CIVIL ENGINEERING DEPARTMENT

M.TECH. GEOTECHNICAL ENGINEERING

Course of Study & Scheme of Examination
2016-17

Maulana Azad National Institute of Technology,
Bhopal

SCHEME

M. TECH. IN GEOTECHNICAL ENGINEERING

FIRST SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
GEO511	Advanced Geotech Engg.	3	-	-	3
GEO512	Foundation Engg. 1 (Shallow Foundation)	3	-	-	3
GEO513	Machine Foundation Analysis	3	-	-	3
	Elective 1	3	-	-	3
	Elective 2	3	-	-	3
	Open elective 1	3	-	-	3
GEO514	Lab. Practice 1	-	-	3	2
GEO515	Seminar 1	-	2	-	2
					Total credits 22

SECOND SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Total Credits
		L	T	P	
GEO521	Soil Dynamics	3	-	-	3
GEO522	Design and Construction of Machine Foundation	3	-	-	3
GEO523	Foundation Engg. 2 (Deep Foundation)	3	-	-	3
	Elective 3	3	-	-	3
	Elective 4	3	-	-	3
	Open elective2	3	-	-	3
GEO524	Lab. Practice 2	-	-	3	2
GEO525	Seminar 2	-	2	-	2
					Total credits 22

LIST OF DEPARTMENT ELECTIVES

GEO531 Software Application in Geotechnical Engineering
GEO532 Forensic Geotechnical Engineering
GEO533 Reinforced soil structure
GEO534 Rock mechanics and engineering Geology
GEO535 Environmental Geotechnique
GEO536 Theory of Elasticity and Plasticity
GEO537 Geotechnical Investigations and Field Testing of Soils
GEO538 Critical State Soil Mechanics
GEO539 Strength and Deformation Behavior of Soils
GEO540 Modern Geotechnical Processes
GEO 541 Expansive And Shrinkable Soils

LIST OF OPEN ELECTIVES

GEO551 Advanced Mathematics
GEO552 Advanced Soft Computing Techniques
GEO553 Probability and Statistical methods
GEO554 Finite Element Method
GEO555 Earthquake Engineering
GEO556 Ground Improvement Techniques

THIRD SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
GEO611	Major Project Dissertation Phase- I	-	-	-	23
					Total credits 23

FOURTH SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
GEO648	Major Project Dissertation Phase- II	-	-	-	23
					Total credits 23

SYLLABUS

M.TECH IN GEOTECHNICAL ENGINEERING

FIRST SEMESTER

GEO511 ADVANCED GEOTECH ENGINEERING

Geological cycle of formation, clay mineralogy base exchange, pH values, clay water system, Plasticity in soils. Empirical connection of index properties with engineering parameters. Common soil deposits in Madhya Pradesh and their typical characteristics. Problems of black cotton soil. Permeability, Flow nets, quick conditions, flow of water in unsaturated soils. Consolidation, Calculation of settlements time rate of settlement. Three dimensional consolidation, design of sand/rope drains. shear strength of soil, pore pressure coefficients and their use. Introduction to rock mechanics. physical and mechanical properties of rocks, in-situ stress in rock behavior of rock in tri-axial compression.

References

1. Soil Mechanics.- Lambe and Whitman , Wiley.
2. Physical properties of soils- Means and Parcher, Charles E. Merrill Publishing
3. Foundation Analysis & Design- Joseph E. Bowles, McGraw-Hill
4. Foundations on expansive soils- Chen, Amsterdam ; New York :

GEO512 FOUNDATION ENGINEERING 1 (SHALLOW FOUNDATIONS)

The components and classification of foundation, Choice of foundation. Soil Design Parameters: Bearing capacity, settlement, depth of foundation, depth of soil exploration, footings subjected to moments, footings subjected to Tension. Study of IS Codes: IS : 1498,1982,IS : 1888, IS : 2131, IS: 6403 and IS : 1904 & All other relevant codes with latest editions. Shallow Foundations design of footings in clay and sand, Raft Foundations Floating rafts. Retaining Structures: Types, Stability Analysis, Anchored- bulkheads.

References

1. Basic and Applied Soil Mechanics - Gopal Ranjan and Rao, New Age International
2. Principles of Foundation Engineering - B.M. Das ,Wadsworth Publishing Co Inc
3. Design Aids in Soil Mechanics & Foundation & Engg.- S.R. Kaniraj, Tata McGraw Hill,
4. Soil Mechanics & Foundation Engg- P. Purshothama Raj, Pearson Education India, 2008

GEO513 MACHINE FOUNDATION ANALYSIS

Vibrations: phenomenon of beat, damping, different types of excitation- impulse, inertial, harmonic, periodic, transient, Overturned & under tuned machine Foundation. Magnification / Amplification Factor. Equivalent mass, equivalent spring constant, Equivalent forcing function.

Formulation of Mathematical Model: Transient or free vibrations, steady state solution of forced vibration. Dynamic system subjected to rotating mass type Excitation. Two degree of freedom system without and with damping, multi degree of freedom system. Vibration of block foundation. Induced Vibrations due to Vehicular traffic and blast waves, vibration of structures due to earth quake and man made ground vibration, structural damage and human sensitivity to the vibration. Vibration isolation- active and passive, various methods of vibration isolation.

References

1. Soil dynamics and machine foundation - Swami saran, Galgotia Publication Pvt.Ltd.
2. Soil dynamics - Shamsher Prakash, McGraw-Hill,
3. Soil dynamics- Bharat Singh andV.K. Puri, John Wiley and Sons, New York, 1990.
4. Mechanical Vibration- Grover, Nem Chand & Bros

GEO514 LAB PRACTICE 1 SOIL MECH

Laboratory Work: Laboratory experiments to cover the above course.

GEO515 SEMINAR 1

SECOND SEMESTER

GEO521 SOIL DYNAMICS

Historical development of soil dynamics, Damage to foundations and earthen structures due to vibrations and other dynamic forces. Earthquakes and related terminology. Propagation of Elastic waves in soil.

Dynamic soil properties factor affecting, Determination using various laboratory and field methods, selection of appropriate value of dynamic soil property for the Design of Structure subjected to vibration.

Dynamic earth pressures: Active and Passive Pressures, Retaining wall problems under Dynamic loads. Dynamic Bearing Capacity of soils. Dynamic characteristics of Pile Foundation, Liquefaction of soils.

References

1. Soil dynamics and Machine foundation - Swami saran, Galgotia *Publications*
2. Soil dynamics - Shamsher Prakash, McGraw-Hill
3.Analysis and design of foundation for vibration-P.J.Moore, Oxford & IBH Publishing Company.

GEO522 DESIGN AND CONSTRUCTION OF MACHINE FOUNDATIONS

Machine foundation types and fundamental principles for the design of machine foundation under static and vibratory systems. Criteria for design. Dynamic Soil investigation: Theoretical and practical determination of elastic properties of soil, Behaviour of soil under dynamic loads, determination of allowable soil stress for dynamic loads.

Computation of machine foundations taking into consideration the vertical, horizontal and rotational vibrations for heavy machines like mechanical hammers, reciprocating engines, turbines, rolling mills, forging presses and crushing machines. Structural details for machine foundations- Concreting of foundations and their connection to superstructure including details of form work-reinforcements. Floors and their connection to buildings. Prestressed concrete, brick work and shallow foundations. Plants and equipments used for the construction of machine foundations. Examples of heavy machine foundations in one major design of heavy machine, Isolation of machine foundations.

References

1. Machine Foundation Design - K.G. Arora, D-CAD Publishers, New Delhi – India
2. Soil dynamics - Shamsher Prakash, McGraw-Hill,
3. Soil dynamics - Bharat Singh and V.K. Puri, John Wiley and Sons, New York, 1990.
4. Mechanical Vibration- Grover, Nem Chand & Bros

GEO523 FOUNDATION ENGINEERING 2 (DEEP FOUNDATION)

Introduction to various types of deep foundations, Piles, Types, mechanics of load transfer, negative skin friction, determination of ultimate load capacity of individual and group of piles, under reamed piles. Laterally loaded piles study of Codes: Study of all the codes of Indian Standards relevant to deep foundations, such as IS: 8009, IS: 3955, IS 2911 and relevant IRC Codes latest editions. Well Foundations: Classification, forces acting and stability construction techniques, tilt and shift, dewatering.

Analysis and design of piers, supporting system for cuts, Arching of soils.

References

1. Deep Foundations and Geotechnical insitu Testing- R.Y. Liang, Feng Zhang
2. Foundation Analysis and Design- J.E. Bowles, McGraw Hill, companies, Inc.
3. Foundation Design Manual- N.V. Nayak, Jain Book Depot (JBD)

GEOTECHNICAL ENGG. LABORATORY PRACTICE – 2

Demonstration of the Block Vibration Test.

Demonstration of the Field Vane Shear Test.

Demonstration of the Field C.B.R. Test.

Demonstration of the Plate Load Test.

Demonstration of the Electrical Resistivity Test.

Complete Investigations and Preparation of the Geotechnical Investigation Report of a Sample Field Site.

GEO525 SEMINAR 2

DEPARTMENT ELECTIVES

GEO531 SOFTWARE APPLICATIONS IN GEOTECHNICAL ENGINEERING

Introduction to modeling, Constitutive models (elasticity, ideal plasticity, Mohr-Coulomb model, plasticity with hardening). FEM Analysis of simple Geotechnical Problems using PLAXIS Software. Theory and modeling of shallow foundations, deep foundations, retaining walls, reinforcement structures (nail, geosynthetic), embankments and cuttings, and underground structures. Application of ANN Modeling in area of Geotechnical Engg,

References :

1. Neural Networks ,Fuzzy Logic and Genetic Algorithm - Synthesis and Applications- Rajasekaran S., Vijaylakshmi and Pai G.A, PHI Learning Private Limited

GEO532 FORENSIC GEOTECHNICAL ENGINEERING

Introduction, Types of Damages, Preliminary Information, Accepting Assignment, Planning the Investigations, Site Investigations, Settlement of sub structures, Expansive soils, types of expansive soil movements, Foundation design for expansive soils, lateral movements of soils, Ground water moisture related problems of substructures, Repairs and crack diagnosis.

References:

1. Forensic Geotechnical Engineering Developments in Geotechnical Engineering- V.V.S. Rao and G.L. Shivakumar Babu (eds) Springer India
2. Geomechanics of failures- A.M. Puzrin et al, Springer Science + Business Media B.V.2010.

GEO533 REINFORCED SOIL STRUCTURES

Reinforced Earth: History, field of applications, natural fibres, overview of Geo-textiles, Geo-membranes, Geo-grids, Geo-nets, Geo-webs, Geo-mats and Geo-composites, economic aspects of their applications, Functions of Geo-synthetics, Soil Reinforcement: Basic principle of soil reinforcement, shear strength of reinforced soil, Factors affecting, installation techniques, Design of reinforced earth retaining wall: Internal stability, External stability, soil nailing. Calculation methods: Basic concepts, embankment on soft soils, internal stability, overall stability, foundation stability and bearing capacity failures Construction of the steep slope, retaining walls-external stability, internal stability.

Application of Geo-synthetics in Roads and Railways, drainage system- Control of groundwater level, dewatering and reclamation of land, use of Geo-membranes – For lining applications, management and maintenance.

References

1. Geo-textiles and Geo-membranes in Civil Engg.- Gerard P.T.M. Van Santvrot A. A., CRC Press
2. Reinforced Soil and Geo-textiles- J. N. Mandal, proceedings FIGC- 1988, Oxford and IBH publishing company private Ltd., New Delhi.
3. Geosynthetics: Applications, Design and construction- R. J. Tarmat, proceedings First Europian Geosynthetics Conference, Netherland A. A. Balkema, publisher-Brookfield, U.S.A.
4. Geosynthetics World- J. N. Mandal ,John Wiley & Sons (Asia) Pvt. Ltd

GEO534 ROCK MECHANICS & ENGINEERING GEOLOGY

Sub surface Exploration: General Principles, Geophysical explorations, Structural features of Rock Masses, Engineering Properties of intact/in-situ rock, Rock mechanics. Model Simulation of Rock mechanics Problems: Rock mass joints behaviour and stability of slopes. Dynamic behaviour of Rock mass: Rock as a structural foundations: Foundation problems in Igneous, Sedimentary and metamorphic rocks, Geotechnical investigation for dam, Tunnels, Bridges and pavements. Ground water Geology: Classification and distribution of ground water, Geologic control of Ground water, free and confined ground water, hydrologic properties of water bearing material except soil.

References

1. Introduction to rock mechanics- Rechard E. Goodman, John Wiley & Sons.
2. Rock Mechanics- B.H. Beny H.G. Brady, Springer Netherlands.
3. Engineering Rock Mechanic (An Introduction to the principles)- John A. Hudson & John P. Harison, Elsevier; Digital Edition.
4. Geological Engineering- Luis I , Gonzalez De Vallejo, CRC Press.
5. Geology for Engineers- Joseph M. Trefethen, Princeton, N.J., Van Nostrand.

GEO535 ENVIRONMENTAL GEOTECHNIQUE

Flow of water in soils; Energy states of water in soil, principles of flow in saturated soils, Governing equation for saturated flow, principle of flow in unsaturated soils, Governing equation for unsaturated flow. Mass Transport and mass transfer mechanisms, Site characterization and contaminant release mechanism. Vaporization, dusting, leaching. Principles of site and Geo-material treatment techniques:- natural attenuation principles, phyto remediation and bioremediation principles, ex-situ stabilization and chemical treatment principles. Waste containment system containment effects on source. Engineered Landfills dry tomband bioreactor concepts. Environmental impact assessment and management - preparation of environmental base map, Principles of NAPL.

References

1. Geo-Environmental Engineering-Principles and Applications- Lakshmi N. Reddy and Hilary. I. Inyang, CRC Press.

GEO536 THEORY OF ELASTICITY AND PLASTICITY

Theory of Elasticity: Analysis of stress, stress vector at a point across an area components of stress tensor and sign convention. Definition of surface and body forces. Principal stress, Mohr's circle, Stress invariants, transformation of axes complementary shear. Equations of stress equilibrium. Saint Venant's Principles. Strain tensor, strain invariants, spherical and Deviator stress and strains, Transformation of axes, Mohr's Diagram for strain, Relations between strain and displacements, Equations on compatibility.

Generalised Hooke's law. Relationship between the various elastic constants e.g. between Young Modulus of Elasticity, Poisson's Ration. Modulus of Rigidity and Bulk modulus. Plain stress and Plain strain: Formulation of problem in two dimension. Airy's stress function. Polynomial and series solutions to the Biharmonic equations. Airys stress function in polar

Coordinates. Solutions for displacements. Two dimensional problems will include the following: (1) Cantilever loaded at ends (2) Stress in a plate with a circular hole (3) Concentrated load on a semi infinite plate. Introduction to the general three –dimension problem in theory of Elasticity. Equations expressed in terms of displacements. Boussinesq's solution.

Theory of Plasticity: The stress strain curve. The ideal plastic body. Theories of failure and Criterion for yielding (plasticity conditions) Material, Reuss's and Henky's theories of plastic deformations work of plastic deformation. Two dimensional plastic flow problems: incompressible two dimensional flow, Stresses in plastic Materials in conditions of place strain. Eqilibrium equations referred to slip lines. The simples stop line fields. Example- strip load on a semi infinite body.

References

1. Theory of Elasticity- Timoshenko and Goodier, Mcgraw Hill; 3rd Edition edition.
2. Applied Elasticity- Chi-teh Wang. McGraw-Hill.
3. Mechanics of deformable solids- Irving Shames, Krieger Pub Co.
4. Elasticity in Engineering- Scholer, McGraw- Hill Publications.

GEO537 GEOTECHNICAL INVESTIGATION AND FIELD TESTING OF SOILS

Need and importance of site investigations, sits exploration and phasing of site exploration programme, Spacing and depth of bore holes, significant depth. Methods of site exploration-soundings, bore holes, drilling methods and equipment wash boring, rotary boring and percussion boring in soils, stabilization of bore holes, Procuring and handling of disturbed and un disturbed samples, various types of samplers and sampling techniques, their relative merits and suitability in particular cases, lowering of water table.

Geophysical methods of soil exploration. Observation of ground water level and pressure Soil testing techniques used in Laboratory, field tests for permeability, in place density, vane test, plate bearing test, standard penetration test. Discussion and seminar on published papers of recent origin connected with exploration and testing of soils, case histories of failure of structures.

References

1. Basic and Applied Soil Mechanics- A.S. Rao and Gopal Ranjan, New Age International.

GEO538 CRITICAL STATE SOIL MECHANICS

Introduction to constitutive modeling of soils, stress and strain parameters, elasticity (including anisotropy), plasticity and yielding (yield surface, hardening law, flow rule), volume changes under isotropic stress states or one-dimensional straining (normal compression line, swelling lines), shearing and the critical state line, drained and undrained shearing of normally consolidated and over consolidated samples, Modified Cam Clay as an example of a simple elasto-plastic model, strength of soils, index tests interpreted through critical state soil mechanics, application of critical state soil mechanics, complexities of real soil behaviour and development of advanced constitutive models.

References:

1. Soil behaviour and critical state soil mechanics- Wood, D.M., Cambridge University Press
2. An introduction to the mechanics of soils and foundations- Atkinson, J.H., McGraw-Hill Book Co.
3. The mechanics of soils: an introduction to critical- Atkinson, J.H. and Bransby, P.L.,Indo American Books.
4. Finite element analysis in geotechnical engineering- Potts, D.M. and Zdravkovic, L,Thomas Telford Ltd .

GEO539 STRENGTH AND DEFORMATION DEHAVIOUR OF SOILS

Clays and Sands, Behavior of Normally Consolidated Clay, Behavior of over consolidated Clay, Soil Composition, Water Absorption, Clay-water Forces and Measurement of Soil Suction, Soil Structure, Basic Strength Principles and Stress-Strain Behavior of Simple Clay; Soil Modeling, Types of Triaxial Tests and Strength Principles, Mechanisms of Volume (Pore Pressure) Change Hvorslev Parameters and Extension Tests Modified Cam-Clay Model, Consolidation Behavior of Saturated Soils:

2-D and 3-D Settlement (Initial, Amount and Rate of Consolidation) Problematic Soils (Sensitive, Organic, Expansive, Collapsing, Varved, etc.) Stability Problems and Drained Strength Analyses Effective Stress Parameters for Drained Analyses Undrained Strength-Deformation Behavior of Saturated Clays and Undrained Strength Analyses, Conventional Practice for UU Case (In Situ and Lab Techniques) Sample Disturbance, Stress System (s2 and Anisotropy), Staged Construction (CU Case), Strength-Deformation Behavior of Cohesionless Soils Strength Components and Steady-state Line, Effects of Density, Confinement Drained and Especially Undrained Behavior Effects of Sand Structure (Anisotropy, Stress History, Heterogeneity etc.) Compacted Clays, Compaction Process (Fundamentals) Structure and

Engineering Properties, Effective Stress with S < 100%, Constitutive, Modeling, Miscellaneous including Pre-compression, Vertical Drains, and Case Histories

References

1. Behaviour of Saturated Expansive Soil- R. K. Kathi, A. R. Khati, A.A. Balkema., Taylor & Francis
2. Foundation on Expansive Soils- Fu Hua Chen, Elsevier.

GEO540 MODERN GEOTECHNICAL PROCESSES

Soil Stabilization- Mechanical Stabilization, role of fine and coarse fraction, method of mixing soils to get designed plasticity index and particle size distribution stabilization using cement, lime, fly ash etc., effect on soil properties. Compaction. Laboratory compaction, comparison of properties of oil compacted to wet -of and dry-of OMC. Field compaction- Available equipments and their suitability, methods for shallow surface compaction, deep compaction. Difficulties in compaction. Dewatering Methods-Dewatering of excavation and drainage of slopes, electro-kinetic dewatering. Pre loading and use of vertical drains. Grouting- Grout materials, grouting techniques. Reinforced Earth. Design of retaining wall. Geosynthetics- various types, testing of geo-synthetics, case studies.

References

1. Engineering Principles of Ground Modification- M. R. Hausemann, McGraw-Hill Education
2. Soil Stabilization- O.G.Ingles and J.B. Metcallf, Wiley Publication
3. Earth and Rockfill Dams- Bharat Singh and Sharma, Sarita Prakashan

GEO 541 EXPANSIVE AND SHRINKABLE SOILS

Origin of expansive soils , physical properties of expansive soils, mineralogical composition – identification of expansive soils, civil engineering problems due to expansive soil, swelling characteristics- laboratory tests, prediction of swelling characteristics, remedial measures to control swelling, chemical stabilization, horizontal moisture barriers, vertical moisture barriers, surface and subsurface drainage, pre wetting, soil replacement, sand cushion techniques, CNS layer technique, Foundations of Expansive soils, under reamed piles Design and construction.

References

1. Basic and Applied Soil Mechanics- Gopal Ranjan& A.S.R Rao, New Age International
2. Hand Book on Under – reamed and Bored Compaction Pile Foundation- CBRI, Roorkee
3. Measurement of Swelling Pressure of Soils: IS : 2720 (Part XLI) – 1977 , Bureau of Indian Standard.
4. Search for Solutions in Expansive Soils- R.K. Katti, http://www.igs.org.in/annual-lecture/annual-lecture-1978.pdf
5. Analysis and Design of Substructures- Limit Stress Method: Swami Saran, CRC Press

OPEN ELECTIVE

GEO551 ADVANCED MATHEMATICS

Ordinary and partial differential equations: Application to boundary value problems. Laplace and wave equations, time dependent equations with vibratory systems. Theory of complex variables and conformal mappings: Complex numbers, the elementary functions, Cauchy's theorem, infinite series. Elementary conformal mapping – conformal transformation of harmonic functions and boundary conditions. Matrix Theory: System of linear equations determinate, finite dimensional vector, space matrices- matrix rotation. Calculus of tensors with its applications to differential geometry. Application of matrices and tensors to simple problems in soil mechanics. Numerical methods in engineering analysis: Interpolation and relaxation methods. Methods of minimum potential energy, variational principles, Rayleigh – Ritz Method, Galerkin's Method, Treffitz's Procedure, Pargers Function, Percubation and collection procedures. Solution of linear and nonlinear equations by mechanical methods.

References:

1. Higher Engg. Mathematics - S Grewal, Khanna Publications
2. Engineering Mathematics- S. S. Shastri, PHI Learning Pvt. Ltd.
3. Advance Mathematics for engineers- Gorakh Prasad, John Wiley & Sons.

GEO552 ADVANCED SOFT COMPUTING TECHNIQUES

Artificial Neural Systems – Perceptron – Representation – Linear separability – Learning – Training algorithm – The back propagation network – The generalized delta rule – Practical considerations – BPN Geomatic applications. Hopfield nets – Cauchy training – Simulated annealing – The Boltzmann machine. Associative memory – Bidirectional Associative Memory Network – Geomatic Applications.

Counter propagation network and self organizing maps:CPN building blocks – CPN data processing. SOM data processing - Adaptive Resonance Theory network - Geomatic Applications

Fuzzy logic**:** Fuzzy sets and Fuzzy reasoning – Fuzzy matrices – Fuzzy mebership functions – Operators Decomposition – Fuzzy automata and languages – Fuzzy control methods – Fuzzy decision making

Neuro – fuzzy modeling: Adaptive networks based Fuzzy interface systems – Classification and Regression Trees – Data clustering algorithms – Rule based structure identification – Neuro-Fuzzy controls – Simulated annealing – Evolutionary computation - Geomatic Applications.

References

1. Neural Networks – Algorithms, Applications & Programming Techniques- James Freeman A. and David Skapura, Addison-Wesley
2. Fuzzy Logic with Engineering Applications- Timothy J.Ross, Wiley
3. Artificial Neural Networks -Yegnanarayana B,. Prentice Hall India Learning Pvt. LTM.
4. Fundamentals of Neural Networks- Lqurene Fausett , Pearson; US ed edition

GEO553 PROBABILITY AND STATISTICAL METHODS

One dimensional random variables: Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable, weighting of observations.

Two dimensional random variables: Joint distributions– Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

Estimation theory: Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines, Propagation of systematic and accidental errors, theory of least squares and its application to adjustment problems.

Testing of hypothesesCovariance matrix – Correlation Matrix – Multivariate Normal density function Principal components – Sample variation by principal components – Principal components by graphing.

Multivariate analysis Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

References

1. Probability and statistics for Engineering and the Sciences - Jay L. Devore, Cengage Learning, Inc
2. Applied multivariate methods for data analysis - Dallas E Johnson ,Duxbury Resource Center
3. Probability and Statistics for Engineers- Richard Johnson Prentice Hall India
4. Applied Multivariate Statistical Analysis- Richard A. Johnson and Dean W. Wichern, Prentice Hall,

GEO554 FINITE ELEMENT METHOD

Fundamental concepts: Introduction, stresses & equilibrium, Boundary conditions, Stress-displacement relations, stress strain relations, Galerkin method, St. Venant's principle. Matrix algebra & Gaussian Elimination, one dimensional problems, Co-ordinates, Shape functions, Potential energy approach, Assembly of global stiffeners, Matrix & Load Vector, The finite Element equations and treatment of boundary conditions. Two Dimensional Problems: F. E. Modeling, Problem modeling & boundary conditions, Orthotropic materials Numerical Treatment of some geo-mechanical problems in two dimensions. Three dimensional Problems: Introduction to 3-D problems, Problem & boundary conditions development.

References

1.An Introduction to Finite Element Method- Reddy, J. N. , McGraw-Hill Education
2.Finite Element Analysis Theory and Programming - Krishnamoorthy, C.S., Tata McGraw-Hill Education
3.FiniteElement Handbook- H. Kardestuncer and Douglas H. Norrie, McGraw-Hill, Inc.

GEO555 EARTHQUAKE ENGINEERING

Introduction to Seismology and plate tectonics. Definitions : Focus, Epicenter, Magnitude, Intensity, etc. Geotechnical aspects of Earthquake Engineering. Codal provisions for Earthquake resistant design and construction of R.C.C. Structures, Masonry Structures, etc. Case studies of previous Earthquake Geotechnical engineering problems.

References

1. Dynamics of Structures- Anil K. Chopra, Prentice Hal
2. Geotechnical Engineering Principles and Practices- Donald P. Coduto, Prentice Hall
3. Geotechnical Earthquake Engineering- Steven L. Kramer, Pearson Education
4. Geotechnical Modeling- Muir Wood, D.,CRC Press

GEO 556 GROUND IMPROVEMENT TECHNIQUES

Soil distribution in India, requirements of ground improvement technique, Factors affecting ground improvement techniques: effect of seasonal moisture variation, water seepage and surface erosion, vegetation, temperature variation, vibration, mining subsidence and construction operation on ground improvement techniques.

Methods of ground improvement: Sand columns, stone columns, fibre reinforced soil, use of geo synthetics, vibro-floatation technique, vibro-compaction technique, electrical stabilization, methods of dewatering, grouting, modern techniques involved in ground improvement.

Ground improvement using chemical stabilizers:

Traditional chemical stabilizers: Cement, Lime, Fly ash, Surkhi, Bitumen.

Nontraditional chemical stabilizers: Bioenzymens, Polymers, Ionic stabilizers, Molasses, Ligno-sulphonates.

PREREQUISITES

1. Soil Mechanics (Geotechnical Engineering I).
2. Foundation Engg (Geotechnical Engineering II).

References

1. Engineering Principles of Ground Modification- Manfired R. Hausmann, McGraw-Hill Pub, Co.
2. Ground improvement geosystems- M C. R. Davies, F.Schlosser
3. Designing with geosynthetics, - Koerner, R. M., Prentice Hall Inc.
4. Principles of Ground Modification- Hausmann, H.R, McGraw-Hill Book Company.
5. Ground Engineering - The Institute of Civil Engineers, London,
6. Geotechnical Engineering- Gulati and Datta, Tata Mc Graw Hill.