

KAMLA NEHRU INSTITUTE OF TECHNOLOGY

SULTANPUR (U.P.)

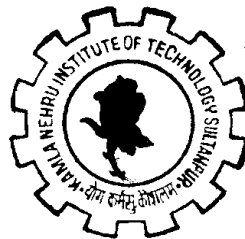
SYLLABUS

FOR

M.TECH. (REGULAR)

IN

GEO-TECHNICAL & GEO-ENVIRONMENTAL ENGINEERING



**DEPARTMENT OF CIVIL ENGINEERING
K.N.I.T., SULTANPUR(U.P.)**

(Affiliated to U.P.T.U. ,LUCKNOW)

U.P. TECHNICAL UNIVERSITY LUCKNOW
CIVIL ENGINEERING
M. TECH. (Regular)

Sr.No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
						Sessional				Examination	
		Theory	L	T	P	CT	Attendance	TA	Total	ESE	
1.	GSR 11	Engineering Behaviour of Soils	3	1	0	30	10	10	50	100	150
2.	GSR 12	Shallow & Deep Foundation	3	1	0	30	10	10	50	100	150
3.	GSR 13*	Earth Retaining Structure	3	0	2	30*	10	10	50	100	150
4.	GSR 14*	Ground Water Hydrology	3	0	2	30*	10	10	50	100	150
		Total	12	2	4				200	400	600

* 15 Marks are for class test and 15 marks are for lab if any otherwise 30marks are for class tests

SEMESTER II.

Sr.No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
						Sessional				Examination	
		Theory	L	T	P	CT	Attendance	TA	Total	ESE	
1.	GSR 21	Geoenvironmental Engg.	3	1	0	30	10	10	50	100	150
2.	GSR 22	Site Investigation & Ground Improvement	3	1	0	30	10	10	50	100	150
3.	GSR 23	Elective I	3	0	2	30	10	10	50	100	150
4.	GSR 24*	Lab. I-Soil Engg. Laboratory	0	0	3	--	10	15	25	50	75
5.	GSR 25*	Lab II – Geoenvironmental & Geotechnical Engg. Laboratory	0	0	3		10	15	25	50	75
		Total	9	2	7				200	400	600

SEMESTER III

Sr.No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
						Sessional				Examination	
		Theory	L	T	P	CT	Attendance	TA	Total	ESE	
1.	GSR 31	Elective II	3	1	-	30	10	10	50	100	150
2.	GSR 32	Elective III	3	1	-	30	10	10	50	100	150
3.	--	Seminar	-	-	2	-	-	-	100	-	100
4.	GDR I	Dissertation	-	-	8	-	-	-	-	-	-
		Total	6	2	10				200	200	400

* 100 Marks are for dissertation work will be evaluated during IV semester.

SEMESTER IV

Sr.No.	Course Code	Subject	Periods			Evaluation Scheme					Subject Total
						Sessional				Examination	
		Theory	L	T	P	CT	Attendance	TA	Total	ESE	
1.	GDR 2	Dissertation	-	-	18	-	-	-	200*	200	400
		Total	-	-	18						400

* 100 Marks are for DR I work of semester III and 100 marks are for DR 2 work of semester IV.

SR 23: Elective I

- Slope Stability and Earth Dam
- Pavement Material & Design
- Finite Element Analysis

SR 31: Elective II / SR 32: Elective III

- Solid & Hazardous Waste Management
- Transportation Safety & Environment
- Basic Concepts of Rock Engineering
- Introduction to Geo-synthetics
- Geohazards Engg
- Ground Water Flow & Pollution Modelling

SR 11 - ENGINEERING BEHAVIOUR OF SOIL

Clay mineralogy & soil structure Clay minerals, Atomic & modular bonds, single grained structures. Flocculent & Honey comb structure. Seepage analysis, Three dimensional Consolidation Introduction, Equation, vertical & sand drain, effect of peripheral, shear. Compaction, Methods of compaction Factor affecting compaction. Stabilization- Introduction & different methods. Shear strength & Failure theories, introduction, Pore pressure parameter & theories Stability of slopes: Stability analysis of finite & infinite slopes, Bishop's method, Stability Number.

Suggested Reference Books:

1. Atkinson J. H. - An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics, McGraw- Hill Co. (1993)
2. Wood, D.M.- Soil Behavior and Critical State Soil Mechanics.cambridge university press (1991)
3. J A Knappett and R F Craig – Craig's Soil Mechanics, Eighth Edition, Spon Press Taylor & Francis (2012)
4. Lambe, T. W. and Whitman, R. V.- Soil Mechanics SI version , John Wiley & Sons.(2011)
5. Muniram Budhu.- Soil Mechanics and Foundations, John Wiley & Sons, Inc.(2007)
6. Gulhati, Shashi K. and Datta Manoj, Geotechnical Engineering, McGraw Hill Book Co., 2005.
7. Baver, L. D., Soil Physics, Asia Publishing House, 1960.
8. Malcom D Bolton, A Guide to Soil Mechanics, University Press (India) Pvt. Ltd., 2003.
9. Mitchell, J. K., Fundamentals of Soil Behavior, John Wiley & Sons Inc., 1993.
10. Nyle C. Brady and Ray R. Weil, The Nature and Properties of Soils, Pearson Education Inc., 2002.

SR 12 – SHALLOW & DEEP FOUNDATION

Role of soil properties in foundation Engineering, Shallow foundation, History and development, Method of estimating, bearing capacity, Settlement of footings, footings in earthquake zones, footings subjected to eccentric and inclined loads, proportioning of foundations, raft foundation. Pile foundation, History and development, type of piles, bearing capacity, Settlement of piles, group action in piles, laterally loaded piles, Piles subjected to eccentric loading batters piles. Piles in earthquake zones coefficient of sub grade soil / pile reactions. Well foundation component parts, Stability analysis, bearing capacity and skin friction, Shirts & tilts. Retaining walls-tyden and stability analysis, Sheet piles and bulk heads design methods. Machine foundation, Underpinning of foundations.

Suggested Reference Books:

1. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering (2004)
2. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012. Phi Learning (2008)
3. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996) 4. Poulos, H. G. & Davis, E. H. - Pile Foundation Analysis and Design john wiley & sons inc (1980-08)
5. Reese, L. C. & Van Impe, W. F. - Single Piles and Pile Groups under Lateral Loading -Taylor & Francis Group (Jan 2000)
6. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Hand Book -Springer (2001)
7. Tomlinson, M. J. - Foundation Design and Construction - Prentice Hall (2003)
8. Lymon C. Reese, William M. Isenhower, Shin-Tower Wang- Analysis and Design of Shallow and Deep Foundations (2006)
9. Salgado, R. - The Engineering of Foundations McGraw-Hill, Boston (2008)

SR 13 - EARTH RETAINING STRUCTURES

Introduction: Earth Pressure Theories, Rankine's and Coulomb's earth pressure theories for cohesionless and cohesive backfill, Computation of earth pressure for various cases-Inclined with surcharge-submerged and partially submerged strata backfill, Rigid Retaining structures, Graphical Method of Earth pressure computation, Design of Gravity Retaining Wall, Flexible Retaining Structure, Diaphragm wall, Cofferdams.

Suggested Reference Books:

1. Sowers, G. F. and Salley, H. I. – Earth and Rockfill Dams, Willams, R.C., and Wallace, T.S. 1965.
2. Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilisation methods – John Wiley & sons. (2002)
3. Bromhead, E. N. (1992). The Stability of Slopes, Blackie academic and professional, London.
4. Christian, Earth & Rockfill Dams – Principles of Design and Construction, Kutzner Published Oxford and IBH.
5. Ortiago, J. A. R. and Sayao, A. S. F. J. - Handbook of Slope Stabilisation, 2004.
6. Bowels, Joseph E., Foundation Analysis and Design, McGraw Hill Book Co., 1997.
7. Das, B. M., Foundation Engineering, Cengage Learning, 2007.
8. Gulhati, Shashi K. and Datta Manoj, Geotechnical Engineering, McGraw Hill Book Co., 2005.

SR 14 – GROUND WATER HYDROLOGY

Occurrence and movement of groundwater, Surface and subsurface investigation of groundwater, Flow through saturated porous medium, Mechanics of well flow, Aquifer parameters, Pumping tests, Design of water wells, Monitoring well design and construction, Well development, well maintenance and rehabilitation, Natural and Artificial recharge of ground water, Salt water intrusion, Introduction to analog and numerical models to solve ground water problems Application of finite difference method in ground water.

Suggested Reference Books:

1. Irrigation Engg. and Hydraulic Structures by S.K. Garg, Khanna Publishers.
2. Irrigation and water Power engineering by B.C. Punmia, Laxmi Publications.
3. Irrigation Water Power and Water Resource Engg. by K.R. Arrora.
4. Groundwater Hydrology' by Todd D. K.
5. Groundwater' by Raghunath H. M.
6. Water Resources Engg. By Larry W. Mays, John Wiley India
7. Water resources Engg. By Wurbs and James, John wiley India
8. Water Resources Engg. By R. K. Linsley, McGraw Hill

SR 21 – GEOENVIRONMENTAL ENGINEERING

Sources and effects of subsurface contamination; Physical, chemical and biological characteristics of solid wastes; Soil –waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability; Waste disposal on land; Types of landfills: Silting criteria; Waste containment principles; types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination, Engineering properties and geotechnical reuse of waste materials such as coal ash, mining waste, demolition waste etc; Reclamation of old waste dumps; Regulations; Case studies.

Suggested Reference Books:

1. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Handbook, Kluwer Academic, 2001
2. Reddi, L. N. and Inyang, H. I. - Geoenvironmental Engineering Principles and Applications, Marcel Dekker, Inc., New York (2000).
3. LaGrega, M. D., Buckingham, P. L. and Evans, J. C. - Hazardous Waste Management, New York: McGraw-Hill, 2001

SR 22 -SITE INVESTIGATION & GROUND IMPROVEMENT

Planning of investigation programmes, Information required for planning different stages of investigations, Geophysical methods: electric al resistivity, and seismic refraction methods, Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods, Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions; Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties; Report writing. Safety measures; Geotechnical Processes; Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques – static, vibratory, impact, Earth moving machinery, Compaction control, Shallow Stabilization with Additives: Lime, fly-ash, cement and other chemicals and bitumen; Deep Stabilization; sand column , stone column, sand drains, prefabricated drains, electro-osmosis, lime column, soil-lime column. Grouting : permeation, compaction and jet, vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems.

Suggested Reference Books:

1. Bowles, J. E., Foundation Analysis and Design, McGraw Hill Companies, 1997.
2. Desai, M. D., Ground Property Characterization from In-Situ Testing, Published by IGS-Surat Chapter, 2005.
3. Hvorslev, M. J., Sub-Surface Exploration and Sampling of Soils for Civil Engineering Purposes, US Waterways Experiment Station, Vicksburg, 1949.
4. Bell, F.G., Engineering Treatment of Soils, E and FN Spon, New York, 2006.
5. Jie Han et al, Advances in ground Improvement, Allied Pub., 2009.
6. Manfred R. Haussmann, Engineering Principles of Ground Modification, Pearson Education Inc. New Delhi, 2008.
7. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Limited, 2006.

SR 24 – SOIL ENGINEERING LABORATORY

Field Investigations and field tests: Drilling of bore hole, standard penetration test, undisturbed and representative sampling. DCP Test, SCP Test, Electrical resistivity. Plate load test. Pile load test; Laboratory Tests: Consolidation test, Direct shear test, Vane shear test. Unconfined compression test. Unconsolidated undrained triaxial test. Consolidated drained triaxial test. Consolidated undrained triaxial test with pore water pressure measurement. Free swell index test, Swelling pressure test, Flow net solutions.

Suggested Reference Books:

1. Bishop, A. W. and Henkel, D. J., Measurement of Soil Properties in Triaxial Test, Edward Arnold Ltd., 1962.
2. Head, K. H., Manual of Soil Laboratory Testing, CRC Press, 2006.
3. Mittal, S. and Shukla, J. P., Soil Testing For Engineers, Khanna Pub., 2003.

SR 25 – GEOENVIRONMENTAL & GEOTECHNICAL ENGINEERING LABORATORY

Engineering properties and compaction characteristics of waste – coal ash, mine tailings, Permeability of clays and bentonite amended soils, Tensile strength of geo-membranes, geo-textiles, Soil – geomembrane interfacial shear strength, Project based laboratory for evaluation of engineering properties of soils for design of embankments and foundations.

Suggested Reference Books:

1. Bishop, A. W. and Henkel, D. J., Measurement of Soil Properties in Triaxial Test, Edward Arnold Ltd., 1962.
2. Head, K. H., Manual of Soil Laboratory Testing, CRC Press, 2006.
3. Mittal, S. and Shukla, J. P., Soil Testing For Engineers, Khanna Pub., 2003.

List of Electives SR 23

(I) – Slope Stability and Earth Dams (Elective)

Slope Stability: Short term and long term stabilities; Limit equilibrium methods; Infinite slopes; Finite height slopes – Swedish method, Bishop's Infinite slopes; Finite height slopes – Swedish method, Bishop's simplified method, other methods; Stability charts; Conditions of analysis – steady state, end of construction, sudden draw down conditions; Factor of safety; Codal provisions; Earthquake effects; Seepage Analysis: Types of flow; Laplace equation; Flow net in isotropic, anisotropic and layered media; Entrance – exit conditions; Theoretical solutions; Determination of phreatic line; Earth Dams: Introduction; Factors influencing design, Design of components; Construction; Instrumentation- piezometer, settlement gauge, inclinometer; Road and rail embankments, Reinforced Slopes: Steep Slopes; Embankments on soft soils; Reinforcement design; Landslides: Remedial measures for unstable slopes – soil nailing, gabions, drainage.

Suggested Reference Books:

1. Bharat Singh and Sharma, H. D. – Earth and Rockfill Dams, 1999
2. Sowers, G. F. and Salley, H. I. – Earth and Rockfill Dams, Willams, R.C., and Wallace, T.S. 1965.
3. Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilisation methods – John Wiley & sons. (2002)
4. Bromhead, E. N. (1992). The Stability of Slopes, Blackie academic and professional, London.
5. Christian, Earth & Rockfill Dams – Principles of Design and Construction, Kutzner Published Oxford and IBH.
6. Ortiago, J. A. R. and Sayao, A. S. F. J. - Handbook of Slope Stabilisation, 2004.
7. Rowe, R. K. - Geotechnical & Geoenvironmental Engineering Hand Book -Springer (2001)
8. Hans Friedrich Winterkorn, Hsai-Yang Fang - Foundation Engineering Handbook, Van Nostrand Reinhold, 1975
9. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012.

10. Bowels, Joseph E., Foundation Analysis and Design, McGraw Hill Book Co., 1997.
11. Das, B. M., Foundation Engineering, Cengage Learning, 2007.
12. Gulhati, Shashi K. and Datta Manoj, Geotechnical Engineering, McGraw Hill Book Co., 2005.

(II) – Pavement Material & Design (Elective)

Introduction, Types of pavements, Road pavement and Airport pavement, Design factors. Design of Flexible pavements, Empirical, Semi empirical and theoretical methods, practical approach, design of Rigid pavements including reinforced concrete pavement.

Pavement Evaluation and Strengthening., pavements failures, Evaluation of existing pavements and then strengthening for future use.

Suggested Reference Books:

1. Yang H Huang - Pavement Analysis and Design, 2nd Edition, Pearson Education 2004
2. Khanna & Justo – Highway Engineering, Khanna Publishers.
3. Srinivasa kumar R – Pavement design , University press(India) Pvt.Ltd 2013
4. Kadiyali, L. R., Traffic Engineering and Transportation Planning, Khanna Publishers, 2011.
5. Khisty, C. J., and Lall, B. K., Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2002.
6. Mallick, R. B., and El-Korchi, T., Pavement Engineering - Principles and Practice, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
7. Papagiannakis, A. T., and Masad, E. A., Pavement Design and Materials, John Wiley and Sons, New Jersey, USA, 2008.
8. Yoder, E. J., and Witzak, M. W., Principles of Pavement Design, 2nd Edition, John Wiley and Sons, New York, USA, 1975.
9. IRC 37 – 2001 “Guidelines for Design of Flexible Pavements”, Indian Roads Congress, New Delhi.
10. IRC 58 – 2002 “Guidelines for Design of Rigid Pavements”, Indian Roads Congress, New Delhi.

(III) - Finit Element Analysis (Elective)

Finite element technique, discretization, energy and variational approaches.

Basic theory, Displacement and force models, slope function theory, use of parametric and local coordinates, Convergence criteria, Numerical integration applications.

Plane stress and Plain strain problems, axis symmetric solids, three dimensional problems, plate and shell structures, and temperature and flow problems.

Nonlinear problems, Introduction to iterative and incremental procedures for material and geometrically nonlinear problems, examples from plane stresses and stability.

Programming, Organization of FEM programs, equations solving techniques, input/output plotting and mesh generation aspects, Graphic package for finite element method, time dependent problems by explicit and implicit schemes.

Suggested Reference Books:

1. Desai, C. S. and J.F. , Abel, Introduction to the Finite. Element Method Van Nostrand Reinhold Company (1972)
2. J. N. Reddy - Introduction to the Finite Element Method - McGraw-Hill Publishers, 1993
3. Krishna Murthy, C. S. - Finite element analysis - Theory and programming, Tata McGraw- Hill,1994
4. Zienkiewicz, O. C. - Finite element Methods, McGraw-Hill Publishers, 1971

List of Electives SR 31/32

(1) Solid & Hazardous Waste Management (Elective)

Municipal Solid Waste: Generation, Rate Variation, Characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling, Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, incineration, Refuse Derived fuels, Land filling). Norms, Rules and Regulations, Biomedical, Hazardous and Nuclear waste Management, Economics of the on-site v/s off site waste management options, Integrated waste management.

Suggested Reference Books:

1. Tchobanoglous, G., Theisen, H., and Vigil, S. A., Integrated Solid Waste Management, Engineering Principles and Management Issues, McGraw-Hill, 1993.
2. Vesilind, P. A., Worrell, W., and Reinhart, D., Solid Waste Engineering, Brooks/Cole Thomson Learning Inc., 2002
3. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., Environmental Engineering, McGraw Hill Inc., 1985.
4. Tchobanoglous, G., and Frank Kreith, Hand Book of Solid Waste Management, McGraw Hill, Inc., 2002.

(II)- Transportation Safety & Environment (Elective)

Multidisciplinary approach to planning for traffic safety and injury control; precrash, crash and post crash models; roles of vehicle, roadway, traffic, driver, and environment, crash and injury causations; Mixed traffic flow; Transport related pollution; Technology Vision- 2020; Urban and non-urban traffic noise sources, Noise level factors, Noise pollution; Energy related aspects of different transport technologies, Road transport related air pollution, Sources of air pollution, effects of weather conditions; Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; Mitigative measures; EIA requirements of Highway projects, procedure; MOEF/World Bank/RC/UK guidelines; EIA practices in India.

Suggested Reference Books:

1. Institute of Transportation Engineers, Traffic Engineering Hand Book, 4th Edition, Prentice Hall, 1999.
2. Kadiyali, L. R., Traffic Engineering and Transportation Planning, Khanna Publishers, 2011.
3. Khisty, C. J., and Lall, B. K., Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2002.
4. May, A. D., Traffic Flow Fundamentals, Prentice Hall, 1990.
5. Yang H Huang - Pavement Analysis and Design, 2nd Edition, Pearson Education
6. Khanna & Justo – Highway Engineering, Khanna Publishers.
7. Glynn, J. and Gary, W. H. K. - Environmental Science and Engineering, Prentice Hall Publishers, 1999
8. Canter, L. W., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1997.
9. Peter Morris and Riki Therivel, Methods of Environmental Impact Assessment (Natural and Built Environment Series), 3rd Edition, Routledge, 2009.
10. Rau, J. G., and Wooten, D. C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
11. Cohen LF, Environmental Analysis of Transportation Systems, John Wiley & Sons, 1982.

(III) – Basic concepts of Rock Mechanics (Elective)

Geological classification, rock and rock mass classification, strength and deformation behaviour of rocks, pore pressures, failure criteria, laboratory and field testing, measurement of in-situ stresses and strains, stability of rock slopes and foundations, design of underground structures, improvement of in situ properties of rock masses.

Suggested Reference Books:

1. Goodman – Introduction to Rock mechanics, Willey International (1980).
2. Ramamurthy, T. - Engineering in Rocks for slopes, foundations and tunnels, Prentice Hall of India.(2007)
3. Jaeger, J. C. and Cook, N. G. W. – Fundamentals of Rock Mechanics, Chapman and Hall, London.(1979)
4. Hoek, E. and Brown, E. T. - Underground Excavation in Rock, Institution of Mining and Metallurgy, 1982.
5. Brady, B. H. G. and Brown, E. T. - Rock Mechanics for Underground Mining, Chapman & Hall, 1993.
6. Verma, B. P., “Rock Mechanics for Engineers” Khanna Publishers
7. Singh, B. and Goel, R. K. “Rock Mass Classification Systems – A Practical Approach in Civil Engineering “Elsevier Publisher.
7. Hoek, E. and Brown, E. T. “Underground Excavations “, Span Press.
8. Hoek, E. and Bray, J D., “Rock Slope Engineering “, Span Press.
9. Brown, E.T., “Rock Characterisation, Testing and Monitoring”, Pergamon Press, London, U.K.

(IV) – Introduction to Geosynthetics (Elective)

Geosynthetics and Reinforced Soil Structures:

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures – walls and slopes; Code provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences; Geosynthetics in Pavements: Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; French drains; Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills – material aspects and stability considerations; Landslides – occurrences and methods of mitigation; Erosion – causes and techniques for control.

Suggested Reference Books:

1. Koerner, R. M., Designing with Geosynthetics, Pearson Education Inc., 2005.
2. Mandal, J. N., Geosynthetics World, New Age Int. Pub. (P) Ltd., 1994.
3. Rao, G. V., Engineering with Geosynthetics, Tata McGraw Hill, New Delhi, 1990.
4. Sivakumar Babu G. L., An Introduction to Soil Reinforcement and Geosynthetics, University Press, 2005.
5. Hausmann, M. R. - Engineering Principles of Ground Modifications, McGraw Hill Pub Co, 1989
6. Xianthakos, Abreimson and Bruce - Ground Control and Improvement, John Wiley & Sons, 1994.
7. M. P. Moseley and K. Krisch (2006) – Ground Improvement, II Edition, Taylor and Francis
8. Jones C. J. F. P. (1985) – Earth Reinforcement and soil structures – Butterworths, London.
9. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012.

(V) Geohazards Engineering (Elective)

Geo-environmental Engineering; Waste generation; subsurface contamination, waste containment; Types of landfills, design and operation of landfills, subsurface contamination control and remediation; Geotechnical Earthquake Engineering: Engineering seismology, Strong ground motion, Seismic hazard analysis, Local site effects and design ground motions, liquefaction hazard evaluations and remedial measures; Landslides: Cause and phenomenon associated with landslides, effect of rainfall on slope stability, earthquake triggered landslides, landslide prevention, control and remedial measures; Other Hazards: ground subsidence, ground heave, erosion.

Suggested Reference Books:

1. Tchobanoglous, G., Theisen, H., and Vigil, S. A., Integrated Solid Waste Management, Engineering Principles and Management Issues, McGraw-Hill, 1993.
2. Vesilind, P. A., Worrell, W., and Reinhart, D., Solid Waste Engineering, Brooks/Cole Thomson Learning Inc., 2002
3. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G., Environmental Engineering, McGraw Hill Inc., 1985.
4. Tchobanoglous, G., and Frank Kreith, Hand Book of Solid Waste Management, McGraw Hill, Inc., 2002.,

(VI) Ground Water Flow & Pollution Modeling (Elective)

Subsurface processes and concepts for groundwater resources evaluation, Unsaturated zone properties: Soil moisture levels, Retention curves, Flow through unsaturated porous media, infiltration and Wetting front, Groundwater contamination, Sources and causes of groundwater pollution, Pollution dynamics, Hydrodynamics dispersion, Biodegradation, Radioactive decay, Reactive processes, Multiphase contamination, NAPLs, VOCs, Site specific groundwater quality problems in Indian context, Numerical models, Finite difference methods, Numerical modeling of steady and transient flows in saturated and unsaturated domain, Contaminant transport modeling, Application of FEM and BIEM in groundwater modeling, Regional aquifer simulation, Contaminated groundwater systems and their rehabilitation, Development and optimization based management of aquifer systems, Stochastic models, Random field concepts in groundwater models; Application emerging techniques to groundwater management.

Suggested Reference Books:

1. Irrigation Engg. and Hydraulic Structures by S.K. Garg, Khanna Publishers.
2. Irrigation and water Power engineering by B.C. Punmia, Laxmi Publications.
3. Irrigation Water Power and Water Resource Engg. by K.R. Arrora.
4. Groundwater Hydrology' by Todd D. K.
5. Groundwater' by Raghunath H. M.
6. Water Resources Engg. By Larry W. Mays, John Wiley India
7. Water resources Engg. By Wurbs and James, John wiley India
8. Water Resources Engg. By R. K. Linsley, McGraw Hill