DEPARTMENT OF CIVIL ENGINEERING

COURSE STRUCTURE AND SYLLABUS

(1^{ST} – 4^{TH} SEMESTER)

FOR

M. TECH PROGRAMME

SPECIALISATION

IN

GEOTECHNICAL ENGINEERING

(EFFECTIVE FROM 2012-13)

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

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	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	0-0-4	4
7	Seminar – I	0-0-3	2
8	Comprehensive Viva Voce-I		2
TOTAL		20-0-07	28
II SEMESTER			
1	Earthquake Analysis and Design	4-0-0	4
2	Stability Analysis of Slopes, Dams and Embankments	4-0-0	4
3	Ground Improvement Techniques	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	0-0-4	4
7	Seminar – II	0-0-3	2
8	Comprehensive Viva Voce-II		2
TOTAL		20-0-07	28
III SEMESTER			
1	Dissertation interim evaluation		10
2	Comprehensive Viva		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. Groundwater Assessment and Development

9. Finite Element Method

10. Optimisation

Electives for II-Semester in Group-B

1.. Environmental Geotechnics

2. Geoinformatics

3. Earthquake Geotechnical Engineering

4. Geo-engineering Investigation

5. Environmental Impact and Risk Assessment

6. Numerical Methods in Engineering

7. Soil-Structure Interaction

Core Subjects: I semester

Advanced Soil Mechanics (4-0-0), 4 credits

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

Consolidation: Steady State flow, 2D and 3D seepage, transient flow; Compressibility and rate of consolidation, one, two, and three dimensional consolidation theories; Sand drains ; Critical state soil mechanics: Critical State Line, Hvorslev Surface, Yield Surfaces: Modified Cam-clay and Original Cam-clay ;

Module III

Elastic and plastic analysis of soil:- Constitutive relationships of soil; failure theories. Limit analysis-Upper bound theorems, lower bound theorems, limit equilibrium methods ; Soil Stabilization: Classification of stabilizing agents and stabilization processes.

Module IV

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.

References :

1. B M Das, *Advanced Soil Mechanics*, Taylor and Francis
2. R F Scott, *Principles of Soil Mechanics*, Addison & Wesley.
3. R.O. Davis and A.P.S. Selvadurai, *Elasticity and Geomechanics*, Cambridge University Press, New York.
4. Mitchell, James K, *Fundamentals of Soil Behaviour*, John Wiley and Sons
5. D.M. Wood, *Soil Behaviour and Critical State Soil Mechanics*, University of Glasg

Advanced Foundation Engineering(4-0-0), 4 credits

Module I

Shallow foundation: Bearing capacity factors. Effect of foundation shape, eccentricity and inclination of load, Influence of soil compressibility and water table.
Deformation modulus and settlement: Tsytovich equivalent stratum, 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

Theory of Elasticity and Plasticity (4-0-0)

Module I

Linear elasticity; stress, strain, constitutive relations, strain displacement relations, Equilibrium and compatibility equations, stress and displacement functions, Two dimensional problems in cartesian and polar coordinates, description of an elasticity problem as a boundary value problem, bending of beams- cantilever and simply supported beam, stress distribution for axi-symmetric problems, pure bending of curved bars, effect of circular holes on stress distribution in plates

Module II

Stress and strain in three dimensions; Principal stresses, maximum shearing stress, principal axes of strain, Stretching of prismatical bar by its own axis, Elementary problems of elasticity in three dimension

Module III

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

Module IV

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.

References

1. S.P. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw Hill
2. Hoffman and Sachs, Theory of plasticity
3. W. Johnson and P B Meller, Plasticity of Mechanical Engineers
4. C.R. Calladine, Plasticity for Engineers, Ellis Herwood Chichester, UK, 1985
5. M, Kachanov, Theory of Plasticity, MIR Publication

Geotechnical Engineering Laboratory

Standard and Modified Proctor Compaction Test; Permeability test; Direct Shear Test; Triaxial Shear Test (CU, CD, UU); C.B.R. Test (Unsoaked& soaked); Consolidation Test

Electives: I Semester

Soil Exploration and Analysis of Foundations

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

Clay Mineralogy and Expansive Soil

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.

Strength and deformation behavior of soils

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

Design of Retaining Structures (4-0-0), 4 credits

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.

Ground Water Flow through Porous Media

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.

Soil Dynamics(4-0-0), 4 credits

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.

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

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.

Groundwater Assessment and Development (4-0-0), 4 credits

Module I

Importance of GW, available water on earth, Hydrologic cycle, types of aquifer, storage coefficients, ground water basins,

Module II

Darcy's law, permeability, well hydraulics, pumping test, water wells, test holes and well loss, Methods of Drilling of deep wells, cable tool drilling method, rotary method, pumps. ;

Module III

Surface investigation of ground water, remote sensing, geo-physical exploration, electrical resistivity method, seismic refraction method, gravity and magnetic methods, water witching, sub surface investigation of ground water: test drilling, geologic logging, geophysical logging, resistivity logging,

Module IV

Artificial recharge of ground water, conjunctive use of water.

References:

1. *Ground Water Manuals, A water resources technical Publications*, Scientific Publishers, Jodhpur
2. L. Harvil and F. G. Bell, *Ground Water Resources and Development*, Butterworths, London.
3. H.M. Raghunath, *Ground Water*, New Age International Pvt. Ltd.
4. F. W. Schwartz & H. Zhang, *Fundamental of Ground Water*, John Willey & Sons.

Finite element method (3-1-0)

Module I

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

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.

Module III

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

Module IV

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

References

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.
3. O. C Zienkiewicz .and R. L. Taylor, Finite Element Method, Mc Graw Hill
4. C. S. Krishnamoorthy, Finite Element analysis-Theory and Programming, Tata Mc Hill.

Optimization (3-1-0), 4 credits

Module I

Basic concepts, Kuhn-Tucker conditions, linear and nonlinear programming,

Module II

Integer programming, geometric programming, dynamic programming, stochastic programming,

Module III

Genetic algorithms, simulated annealing, concepts of homogenization.

Module IV

Applications in the design of reinforced concrete and steel- beams, columns, frames and plates. Treatment of shape and topology variables. Introduction to Structural Control.

References

1. Arora, J.S., Introduction to Optimization, McGraw Hill, Intl Edn, 1989.
2. Rao, S.S., Optimization: Theory and Applications, Wiley Eastern, 1992.

Core Subjects: II Semester

Earthquake analysis and design (3-1-0)

Module I

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

Earthquake intensity and magnitude; recording instruments and base line correction, Predominant period and amplification through soil, response spectrum, analysis, spectral analysis

Module III

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

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

References:

1.. Clough R.W. and Penzien J., 'Dynamics of Structures'. McGraw-Hill, 2nd edition, 1992
2. Earthquake Resistant Design: Shrikhandee & Agarwal- PHI Publ
3. Newmark N.M. and Rosenblueth E., 'Fundamentals of Earthquake Engg.', Prentice Hall, 1971.
4. David Key, 'Earthquake Design Practice for Buildings', Thomas Telford, London, 1988.
5. Wiegel R.L., 'Earthquake Engg.' Prentice Hall, 1970.
6. Blume J.A., Newmark N.M., Corning L.H., 'Design of Multi-storied Buildings for Earthquake ground motions', Portland Cement Association, Chicago, 1961.
7. Proc. World Conferences on Earthquake Engg., 1956-1992.
8. I.S. Codes No. 1893, 4326, 13920 etc.

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

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.

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

Module I

Introduction: Necessity of ground improvement, methods of ground improvement, selection of suitable ground improvement technique; Dewatering: methods, Analysis and design of dewatering systems, Preloading with sand drains and fabric drains; 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, vibroflotation, Dynamic compaction and consolidation; Soil stabilization: Chemical and mechanical stabilization, use of chemical additives, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing;

Module III

Stone columns: Principle, design and method of installation; Reinforced earth: Reinforcement-Soil interaction; Concept, Materials, Application and design, Use of geo-synthetics and geo-cells in construction work;

Module IV

Ground Improvement Techniques for Geotechnical Earthquake Engineering and mitigation of liquefaction potential, Case studies on ground improvement techniques

References:

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
4. Koerner R.M., *Construction and Geotechical Methods in Foundation Engineering*, McGraw Hill, 1994.
5. Purushothama Raj, P.*Ground Improvement Techniques*, Laxmi Publications (p) Ltd., New Delhi.
6. Moseley M.P., *Ground Improvement* Blockie Academic and Professional, Chapman and Hall, Glassgow, 1993.
7. Jones J.E.P., *Earth Reinforcement and Soil Structure*, Butterworths, 1995.
8. Craig, R.F., *Soil Mechanics*, Van Nostrant Reinhold Co.,New York, 1993.

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

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

Electives – II Semester

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

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- addective 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

Geoinformatics (4-0-0), 4 Credits

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.

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

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.

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

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.

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

Module I
Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process; Screening and scoping criteria; Rapid and comprehensive EIA; Specialised areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis;

Module II
Expert system and GIS applications; Uncertainties. Legislative and environmental clearance procedures in India and other countries, Siting criteria; CRZ; Public participation; Resettlement and rehabilitation.

Module III
Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical, biological and socio-economic environment; Environmental management plan; Post project monitoring, EIA report and EIS; Review process. Case studies on project, regional and sectoral EIA. Risk assessment fundamentals and methodology, case studies.

Module IV
Environmental laws and policies – Environmental laws for managing Air, water land, waste water, solid waste, hazardous waste, natural resources, energy, ecology and environment, Environmental guide lines and regulation, Environmental auditing, Environmental guidelinews and regulations, environmental auditing, monitoring, reporting, economics and accounting.

References:
1. A.Chadwick, *Introduction to Environmental Impact Assessment*, Taylor & Francis, 2007.
2. Larry, W. Canter, *Environmental Impact Assessment*, McGraw Hill Inc. Singapore, 1996.
4. R.Therirvel, E. Wilson, S. Hompson, D. Heaney, D.Pritchard, *Strategic Environmental Assessment Earthscan*, London, 1992.
5. A.Gilpin, *Environmental Impact Assessment-Cutting edge for the 21st century*, CUP, London, 1994.
6. Paul, A Erickson, *A Practical Guide to Environmental Impact Assessment*, Academic Press, 1994.

NUMERICAL METHODS IN ENGINEERING (3-1-0)

Module- I

Introduction to digital computers & Programming - an overview; Errors - polynomial approximations and interpolations - Numerical differentiation & Integration;

Module- II

Matrices - Eigenvalues and Eigenvectors - nonlinear equations

Module- III

Harmonic and biharmonic equations - solutions, convergence, completeness & stability. Finite Difference scheme - Implicit & Explicit scheme.

Module- IV

Special topics: Theory of computations, Computational complexities, B.E.M., Glimpses of Fuzzy, Neural Network, Fractal theory, surface fitting.

References

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

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.