	2	3	4	5	6	7	8	9	10	11
a	√										
b		√		√							
c			√								
d				√							
e					√						
f						√					
g							√				
h								√			
i									√		
j										√	
k											√
l											√

Proposed Syllabus for M.Tech. in Geotechnical Engineering
Department of Civil Engineering
Veer Surendra Sai University of Technology, Burla

Sl No.	Subject	L-T-P	Credits
I SEMESTER			
1	Advanced Soil Mechanics	4-0-0	4
2	Advanced Foundation Engineering	4-0-0	4
3	Theory of Elasticity and Plasticity (same as M.Tech.–SE)	4-0-0	4
4	Elective-I (Group A)	4-0-0	4
5	Elective-II (Group A)	4-0-0	4
6	Geotechnical Engineering Laboratory	0-0-6	4
7	Seminar – I	0-0-3	2
8	Comprehensive Viva Voce-I		2
TOTAL		20-0-9	28
II SEMESTER			
1	Earthquake Analysis and Design (same as M.Tech.–SE)	4-0-0	4
2	Stability Analysis of Slopes, Dams and Embankments	4-0-0	4
3	Ground Improvement Techniques (same as CE 15046)	4-0-0	4
4	Elective -III(Group B)	4-0-0	4
5	Elective- IV(Group B)	4-0-0	4
6	Geotechnical Engineering Design	0-0-6	4
7	Seminar – II	0-0-3	2
8	Comprehensive Viva Voce-II		2
TOTAL		20-0-9	28
III SEMESTER			
1	Dissertation interim evaluation		10
2	Comprehensive Viva Voce - III		3
3	Seminar on Dissertation		2
TOTAL			15
IV SEMESTER			
1	Dissertation Open Defence		5
2	Dissertation evaluation		20
TOTAL			25

Grand Total=96

Electives for I-Semester in Group-A

1. Soil Exploration and Analysis of Foundations
2. Clay Mineralogy and Expansive Soil
3. Strength and deformation behavior of soils
4. Design of Retaining Structures
5. Ground Water Flow through Porous Media
6. Soil Dynamics
7. Rock Mechanics
8. Finite Element Method (Same as CE 15068)
9. Numerical Methods in engineering (same as CE 15066)

Electives for II-Semester in Group-B

1 Advanced Environmental Geotechnics
2 Geoinformatics
3. Earthquake Geotechnical Engineering
4. Geo-engineering Investigation
5. Environmental Impact Assessment (same as M.Tech. – ESE)
6. Soil-Structure Interaction
7. Ground Water Engineering (same as CE 15050)
8. Optimization Techniques (same as M.Tech. - TE)

Core Subjects: I Semester

ADVANCED SOIL MECHANICS 4 Credits [4-0-0]

COURSE OBJECTIVE:

1 To impart knowledge on the various factors governing the Engineering behaviour of soils and the suitability of soils for various Geotechnical Engineering applications.

2 To characterize stress-strain behaviour of soils, the failure criteria and to evaluate the shear strength and compressibility parameters of soils.

3 To acquire knowledge for computing stress and settlement at any point in the semi infinite elastic soil medium, anisotropic medium and evaluation of stability of foundations, slopes, cuts and retaining structures both for the conditions of undrained and drained loading through theorems of plastic collapses.

COURSE CONTENTS:

Module-I

Introduction: Origin of soil and its types, mineralogy and structure of clay minerals, X-ray and Differential Thermal Analysis; structure of coarse grained soil, behavior of granular and cohesive soils with respect to their water content;

Module-II

Mechanism of consolidation, determination of field compression index for normally and over consolidated soils, coefficient of consolidation and its determination. Calculation of settlements, calculation of time rate of settlement. Three dimensional consolidation, design of sand drains.

Module-III

Critical state soil mechanics: Critical State Line, Hvorslev Surface, Yield Surfaces: Modified Cam-clay and Original Cam-clay; Elastic and plastic analysis of soil:- Constitutive relationships of soil; failure theories. Limit analysis Upper bound theorems, lower bound theorems, limit equilibrium methods.

Module-IV

Soil Stabilization: Classification of stabilizing agents and stabilization processes. Nature and surface characteristics of soil particles; Concepts of surface area and contact points; Inorganic stabilizing agents; Strength improvement characteristic of soft and sensitive clay, Marine clay and waste material

Text Book: 1. B M Das, Advanced Soil Mechanics, Taylor and Francis

2. R F Scott, Principles of Soil Mechanics, Addison & Wesley.

Reference Book 1. R.O. Davis and A.P.S. Selvadurai, Elasticity and Geomechanics, Cambridge University Press, New York.

2. Mitchell, James K, Fundamentals of Soil Behaviour, John Wiley and Sons

3. D.M. Wood, Soil Behaviour and Critical State Soil Mechanics, University of Glasgow

COURSE OUTCOMES:

1 Ability to select suitable soils for various geotechnical applications based on the factors governing the Engineering behaviour of soils.

2 Students are able to select the shear strength and compressibility parameters to design different structures for different conditions of loading, drainage and failure criteria.

3 Capable to estimate the stresses in soil medium of any type due to foundation load, settlement of foundation and to evaluate bound and true collapse loads of soil structures.

ADVANCED FOUNDATION ENGINEERING 4 Credits [4-0-0]

COURSE OBJECTIVE:

1 Ability to evaluate Bearing capacity factors

2 Ability to evaluate the Pile group bearing capacity and settlement

3 Ability to understand Well foundation

4 Ability to understand dynamic loads on soil foundation system

COURSE CONTENTS:

Module I

Shallow foundation: Bearing capacity factors. Effect of foundation shape, eccentricity and inclination of load, Influence of soil compressibility and water table. Settlement of footings on stratified deposits. Influence of adjacent footings. Allowable total and differential settlement of structures. Methods of proportioning. Raft foundations, semi-empirical methods. Foundations on swelling soils.

Module II

Deep foundation: Modes of failure. Bearing capacity and settlement of pile foundation. Types of piles. Allowable load, Pile Load test. Dynamic and static formulae. Bearing Capacity factors. Pile group bearing capacity and settlement. Interference, Behavior of piles under lateral loading.

Winkler's assumption. Pile resistance and deflection under lateral loads, elastic method, Broms method.

Module III

Well foundation: Design and construction. Bearing capacity, settlement and lateral resistance. Tilts and shifts.

Module IV

Load tests: Plate load test and penetration tests, their applications in the design of shallow and deep foundations. Introduction to dynamic loads on soil foundation system, natural frequency and machine foundations.

References:

1.. B.M. Das, *Principles of Foundation Engineering*, Thomson Brooks/Cole
2. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Company
3. N.P. Kurien, Design of Foundation Systems: Principles & Practices, Narosa, New Delhi 1992
4. G. Ranjan and A.S.R Rao, Basic and Applied Soil Mechanics, New Age International Publishers
5. H.F. Winterkorn and H.Y. Fang, Foundation Engineering Hand Book, Galgotia Booksource

COURSE OUTCOMES:

1. To make students understand Allowable total and differential settlement of structures.
2. To provide brief explanation on Plate load test and penetration tests
3. To explain in detail of shallow and deep foundations

THEORY OF ELASTICITY AND PLASTICITY 4 Credits [4-0-0]

COURSE OBJECTIVE:

Theory of pure bending of plates

Theory of circular and rectangular plate problems and solutions

Membrane theory of shells

Theory of cylindrical shells

COURSE CONTENTS:

Module- I **(12 Hours)**

Plane stress and plane strain problems. General stress and strain equations (Equilibrium and compatibility equations).Two dimensional problems in rectangular coordinates. Stress and strain components, differential equation, equilibrium equations and compatibility equations in polar coordinate. Stress distribution for axisymmetric problems. Pure bending of curved bars, thick walled cylinder. Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam. Effect of circular holes on stress distributions in plates.

Module- II **(9 Hours)**

Stress and strain in three dimensions: Principles stresses, maximum shearing stress, principal axes of strain. Stretching of prismatic bar by its own axis. Elementary problems of elasticity in three dimensions

Module- III **(9 Hours)**

Torsion of non-circular prismatic bars, Saint Venant's theory, Various analogies, Torsion of hollow and thin section, Application of energy methods

Module- IV **(10 Hours)**

Introduction to the theory of plasticity, the yield criteria of metals, stress space representation of yield criteria, stress-strain relations plastic potential, flow rules and maximum work hypothesis. Two dimensional plastic flow problems. Incompressible two dimensional flow, stresses in plastic materials in condition of plane strain, equation of equilibrium the simplest slip-line fields.

Text Book:

1. S P Timoshenko and J N Goodier, Theory of Elasticity, Mc Graw Hill

2. Hoffman and Sachs, Theory of plasticity

Reference Books:

1. N.Filonenko-Borodich, Theory of Elasticity, Mir Publishers,Moscow,1965

2. W. Johnson and P B Meller, Plasticity of Mechanical Engineers

3. C.R. Calladine, 'Plasticity for Engineers', Ellis Herwood, Chichester, U.K., 1985

COURSE OUTCOMES:

At the end of the course, the student will be able to:

Apply theory of plates and formulate symmetrical bending problems

Apply theory of plates and formulate circular and rectangular plate problems

Apply membrane theory of shells and formulate spherical and conical shell problems

Apply theory of shells and formulate cylindrical shell problems

GEOTECHNICAL ENGINEERING LABORATORY 4 Credits [0-0-6]

COURSE OBJECTIVE:

Ability to evaluate various soil characteristics

Ability to measure shear strength of soil

COURSE CONTENTS:

Standard and Modified Proctor Compaction Test; Permeability test; Direct Shear Test; Triaxial Shear Test (CU, CD, UU); C.B.R. Test (Un-soaked& soaked); Consolidation Test., Field Density Test, Unconfined Compressive Test, Swelling Pressure Test.

COURSE OUTCOMES:

To make students understand the concept of various soil parameters

ELECTIVES – I SEMESTER

SOIL EXPLORATION AND ANALYSIS OF FOUNDATIONS

COURSE OBJECTIVE:

1 .Ability to evaluate Geophysical exploration
2. Ability to evaluate the Bearing capacity of foundation
3. Ability to understand Well foundation

COURSE CONTENTS:
Module I

Introduction: Planning of Geotechnical exploration, methods of boring, types of samples & sampling, field tests, Geophysical exploration ; standard penetration test, plate load test, cyclic plate load test, static and dynamic cone penetration test, pressure meter tests, dilatometer tests, in-situ permeability tests ; Presentation and processing of soil exploration data and its interpretation ;

Module II

Shallow foundations: Bearing capacity of foundation based on in-situ tests. Bearing capacity for foundation on slope, mat foundations including floating raft, settlement calculations for footings on cohesive and cohesionless soil based on in-situ tests.

Module III

Deep foundations: mechanics of load transfer in piles, load carrying capacity, pile load test, design of pile groups including settlement calculations;

Module IV

Well foundation- Design of well foundation based on bore log data ; Advanced topics on in-situ soil testing

References :

1. B. M Das, *Principles of Foundation Engineering*, Thomson Brooks/Cole
2. J. E. Bowles, *Foundation Analysis and Design*, McGraw-Hill Book Company
3. N.P. Kurien, *Design of Foundation Systems : Principles & Practices*, Narosa, New Delhi 1992
4. G.Ranjan and A S R Rao, *Basic and Applied Soil Mechanics*, New Age international Publishers.
5. H. F. Winterkorn and H Y Fang, *Foundation Engineering Hand Book*, Galgotia Booksource

COURSE OUTCOME:

1. To make students understand concepts of methods of boring, types of samples & sampling, field tests
2. To provide brief explanation on pile load test
3. To explain in detail advanced topics on in-situ soil testing

CLAY MINERALOGY AND EXPANSIVE SOIL

COURSE OBJECTIVE:

1. Ability to understand clay minerals
2. Ability to evaluate Effects of clay minerals on engg. properties of soils
3. Ability to understand Classification of expansive soils

COURSE CONTENTS:

Module I

Origin and occurrence, Weathering and soil formation, clay minerals, composition, classification and nomenclature, non-clay and organic constituents, isomorphism substitution, cation exchange capacity, structure of clay mineral, Kaolinite, Illite and montmorillonite groups, identification by

X-ray diffraction, electron microscope, chemical, DT A methods.

Module II

Clay water relationships, structure of soils effect of cations, Thixotropy, Electrical effects, Electro osmosis and electrophoresis, streaming potentials. Effects of clay minerals on engg. properties of soils, introduction to rheological properties of clay soils.

Module III

Classification of expansive soils, free swells index property tests, swelling potential, measurement and prediction.

Module IV

Theories of swelling, mechanical concepts, physico chemical and electro chemical theories swell calculation for simple systems. Earth pressure and slope stability, code of practice, stabilization of expansive soils.

References:

1. Foundation on expansive soils-Chen, F.H.
2. Clay mineralogy - Grim R. E.
3. Applied clay mineralogy- Grim R. E.

COURSE OUTCOME:

1 To make students understand concepts of rheological properties of clay soils
2 To provide brief explanation on Clay water relationships
3. To explain in detail theories of swelling

STRENGTH AND DEFORMATION BEHAVIOR OF SOILS (4-0-0), 4 CREDITS

COURSE OBJECTIVE:

1 .Ability to understand Elastic and Plastic analysis of soil
2. Ability to evaluate Shear strength of unsaturated soils,
3. Ability to understand Constitutive Models in Soil Mechanics

COURSE CONTENTS:

Module I

Introduction: Physico-Chemical aspects, Failure theories, Yield criteria, Elastic and Plastic analysis of soil, Mohr's diagram. ;

Module II

Stresses in Soil: Description of state of stress and strain at a point, stress distribution problems in elastic half pace. Boussinessqu, Westergard Mindlin and Kelvin problems. Distribution of contact pressure.

Module III

Analysis of Elastic settlement. ; Soil Plasticity. ; Shear Strength of Soils: Experimental determination of shear strength, Types of tests based on drainage conditions and their practical significance, Skempton's and Henkel's pore water pressure coefficients, Stress path, Shear strength of unsaturated soils, Row's stress dilatancy theory.

Module IV

Constitutive Models: Constitutive Models in Soil Mechanics: Isotropic Elastic, Anisotropic Plasticity and Viscous Models. Representing Soil Behaviour using these Models. ; Advances in Constitutive models.

References:

1. A.P.S. Selvadurai, *Plasticity & Geomechanics*, Cambridge University Press, 2002
2. W.F. Chen, *Limit Analysis & Soil Plasticity*, Elsevier Scientific, 1975.
3. C. S. Desai and J. T. Christian, *Numerical Methods in Geotechnical Engineering*, McGrew Hill, New York.
4. R. F. Scott, *Principles of Soil Mechanics*, Addison & Wesley

COURSE OUTCOME:

1 To make students understand Stresses in Soil

2 To provide brief explanation on types of tests based on drainage conditions and their practical significance.

3. To explain in detail Soil Behaviour using Isotropic, Elastic, Anisotropic, Plasticity and Viscous Models.

DESIGN OF RETAINING STRUCTURES (4-0-0), 4 CREDITS

COURSE OBJECTIVE:

1 .Ability to understand Theories of earth pressure:
2. Ability to evaluate Earth pressures due to earthquakes.
3. Ability to understand Retaining structures for excavations.

COURSE CONTENTS:

Module I

Theories of earth pressure: Rankine, Coulomb. Trial wedge and theory of plasticity. Earth pressures at rest, and in active and passive states. Soil properties and lateral Earth pressure. Earth pressures on walls, various types of back fill and condition of loading. Soil tension effects and rupture zones. Effect of flexibility of structure on lateral pressures. Earth pressures due to earthquakes.

Module II

Pressures in soils: Grain elevators and coal bunkers. Types of retaining walls. Gravity, Cantilever-counter fort and Crib types. Basement or foundation retaining walls. Design principles of retaining walls, abutments and wing walls; allowable bearing capacity settlement tilting. Safety against general slip failure. Wall joints and drainage.

Module III

Bulk heads, Cantilevered and anchored, different types. Earth pressure behind bulk heads due to cohesive and non-cohesive soils.
Free and fixed earth support. Rowe's modifications to moments.
Modern trends in retaining walls-Reinforced Earth retaining walls; Tsagareli's relieving platforms.

Module IV

Retaining structures for excavations. Design of shoring and bracing coffer dams, types and design principles.

Course Outcome:

1 To make students understand Pressures in soils
2 To provide brief explanation on Design of retaining walls
3. To explain in detail design of shoring and bracing coffer dams.

Ground Water Flow through Porous Media

Course Objective:

1. Ability to evaluate Effective and Neutral pressures in soil
2. Ability to evaluate the capillarity and permeability characteristics of soil strata
3. Ability to understand consolidation theory and Ground water Hydraulics

Module I

Soil Water: Modes of occurrence of water in soils. Adsorbed water, capillary water, Capillary potential, Capillary tension and soil suction. Effective and Neutral pressures in soil ;

Module II

Flow through porous Media: Darcy's law and measurement of permeability in laboratory and field. Steady State flow solutions of LaPlace's equation, Plane problems, 3-dimensional problems,

Module III

Partial cut-offs, uplift pressure, consolidation theory –one and three dimensional consolidation Secondary consolidation ; Ground water Hydraulics: Water table in regular materials, Geophysical exploration for locating water table.

Module IV

Confined water, Equilibrium conditions, Non-equilibrium conditions, Water withdrawal from streams, Method of ground water imageing.

References:

1. D.K.Todd, *Groundwater Hydrology*, John wiley and Sons
2. H.M. Raghunath, *Ground Water*, Willy Eastern Ltd.
3. C.Fitts, *Ground Water Science*, Elsevier Publications, U. S. A.
4. P. P. Raj, *Geotechnical Engineering*, Tata McGraw-Hill
5. A. Jumikis, *Soil Mechanics*, East West Press Pvt Ltd.

Course Outcome:

To make students understand concepts of Soil Water

To provide brief explanation on consolidation theory

To explain in detail ground water hydraulics

SOIL DYNAMICS (4-0-0), 4 CREDITS

Course Objective:

1 .Ability to understand theory of vibration.
2. Ability to evaluate dynamic soil properties.
3. Ability to understand liquefaction of soils.
4. Ability to understand behaviour of retaining walls during earthquakes

COURSE CONTENTS:

Module I

Introduction: Soil mechanics and Soil Dynamics, Nature of Dynamic loads, Stress conditions on soil element under earthquake loading, seismic force for pseudo static analysis as per IS code.
Theory of vibration: Definitions, Harmonic motion, free and forced Vibration of a single degree freedom system with and without damping, Vibration Isolation, Theory of vibration measuring Instruments. Vibration isolation, spectral response.

Module II

Dynamic soil properties: Dynamic moduli, Dynamic elastic constants. Poission's Ratio, Damping ratio, Liquefaction parameters, Laboratory techniques, Field tests, Factors affecting shear modulus, Elastics modulus and Elastic Constants.
Dynamic Earth Pressure: Pseudo static methods, Displacement methods for active and passive case. Behaviour of Retaining walls during earthquakes. Modification of Coulomb's theory.

Module III

Liquefaction of soils: Definition, Mechanism of liquefaction. Laboratory studies, Dynamic Triaxial test, Cyclic simple shear test. Evaluation of zone of liquefaction in field. Vibration table studies, Field blast studies Evaluation of liquefaction using Standard Penetration Resistance. Factors affecting liquefaction and measures for antiliquefaction.

Module IV

Principles of machine foundation design: Typical machine and foundations. General requirements of machine foundation; Permissible amplitude, allowable soil pressure. Modes of vibration of a rigid foundation block, Methods of analysis, Linear elastic weight less spring method, Elastic half space method. Design procedure for block foundation, IS code practice.
Dynamic Bearing Capacity of Shallow Foundation: Criteria for satisfactory action of footing.
Pseudo static analysis, Bearing capacity of footings. Dynamic analysis of horizontal and vertical loads.

Course Outcome:

1 To make students understand Nature of Dynamic loads.
2 To provide brief explanation on Modification of Coulomb's theory
3. To explain in detail Design of machine foundation.

Rock Mechanics (4-0-0), 4 credits

Course Objective:

1 .Ability to understand engineering properties of rocks.

2. Ability to evaluate rock stresses and deformation around tunnels;
3. Ability to understand Foundations on rocks.
4. Ability to understand Modes of failure in rock mass

COURSE CONTENTS:

Module I

Introduction, Importance and application of rock mechanics to engineering problems; Classification, Lithological classification of rocks, Engineering classification of intact and fissured rocks, Classification of fissures, joints and faults; Engineering properties of rocks; Laboratory and site measurements;

Module II

Definition of stress in rock, Simple methods of determining in-situ stresses, Borehole over covering technique, Bore hole deformation gauges, Evaluation of rock stresses and deformation around tunnels;

Module III

Simple methods of tunnel design; Stability of rock slope, Modes of failure in rock mass, Analysis by simple field Bishop's method and use of Hoek's chart;

Module IV

Foundations on rocks, Limit equilibrium methods, Plastic equilibrium of foundations, Elastic solutions for loading and excavation of foundations, Consideration of uplift pressures; Methods of improving the properties of rock masses.

References:
1. Goodman, R.E. (1989), 'Introduction to Rock Mechanics', John Wiley, Chichester.
2. Hudson, J.A. and Harrison, J.P. (2000), ' Engineering Rock Mechanics', Pergamon Press, Amsterdam.
3. Roberts, A. (1977)., 'Geotechnology', Pergamon Press, England.
4. Stagg, K.G. and Zienkiewicz (1968)., 'Rock Mechanics in Engineering Practice', John Wiley and Sons, London.

Course Outcome:
1 To make students understand importance and application of rock mechanics to engineering problems.
2 To provide brief explanation on methods of improving the properties of rock masses.
3. To explain in detail tunnel design..

Finite element method (4-0-0), 4 credits

(same as CE 15068 Finite element method)

Course Objectives:

To introduce basic computer programming with MATLAB

To model different types of open channel flow using HEC-RAS

To introduce EPANET/WaterCAD for pipe network analysis

To use analytical methods for solving PDEs

To use different algorithms like SIMPLE and SOLA, introduction to FEM

COURSE CONTENTS:

Module I **(7 Hours)**

Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method.

Module II **(17 Hours)**

One and Two Dimensional Problems: Detail formulation including shape functions, stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria, Finite Element modeling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading.

Isoparametric Elements: Natural coordinates, isoparametric elements, four node, eight node elements. Numerical integration, order of integration

Module III **(8 Hours)**

Plate Bending: Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modeling.

Module IV **(8 Hours)**

Dynamic Considerations: General Equation of motion, Lagrange's approach, mass matrix, lumped and consistent mass matrices, Evaluation of eigenvalue and eigenvectors, stability problems.

Text Books:

1. C.S. Desai and J.F. Abel, Introduction to the Finite Element Method: CBS Publishers
2. R. D. Cook., Concepts and Applications of Finite Element Analysis, Wiley.

Reference Books:

1. Logan, D. L., A First Course in the Finite Element Method, PWS Publishing, Boston,

2. O. C Zienkiewicz .and R. L. Taylor, Finite Element Method, Mc Graw Hill

Course outcomes:

Ability to explain the concept of finite element methods

Ability to identify element properties and isoparametric elements

Ability to determine internal stresses in simple beam by direct stiffness method

Ability to determine internal stresses in plate bending problems

NUMERICAL METHODS IN ENGINEERING (4-0-0), 4 credits

(same as CE 15066 NUMERICAL METHODS IN ENGINEERING)

Course Objectives:

- To apply Computer- oriented methods for solving numerical problems in science and engineering
- To solve Numerically systems of simultaneous linear equations, nonlinear algebraic equations (root solving), differentiation and integration, ordinary differential equations, interpolation

COURSE CONTENTS:

Module I

Introduction to digital computers and programming-an overview, Errors-polynomial approximation interpolation: finite differences, Newton's formula for interpolation ,central difference interpolation formulae, interpolation with unevenly spaced points, divided difference and their properties, inverse interpolation and double interpolation

Numerical differentiation: errors in numerical differentiation, differentiation formula with function values.

Numerical integration: Trapezoidal rule, Simpson's 1/3rd & 3/8th rule, Romberg integration, newton cote's integration formula, Euler-maclaurin formula, Gaussian integration, numerical double integration

Module II

Solution of linear system - Gaussian elimination and Gauss-Jordan methods , necessity for pivoting, LU decomposition methods , Jacobi and Gauss-Seidel iterative methods sufficient conditions for convergence , Power method to find the dominant Eigen value and eigenvector Diagonal dominance, condition number, ill conditioned matrices, singularity and singular value decomposition. Banded matrices, storage schemes for banded matrices, skyline solver. Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method

Module III

Approximate solution technique, static condensation, Rayleigh-Ritz method, subspace iteration, Application of finite difference method, solution of equilibrium equations in dynamics, direct method, central difference method, Houbolts method, Wilson θ method, Newmarks method

Module IV

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method, Taylor's method and Runge-Kutta method for simultaneous equations and 2nd order equations - Multistep methods - Milne's and Adams' methods

Text Book

Numerical methods for Scientists and Engineers by M.K. Jain, S.R. Iyengar & R.K. Jain, Wiley Eastern Ltd.

Numerical methods in engineering and science, Grewal, B.S., Khanna Publishers, Delhi.

Reference Books

Mathematical Numerical Analyis By S.C. Scarborough, Oxford and IBH Publishing Company.

Introductory methods in Numerical Analysis by S.S. Sastry, Prentice Hall of India.

Theory and problems in Numerical Methods by T. Veeranjan and T. Ramachandran, Tata McGraw- Hill Publishing Company, New Delhi-2004.

Numerical Methods for Mathematics Sciences and Engineering 2nd ed. By John H. Mathews, Prentice Hall of India, New Delhi 2003.

Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyengar, Narosa-200 &

Computational engineering: introduction to numerical methods, Schafer, Michael, Springer Verlag, Berlin,

Numerical Methods in Science & Engg., Rajasekaran, S Chand Publication, 1983

Course Outcomes:

- Be aware of the use of numerical methods in modern scientific computing,
- Be familiar with finite precision computation,
- Be familiar with numerical solutions of nonlinear equations in a single variable,
- Be familiar with numerical interpolation and approximation of functions,
- Be familiar with numerical integration and differentiation
- Be familiar with numerical solution of ordinary differential equations
- Be familiar with calculation and interpretation of errors in numerical methods

Core Subjects: II Semester

Earthquake Analysis and Design (4-0-0), 4 credits

(Same as M.Tech –SE- Earthquake Analysis and Design)

Course Objectives:

- To study the earthquake characteristics and seismic inputs to structures
- To study the earthquake recording instruments and its characteristics
- To study various dynamic soil properties and their measurements
- To analysis and design the earthquake resistance buildings

COURSE CONTENTS:

Module I **(10 Hours)**

Characteristics of earthquakes; Earthquake response of structures; Seismology, seismic risk and hazard, Soil dynamics and seismic inputs to structures, Characterization of ground motion; lateral load calculation, base shear

Module II **(10 Hours)**

Earthquake intensity and magnitude; Recording instruments and base line correction; Predominant period and amplification through soil; Response spectrum, analysis, Spectral analysis

Module III **(10 Hours)**

Idealization of structural systems for low, medium and high rise buildings; Nonlinear and push over analysis, Dynamic soil-structure interaction, Earthquake design philosophy

Module IV **(10 Hours)**

Concept of earthquake resistant design; Code provisions of design of buildings;

Reinforcement detailing for members and joints, retrofitting and strengthening of structures, concept of base isolation design and structural control

Text Books:

1. Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992
2. Earthquake Resistant Design: Shrikhandee & Agarwal-PHI Publ

Reference Books:

1. Newmark N.M. and Rosenblueth E., 'Fundamentals of Earthquake Engg.', Prentice Hall, 1971
2. David Key, 'Earthquake Design Practice for Buildings', Thomas Telford, London, 1988.
3. Wiegel R.L., 'Earthquake Engg.', Prentice Hall, 1970
4. Blume J.A., Newmark N.M., Corning L.H., 'Design of Multi-storied Buildings for Earthquake ground motions', Portland Cement Association, Chicago, 1961

Course Outcomes:

- Ability to characterize various ground motions
- Ability to study seismograph data and analysis
- Ability to analyse and design of earthquake resistance buildings
- Ability for reinforcement detailing of RC members and joints based on code provisions

Stability Analysis of Slopes, Dams and Embankments (4-0-0), 4 credits

Course Objective:

1 To enable participants to design and inspect embankment and earthworks effectively
2 To fully understand the related science and engineering principles
3 To interpret test results and standards
4 To make the best choices on embankment construction and inspection methods
5 To learn the most common techniques for slope and embankment stabilization
6 To fully comprehend slope stability analyses and the signs of potential failures

Course Contents:

Module I

Landslide phenomenon: Types and causes of slope failures, Practical applications ; Stability analysis of infinite slopes with or without water pressures ;

Module II

Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method ; Effect of seepage, submerged and sudden draw down conditions ;

Module III

Design of slopes in cutting, Embankments and Earth dams; Site Investigation: Reconnaissance,

Module IV

Preliminary and detailed investigation, Investigation for foundations ; Advances in stability analysis of slopes

References :

1. L. W Abramson, T. S Lee, S Sharma and G M Boyce, Slope Stability and Stabilization Methods, Willey Interscience publications
2. B M Das, Principles of Geotechnical Engineering, Thomson Brooks/Cole
3. T W. Lambe and R V Whitman, Soil Mechanics, John Wiley & sons
4. V N S Murthy, Principles of Soil Mechanics and Foundation Engineering, UBS Publishers Private Ltd.

Course Outcome:

- Recognize potential failure modes or deformation types for soil slopes and embankments
- Identify the potential failure modes for soil slopes and the type of analysis required to evaluate stability of the slope
- Determine the stability of a slope using slope stability software
- Recognize the major design consideration for embankments constructed using earth fill, rock fill, and lightweight fill
- List the steps necessary for designing an embankment over compressible foundation soil
- Distinguish the common causes/triggering mechanisms for landslides/slope instabilities
- Categorize appropriate slope and embankment stabilization methods

Ground Improvement Techniques (4-0-0), 4 credits

(Same as CE 15046 Ground Improvement Techniques)

COURSE OBJECTIVES:

1 To know about Necessity of ground improvement

2 To explain the various methods of ground improvement technique.

3 To explain the Field compaction and its control.

4 To explain about soil stabilisation

5 To explain the Use of geo-synthetics and geo-cells in construction work.

COURSE CONTENTS:

Module – I

Introduction, Necessity of ground improvement, Dewatering, methods, Analysis and design of dewatering systems. Grouting types, Properties, Method of grouting, Ground selection and control.

Module – II

Compaction, Methods of compaction, Engineering prosperities of compacted soil, Field compaction and its control.

Module – III

Soil stabilization, Use of chemical additives, Stone columns, Principle, design and method of installation.

Module – IV

Reinforced earth, Concept, Materials, Application and design, Use of geo-synthetics and geo-cells in construction work.

Text books:

1. Ground Improvement Technique, P. Purusothom Raj

Reference Book

1. Foundation Design and Construction, M.J. Tomlinson

2. Foundation Engineering, G.A. Leonard, Tata McGraw Hill

3. Modern Geotechnical Engineering, Alam Singh, IBT Publishers

COURSE OUTCOMES:

On completion of the course, the students will be able to:

1 Analyze and able to find various engineering properties of soil.

2 Analyze and design of dewatering systems

3 Analyze and design the Stone columns

4 Analyze and design the Reinforced earth

Geotechnical Engineering Design (0-0-4), 4 Credits

Course Objective:

Ability to analysis and design slopes, embankments, retaining walls

Ability to calculate bearing capacity of soil used in dynamic analysis for foundation

COURSE CONTENTS:

Soil-Cement / Soil-lime Mix Design; Design of sheet pile and Retaining wall; Design of Well foundation; Design of slopes and embankments; Design of foundation subjected to dynamic load; Design of reinforced earth works.

Course Outcomes:

To enable students to design various geotechnical structures such as Slopes, embankments, retaining walls and foundation subjected to dynamic loading

Electives – II Semester

Advanced Environmental Geotechnics (4-0-0), 4 Credits

COURSE OBJECTIVES:

1 To know about waste generation and its impact on environment

2 To explain the engineering properties of various waste.

3 To explain the selection & design of landfill.

4 To explain the concept of ash pond disposal process and stability analysis of ash pond

5 To explain the various concept of waste remedial techniques.

COURSE CONTENTS:

Module I

Introduction: Forms of waste, engineering properties (determination and typical values), subsurface contamination.

Module II

Selection of waste disposal sites: Site selection – selection criteria and rating; Solid waste disposal: Ash Disposal facilities- Dry disposal, waste disposal, Design of ash containment system, Stability of ash dykes;

Module III

Contaminant transport through porous media: mechanisms- advective and dispersion; Municipal and hazardous waste landfill: Types- Dry cell, wet cell, bioreactor, Design- clay liners, geosynthetic clay liners for waste containment, cover and gas collection system. ;

Module IV

Remediation: Principle- planning, source control, soil washing, bioremediation.

References:

1. K. R. Reddy and H D Sharma, "Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies", John Willey, 2004.
2. R N. Yong, "Geo Environmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation", Thomson Telford, 2000.
3. L N Reddy and H.I. Inyang, "Geoenvironmental Engineering: Principles and Applications", Marcel Dek, 2000

COURSE OUTCOMES:

On completion of the course, the students will be able to:

1 Analyze and able to find various engineering properties of wastes.

2 Analyze and design engineering landfill.

3 Analyze and design the geosynthetics for waste containment.

4 Analyze and design ash pond dykes

Geoinformatics (4-0-0), 4 Credits

Course objectives

- Identify, locate, and acquire spatial data pertinent to projects in their field of interest, as well as pinpoint significant gaps in or problems with existing information.
- Evaluate the appropriateness of the existing data sources for use in a project.
- Understand the data creation process and create simple data sets and/or add to existing data
- Create spatial data from tabular information that includes a spatial reference
- Perform basic spatial analyses (attribute and spatial queries, buffering, overlays) as well as linking these methods together in a more complex analytical model.
- Create high-quality maps and associated graphics and text that clearly communicate spatial information and analyses.

COURSE CONTENTS:

Module I

Remote Sensing: Physics of remote sensing, Remote sensing satellites and their data products, Sensors and orbital Characteristics, Spectral reflectance curves for earth surface features, methods of remotely sensed data interpretation – Visual interpretation and Digital image processing, Application of remote sensing in natural resources management
Geographic Information System (GIS): Basic concepts of geographic data, GIS and its components, Data acquisition, Raster and Vector formats, Data editing, Spatial modeling, Data output, GIS Applications

Module II

Photogrammetry: Aerial Photographs – Basic terms & Definitions, scales, relief displacements, Flight Planning, Stereoscopy, Characteristics of photographic images, Fundamentals of aerial photointerpretation.

Module III

Global Positioning System (GPS): Introduction, Satellite navigation System, GPS- Satellite constellation, Space segment, Control segment, User segment, GPS satellite signals, Receivers, Static, Kinematic and Differential GPS

Module IV

Optimal Routing of Solid wastes using GIS- Case study.
Environmental Siting of Industries and Zoning Atlas Development
Re-modelling of Water Distribution System using GIS- Case study
Sustainable Urban Development Planning using GIS
Environmental Degradation Assessment using RS and GIS
Ground water vulnerability modeling using GIS

References:

1,, Anji Reddy (2001) 'Remote sensing and GIS', B.S. Publications, Hyderabad
2.. Burrough P.A. (1986), 'GIS for Land Resources Assessment', Oxford University Press, UK.
3.. Star, J.L, and Estes J.E., (1990) 'Geographic Information Systems: An Introduction',Prentice Hall Publications
4. Laurini R. and Thomson D. (1992), 'Fundamentals of Spatial Information Systems', Academic Press
5. Mishra H.C. (1997) 'GIS Handbook','GIS India, Shanti Nivas, Hyderabad
6. Floyd F. Sabins (1996), ;Remote sensing- Principles and Interpretations', W.H. Freeman & Co
7. Michael N. Demas (2000), 'Fundamentals of GIS', John Wiley & Sons, Inc.

Course Outcome:

Upon completion of this course, a fully-engaged student will be able to understand the fundamentals of geoinformatics

Earthquake Geotechnical Engineering (4-0-0), 4 Credits

Course Objective:

1.To know about structural and architectural engineering problems and solutions in attaining efficient earthquake-resistant structures and facilities.

2.To achieve seismic-resistant design and construction of structures and facilities,

3.To know about the different sources of damage that can be triggered by an earthquake.

COURSE CONTENTS:

Module I

Earthquake seismology – Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.

Module II

Earthquake ground motion – Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.

Module III

Ground response analysis – One-dimensional ground response analysis: Linear approaches, Equivalent linear approximation of non-linear approaches,
Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.

Module IV

Seismic design of foundations, Seismic slope stability analysis: Internal stability and weakening instability and Seismic design of retaining walls.

References:

1. Kramer S. L, Geotechnical Earthquake Engineering, Prentice Hall, 1996.
2. R. W. Day, Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002.
3. Seco e Pinto, Seismic behaviour of ground and Geotechnical structure, A. A. Balkema, 1997.
4. Naeim, F, The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.
5. Bolt, B. A, Earthquakes, W. H. Freeman and Company, 4th Edition, 1999.
6. Lourie, W, Fundamentals of geophysics, Cambridge University press, 1997.
7. Wang J. G. Z. Q and J. K Tim Law , Siting in Earthquake zones, A. A. Balkema, 1994.
8. Ferrito, J. M, Seismic design criteria for soil liquefaction, Tech. Report of Naval Facilities service centre, Port Hueneme, 1997.

Course Outcome:

1. Analyze and able understand earthquake magnitude, ground motion.

2. Analyze and able to estimate the damage potential to the structure

3. Analyze and able to understand the effects of earthquake on soil-foundation systems

Geo-engineering Investigation (4-0-0), 4 Credits

Course Objective:

1 .Ability to understand Geo-Engineering investigations for major industries
2. Ability to evaluate Methods of rock exploration
3. Ability to understand Geophysical Techniques for Terrain Evaluation

COURSE CONTENTS:

Module I

Introduction; Geo-Engineering investigations for dams and reservoirs, tunnels, Air fields and highways and Railway lines; Geo-Engineering investigations for coastal and offshore structures; Geo-Engineering investigations for canals and bridges; Geo-Engineering investigations for major industries, Thermal and Nuclear Power stations

Module II

Introduction to Rock Mechanics: Physical properties of rocks: Mineral composition, rock structure, texture; Classification of rocks: Litho logical classification, engineering classification, R Q D and core recovery of rock; Theoretical basis of rock mechanics - elasticity and plasticity Methods of rock exploration - geological, geophysical and drilling

Module III

Geo-Engineering Case Studies; Geophysical Techniques for Terrain Evaluation; Terrain Evaluation for Infrastructure development;

Module IV

Geo-Engineering Investigations for river valley projects; Dam-failure investigations

References:

1. Handbook of Geology in Civil Engineering by Robert F. Legget and Paul F. Karrow (McGraw Hill, 1983)
2. Engineering Geology Publications of G.S.I.

Course Outcome:

1. To make students understand Geo-Engineering investigations for dams and reservoirs
2. To provide brief explanation on Physical properties of rocks
3. To explain in detail Geo-Engineering Case Studie

Environmental Impact Assessment (4-0-0), 4 Credits

(Same as M.Tech –ESE - Environmental Impact Assessment)

Module I

National environmental policy act and its implementation: Terminology, Features of the National Environmental Policy Act, Screening in the EIA Process, Summary Statistical Information on EISs, EIA at the International Level, Utility of the EIA process, Expanded scope of EIA, Narrowed scope of EIA

Planning and management of impact studies: Conceptual Approach for Environmental Impact Studies, Proposal Development, Interdisciplinary Team Formations, Team Leader Selection and Duties, General Study Management, Fiscal Control

Module II

Simple method for impact identification: Background Information, Interaction Matrix Methodologies, Network Methodologies, Checklist Methodologies

Description of environmental setting: Conceptual Framework, Initial List of Factors, Selection Process, Documentation of Selection Process, Data Sources

Environmental indices and indicators: Background Information, Environmental-Media Index-Air Quality, Environmental-Media Index—Water Quality, Environmental-Media Index—Noise

Module III

Prediction and assessment of impacts on the Air environment: Basic Information on Air Quality Issues, Conceptual Approach for Addressing Air Environment Impacts

Prediction and assessment of impacts on the Surface-water environment: Basic Information on Surface-water Quantity and Quality, Key Federal Legislation, Conceptual Approach for Addressing Surface-Water –Environment Impacts

Prediction and assessment of impacts on the soil and ground-water environments: Background Information on the soil Environment, Background Information on Groundwater Quantity and Quality, Key Federal Legislation, Conceptual Approach for Addressing Soil and Groundwater-Environment Impacts

Module IV

Prediction and assessment of impacts on the noise environment**:** Basic Information on Noise, Key federal Legislation and Guidelines, Conceptual Approach for Addressing Noise-Environment Impacts
Prediction and assessment of impacts on the biological Environment: Basic Information on Biological Systems, Key Federal Legislation, Conceptual Approach for Addressing Biological Impacts

Environmental laws and policies – Environmental laws for managing Air, water, land, wastewater, solid waste, hazardous waste, natural resources

REFERENCES:

1. Canter L., (1995), "**Environmental Impact Assessment**", McGraw Hill.

2. Jain R.K., Urban L.V., Stacey G.S., (1977), "**Environmental Impact Analysis – A New Dimension in**

Decision Making", Van Nostrand Reinhold Co.

3. Rau and Wooten, (1981), "**Environmental Impact Assessment Handbook**". McGraw Hill.

4. Environmental Law, Sengar, PHI.

Soil-Structure Interaction (4-0-0), 4 credits

Course Objective:

1.To provide an understanding of the relevance and significance of soil-structure interaction in the case of different types of structures
2. Ability to evaluate Numerical analysis of finite plates
3. Ability to understand Beam on Elastic Foundation..
4. Ability to understand Elastic Analysis of Pile.

COURSE CONTENTS:

Module I
Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behavior ;

Module II

Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

Module III

Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions ;

Module IV

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.

References :

1. N.P. Kurien, Design of Foundation Sytems : Principles & Practices, Narosa, New Delhi 1992,
2. E.S. Melerski, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation, Taylor and Francis, 2006.
3. L.C. Reese, Single piles and pile groups under lateral loading, Taylor & Francis, 2000
4. G. Jones, Analysis of Beams on Elastic foundation, Thomas Telford, 1997.

Course Outcome:

1. Analyze and able understand soil-foundation interaction problems.

2. Analyze and able to estimate beams of finite length.

3. Analyze and able to understand Classification of finite beams in relation to their stiffness.

Groundwater Engineering (4-0-0), 4 credits

(Same as CE 15050 Groundwater Engineering)

Course Objectives:

To know the types of aquifers
To understand the surface and subsurface investigation in detail
To integrate the fundamental and basic knowledge of ground water movement
To introduce the different model studies
To know steady and unsteady ground water flow to wells in unconfined and confined aquifers
To understand the surface and subsurface investigation in detail
To understand the process of artificial recharge of ground water
To understand the process of sea water intrusion in coastal aquifers
To understand the concept of ground water basin management

COURSE CONTENTS:

Module-I

Groundwater Occurrence: Groundwater hydrologic cycle, origin of groundwater, rock properties effecting groundwater, vertical distribution of groundwater, zone of aeration and zone of saturation, geologic formation as Aquifers, types of aquifers, porosity, Specific yield and Specific retention. Groundwater Movement: Permeability, Darcy's law, storage coefficient. Transmissivity, differential equation governing groundwater flow in three dimensions, groundwater flow equation in polar coordinate system. Groundwater flow contours their applications.

Module – II

Analysis of Pumping Test Data – I: Steady flow groundwater flow towards a well in confined and unconfined aquifers – Dupuit's and Theim's equations, Assumptions, Formation constants, yield of an open well, well tests.

Analysis of Pumping Test Data – II: Unsteady flow towards a well – Non equilibrium equations – Thesis solution – Jocob and Chow's simplifications, Leak aquifers.

Tube wells- Types, strainers, yield of a tube well, Interference of wells, causes of failure, optimum capacity, rehabilitation and maintenance of tube wells.

Module – III

Surface and Subsurface Investigation: Surface methods of exploration – Electrical resistivity and Seismic refraction methods. Subsurface methods – Geophysical logging and resistivity logging. Aerial Photogrammetry applications along with Case Studies in Subsurface Investigation.

Artificial Recharge of Groundwater: Concept of artificial recharge – recharge methods, relative merits, Applications of GIS and Remote Sensing in Artificial Recharge of Groundwater along with Case studies.

Module – IV

Saline Water Intrusion in Coastal aquifer: Occurrence of saline water intrusions, Ghyben-Herzberg relation, Shape of interface, control of seawater intrusion. Groundwater Basin Management: Concepts of conjunctive use, Case studies.

Text Books:

1. Groundwater - H.M.Raghunath [Wiley Eastern Ltd.]

References :

1. Groundwater Systems Planning & Management - R.Willes & W.W.G.Yeh [Prentice Hall of India.]

2. Applied Hydrogeology - C.W.Fetta [CBS Publishers & Distributors]

3. Groundwater Hydrology - David Keith Todd [John Wiley & Son, New York.]

Course outcomes:

On completion of the course, the students will be able to:

- Identify types of aquifers carry out surface and subsurface investigation
- To locate groundwater visualise the occurrence and movement of groundwater
- Assess discharge potential of wells in unconfined and confined aquifers
- Carry out surface and subsurface investigation to locate groundwater
- Select suitable type of ground water recharge
- Assess sea water intrusion in coastal aquifers and its control
- Analyze conjunctive use of ground water

Optimization Techniques (4-0-0), 4 credits

(Same as M.Tech –TE - Optimization Techniques)

Course Objectives:

- To study and understand the concepts of linear programming
- To study the methods of nonlinear programming
- To study the various search methods

COURSE CONTENTS:

MODULE I

Linear Programming: Introduction and formulation of models; Convexity; simplex method; Two phase method; Degeneracy, non - existent and unbounded solutions; Duality in L.P.P. Dual simplex method, Sensitivity analysis; Revised simplex method; transportation and assignment problems.

MODULE II

Non-Linear Programming: Classical optimization methods; Equality and inequality constraints; Lagrange multipliers; & Kuhn Tucker conditions; Quadratic forms; Quadratic programming.

MODULE III

Search Methods: One dimensional optimization; Fibonacci search; multi dimensional search methods; Univariate search; gradient methods; steepest descent/ascent methods; Conjugate Gradient method; Penalty function approach.

MODULE IV

Dynamic Programming: Principle of optimality; Recursive relations; solution of L.P.Problem; simple examples. Integer Linear Programming: travelling salesman problem

Text book:

1. Optimisation Theory and Applications - S.S.Rao; Wiley Eastern Ltd., New Delhi

Reference Books:

1. Introduction to Optimisation - J.C.Pant; Jain Brothers; New Delhi.

2. Optimisation Method - K.V.Mital; Wiley Eastern Ltd. New Delhi.

Course Outcomes:

- To understand the concepts of linear programming
- To understand the methods of nonlinear programming
- To understand the various search methods