UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA9103	Applied Mathematics	3	1	0	4
2	SF9101	Theoretical Soil Mechanics	4	0	0	4
3	SF9102	Strength and Deformation Behaviour of Soils	3	0	0	3
4	SF9103	Soil Properties and Behaviour	3	0	0	3
5	E1	Elective I	3	0	0	3
6	E2	Elective II	3	0	0	3
		TOTAL	**19**	**1**	**0**	**20**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	SF9121	Shallow Foundations	3	0	0	3
2	SF9122	Deep Foundations	3	0	0	3
3	SF9123	Ground Improvement	3	0	0	3
4	SF9124	Dynamics of Soils and Foundations	3	0	0	3
5	E3	Elective III	3	0	0	3
6	E4	Elective IV	3	0	0	3
PRACTICAL						
7	SF9125	Advanced Soil Mechanics Laboratory	0	0	4	2
		TOTAL	**18**	**0**	**4**	**20**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	E5	Elective V	3	0	0	3
2	E6	Elective VI	3	0	0	3
3	E7	Elective VII	3	0	0	3
PRACTICAL						
4	SF9131	Practical Training (4 Weeks)	0	0	0	1
5	SF9132	Project work Phase – I	0	0	6	3
		TOTAL	**9**	**0**	**6**	**13**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	SF9141	Project work Phase – II	0	0	30	15
		TOTAL	**0**	**0**	**30**	**15**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 68

UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO VI SEMESTERS (PART TIME)

M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA9103	Applied Mathematics	3	1	0	4
2	SF9101	Theoretical Soil Mechanics	4	0	0	4
3	E1	Elective I	3	0	0	3
		TOTAL	**10**	**1**	**0**	**11**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	SF9121	Shallow Foundations	3	0	0	3
2	SF9122	Deep Foundations	3	0	0	3
3	E2	Elective II	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	SF9102	Strength and Deformation Behaviour of Soils	3	0	0	3
2	SF9103	Soil Properties and Behaviour	3	0	0	3
3	E3	Elective III	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	SF9123	Ground improvement	3	0	0	3
2	SF9124	Dynamics of Soils and Foundations	3	0	0	3
3	E4	Elective IV	3	0	0	3
PRACTICAL						
4	SF9125	Advanced Soil Mechanics Laboratory	0	0	4	2
		TOTAL	**9**	**0**	**4**	**11**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	E5	Elective V	3	0	0	3
2	E6	Elective VI	3	0	0	3
3	E7	Elective VII	3	0	0	3
PRACTICAL						
4	SF9131	Practical Training (4 weeks)	0	0	0	1
5	SF9132	Project work Phase – I	0	0	6	3
		TOTAL	**9**	**0**	**6**	**13**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	SF 9141	Project work Phase – II	0	0	30	15
		TOTAL	**0**	**0**	**30**	**15**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 68

ELECTIVES FOR M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	SF 9151	Earth Pressure and Earth Retaining Structures	3	0	0	3
2	SF 9152	Earth and Rock fill Dams	3	0	0	3
3	SF 9153	Geoenvironmental Engineering	3	0	0	3
4	SF 9154	Rock Mechanics in Engineering Practice	3	0	0	3
5	SF 9155	Finite Element Method and Applications	3	0	0	3
6	SF 9156	Pavement Engineering	3	0	0	3
7	SF 9157	Soil Structure Interaction	3	0	0	3
8	SF 9158	Subsurface Investigation and Instrumentation	3	0	0	3
9	SF 9159	Reinforced Soil Structures	3	0	0	3
10	SF 9160	Geotechnical Earthquake Engineering	3	0	0	3
11	SF 9161	Mechanics of Unsaturated Soils	3	0	0	3

MA 9103 APPLIED MATHEMATICS L T P C

3 1 0 4

OBJECTIVE:

- To familiarize the students in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications.
- To expose the students to variational formulation and numerical integration techniques and their applications to obtain solutions for buckling, dynamic response, heat and flow problems of one and two dimensional conditions.

UNIT I ONE DIMENSIONAL WAVE AND HEAT EQUATIONS 10+3

Laplace transform methods for one-dimensional wave equation – Displacements in a long string – longitudinal vibration of an elastic bar – Fourier transform methods for one-dimensional heat conduction problems in infinite and semi-infinite rods.

UNIT II ELLIPTIC EQUATION 9+3

Laplace equation – Properties of harmonic functions – Solution of Laplace's equation by means of Fourier transforms in a half plane, in an infinite strip and in a semi-infinite strip – Solution of Poisson equation by Fourier transform method.

UNIT III CALCULUS OF VARIATIONS 9+3

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Direct methods – Ritz and Kantorovich methods.

UNIT IV EIGEN VALUE PROBLEMS 9+3

Methods of solutions: Faddeev –Leverrier Method, Power Method with deflation – Approximate Methods: Rayleigh –Ritz Method.

UNIT V NUMERICAL INTEGRATION 8+3

Gaussian Quadrature – One and Two Dimensions – Gauss Hermite Quadrature – Monte Carlo Method – Multiple Integration by using Mapping Function.

TOTAL (L:45+T:15): 60 PERIODS

REFERENCES:

1. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice all of India Pvt. Ltd., New Delhi, 1997.
2. Rajasekaran.S, "Numerical Methods in Science and Engineering A Practical Approach", A.H.Wheeler and Company Private Limited,1986.
3. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
4. Andrews, L.C. and Shivamoggi, B.K., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.

SF 9101	THEORETICAL SOIL MECHANICS	L	T	P	C
		4	0	0	4

OBJECTIVE:

- Students are expected to understand elastic and plastic behaviour of soil and solve problems related to settlement and stability of soils structures.

UNIT I THEORY OF ELASTICITY 10

Introduction –Material behaviour – Idealistic behaviour – elastic, viscous and plastic - Elasticity and stability problems, concept of stress and strain – plane stress, plane strain and axisymmetric problems – equation of equilibrium and compatibility – stress functions.

UNIT II STRESSES AND DISPLACEMENTS (ELASTIC SOLUTIONS) 15

Stresses in elastic half-space medium by external loads – fundamental solutions – Boussinesq, Flamant, Kelvin and Mindlin solution – Applications of fundamental solutions – Anisotropic and non-homogeneous linear continuum – Influence charts - elastic displacement.

UNIT III LIMIT EQUILIBRIUM ANALYSIS 12

Limit equilibrium analysis – perfectly plastic material – stress – strain relationship – stress and displacement field calculations – slip line solutions for undrained and drained loading.

UNIT IV LIMIT ANALYSIS 15

Limit analysis – principles of virtual work – theorems of plastic collapse – Mechanism for plane plastic collapse – Simple solutions for drained and undrained loading – stability of slopes, cuts and retaining structures.

UNIT V FLOW THROUGH POROUS MEDIA 8

Flow through porous media – Darcy's law – General equation of flow – steady state condition – solution by flow net – fully saturated conditions.

TOTAL: 60 PERIODS

REFERENCES:

1. Atkinson, J.H; The Mechanics of Soils and Foundations, Taylor and Francis, London, 2007.
2. Wai-Fah Chen, and Liu, X.L., Limit Analysis in Soil Mechanics, Elsevier Science Ltd., 1991.
3. Cedergren, H.R., Seepage, Drainage and Flownets, John Wiley, 1997.
4. Aysen, A., Soil Mechanics: Basic concepts and Engineering Applications, A.A.Balkema Publishers, 2002.
5. Ulrich Smoltc, YK, Geotechnical Engineering Handbook (Vol.1), Ernot & Sohn, 2002.
6. Aysen, A., Problem Solving in Soil Mechanics, A.A.Balkema Publishers, 2003.
7. Davis, R.O., and Selvadurai, A.P.S., Elasticity and Geomechanics, Cambridge University Press, 1996.
8. Muni Budhu, Soil Mechanics and Foundations, John Wiley and Sons, Inc., Network, 2000.
9. Atkinson, J.H., Foundations and Slopes, McGraw Hill, 1981.
10. Winterkorn, H.F., and Fang, H.Y., Foundation Engineering Handbook, Galgotia, Booksource, 2000.

SF 9102 STRENGTH AND DEFORMATION BEHAVIOUR OF SOILS

L	T	P	C
3	0	0	3

OBJECTIVE:

- The main objective of this course is to understand stress-strain characteristics of soils, the mechanism of failure, the factors that affects the shear strength and the various test procedures to determine the shear strength.

UNIT I SHEAR STRENGTH OF COHESIONLESS SOILS 9

Shear strength of granular sols - Direct shear - Triaxial Testing- Drained and untrained Stress-strain behaviour - Dilation, contraction and critical states - Liquefaction and cyclic mobility of saturated sands. Factors influencing stress-strain and shear strength**.**

UNIT II SHEAR STRENGTH OF COHESIVE SOILS 9

Shear strength of clays - Stress-strain behaviour - Triaxial testing and stress path plotting - pore pressure parameter of Skempton and Henkel - Total stress and effective stress approach - shear strength of partially saturated clay in terms of stress state variables. Factors influencing stress-strain and shear strength.

UNIT III YIELD CRITERION 9

Concepts of yield and failure in soils- yield criteria of von Mises, Tresca and their extended form, their applicability to soils - Detailed discussion of Mohr. - Coulomb failure criterion.

UNIT IV STRESS - STRAIN LAWS FOR SOILS 9

Stress-strain laws for soils - hyperbolic law - Linear visco-elastic and Elasto -plastic laws - yield functions, hardening law, flow rules and plastic strain computation - Rheological models of Kelvin, Maxwell and Burger and Burger as applied to soils.

UNIT V CRITICAL STATE SOIL MECHANICS 9

Introduction to critical state soil mechanics - state boundary - surface- Roscoe and Hvorslev's - A perspective only on mechanical behaviour of soils within the critical state framework.

TOTAL: 45 PERIODS

REFERENCES:

1. Hotlz, R.D.& Kovacs, W.D. Introduction Geotechnical Engg, Prentice-Hall, 1981
2. Braja, M, Das., Advanced soil mechanics, McGraw Hill, 1997.
3. Atkinson J.H. and Brandsby P.L. Introduction to critical state soil mechanics McGraw Hill, 1978.
4. Lambe, T.W. and Whitman R.V. Soil Mechanics in S.I. Units John Wiley, 1979.
5. Wood, D.M., Soil behaviour and Critical State Soil Mechanics, Cambridge University Press, New York, 1990.
6. Bazant, Z.P., Mechanics of Geo-materials, Rocks, Concrete and Soil, John Willey and Sons, Chilchester, 1985.
7. Graham Barnes, Soil Mechanics Principles and Practices, Macmillan Press Ltd., London, 2002.
8. Shear Strength of Liquefied Soils, Final Proceedings of the workshop, National Science Foundation, Urbane, Illinois, July 1998.
9. Braja, M. Das, Principles of Geotechnical Engineering, Brooks/Cole, Thomson Learning Academic Resource, Center, Fifth Edition, 2002.
10. Keedwell, M.J., Rheology and Soil Mechanics, Elsevier applied science Publishers Ltd., 1984.
11. Malcolm D. Bolton, A guide to soil mechanics, Universities Press (India) Private Ltd., Hyderabad, India, 2003.

SF 9103	SOIL PROPERTIES AND BEHAVIOUR	L	T	P	C
		3	0	0	3

OBJECTIVE:

- At the end of the course the student gains knowledge on the various factors governing the Engineering behaviour of soils and the suitability of soils for various Geotechnical Engineering applications.

UNIT I SOIL DEPOSITS AND CLAY MINERALS 8

Introduction – formation of soils – various soil deposits and their engineering suitability – Genesis of clay minerals – classification and identification – Anion and Cation exchange capacity of clays – specific surface area – bonding in clays.

UNIT II PHYSICAL AND PHYSIO-CHEMICAL BEHAVIOUR OF SOILS 10

Physical and physio – chemical behaviour of soils – diffused double layer theory – computation of double layer distance – effect of ion concentration, ionic valency, dielectric constant, temperature on double layer – stern layer – attractive and repulsive forces in clays – soil structure – soil water – mechanism of soil – water interactions.

UNIT III SWELLING AND SHRINKAGE BEHAVIOUR 10

Swelling and shrinkage behaviour of soils – problems associated – factors influencing swell – shrink characteristics – swell pressure determination – osmotic swell pressure – soil fabric and measurement – sensitivity, thixotrophy – stress history – soil compaction – soil suction – determination of suction potential.

UNIT IV COMPRESSIBILITY, PERMEABILITY AND SHEAR STRENGTH BEHAVIOUR 10

Compressibility and shear strength behaviour of soils and clays – mechanisms involved – liquefaction potential – Factors governing compressibility, shear strength and permeability of soils.

UNIT V CONDUCTION PHENOMENA AND PREDICTION OF SOIL BEHAVIOUR 7

Conduction in soils – coupled flows – electrical, chemical , hydraulic and thermal flows in soils – consolidation by electro osmosis – prediction of engineering behaviour of soils – empirical correlations and their applicability.

TOTAL: 45 PERIODS

REFERENCES:

1. Mitchell, J.K., Fundamentals of Soil Behaviour, John Wiley, New York, 1993.
2. Yong, R.N. and Warkentin, B.P., Introduction to Soil Behaviour, Macmillan, Limited, London, 1979.
3. Coduto, D.P., Geotechnical Engineering – Principles and practices, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Perloff, W.H. and Baron, W, Soil Mechanics, The Ronal Press Company, 1976.
5. Van Olphen, H., Clay colloid Chemistry, John Wiley, 1996
6. Grim, R.E., Applied Clay Mineralogy, McGraw Hill, New York, 1966.
7. Lambe, T.W. & Whitman, R.V. Soil Mechanics, John Wiley & Sons, New York, 1979.
8. Das, B.M.,Principles of Geotechnical Engg, PWS Publishing Comp, Boston, 1998
9. McCarthy D.F., Essentials of Soil Mechanics & Foundations, Prentice-Hall, 2002.

SF 9121 SHALLOW FOUNDATIONS L T P C
3 0 0 3

OBJECTIVE:

- To develop an awareness of the different type of shallow foundation, its design methodology with and without interactive analysis by considering the performance criterion.

UNIT I INTRODUCTION 6

Developments - Need of Foundation Engineering - Responsibility of Foundation Engineer - Classification - General requirements - Additional consideration - selection of type of foundation - hostile environment - structural integrity - economy.

UNIT II BEARING CAPACITY ESTIMATIONS 9

Bearing capacity of shallow foundations - Homogeneous - Layered soils - Soft and Hard Rocks - Evaluation of bearing capacity from insitu tests - partial safety factor approach codal - Recommendations.

UNIT III SETTLEMENT EVALUATION 9

Settlement analysis-immediate-consolidation settlement-stress path method of settlement evaluation-layered soil and rocks-construction period correction-evaluation from insitu tests - code recommendations.

UNIT IV INTERACTIVE ANALYSIS AND DESIGN OF FOUNDATIONS 14

Analysis of foundation - isolated - strip - combined footings and mat foundations. Conventional - elastic approach - Soil Structure Interaction Principles - Application - Numerical techniques - finite element method - Application of softwares - Structural Design of shallow foundations - working stress method - limit state method - Codal Recommendations.

UNIT V FOUNDATION FOR SPECIAL CONDITIONS 7

Structural Design of shallow foundations - working stress method Introduction to special foundations - Foundation design in relation to ground movements - Foundation on recent refuse fills - Design of Foundation for seismic forces - Codal Recommendations.

TOTAL: 45 PERIODS

REFERENCES:

1. Donald P. Coduto, Foundation Design Principles and Practices - Prentice Hall, Inc., Englewood Cliffs, New Jersey, 2001.
2. Winterkorn, H.F. and Fang, Y.F., Foundation Engineering Handbook, Van Nostrand Reinhold, 1994.
3. Bowles, J.E., Foundation Analysis and Design, Fifth Edition, McGraw Hill, New York, 1995.
4. Robert Wade Brown, Practical Foundation Engineering Handbook, McGraw Hill, New York, 1996.
5. Tomlinson, M.J. Foundation Engineering, ELBS, Long man Group, UK Ltd., England, 1995.
6. Swami Saran, Soil Dynamics and Machine Foundation, Galgottia Publications Pvt. Ltd., New Delhi-110002, 1999.
7. Vargheese, P.C. Limit State Design of Reinforced concrete, Prentice-Hall of India, 1994.

8. Day, R.W., Geotechnical and Foundation Engineering, Design and Construction, McGraw Hill 1999.
9. Muni Budhu, Soil Mechanics and Foundation, John Wiley and Sons, INC 2000.
10. Donald P. Coduto, Geotechnical Engineering. Principles and Practices, Prentice - Hall of India Private Limited, 2002.
11. Nainan P. Kurian, Design of Foundation Systems, Principles and Practices, Narosa Publishing House, Third Edition, 2006.
12. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.
13. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, basic geotechnics, Sixth Edition, Prentice Hall, 2002.

SF 9122 **DEEP FOUNDATIONS** **L T P C**
3 0 0 3

OBJECTIVE:

- The student will be exposed to the design of piles, pile groups and caissons with respect to vertical and lateral loads for various field conditions.

UNIT I PILE CLASSIFICATIONS 10

Function – classification of piles – Factors governing choice of pile foundation – Load transfer principles – piling equipments and methods – changes in soil condition during installation of piles – requirement of code of practice – responsibility of engineer and contractor.

UNIT II AXIALLY LOADED PILES AND PILE GROUPS 10

Allowable load evaluation of piles and pile groups – Static method – cohesive – cohesionless soil – time effects – Dynamic method – pile driving formulae – Wave equation application – modeling – theoretical analysis – Interpretation of field test results and pile load test results – Settlement of Piles and Pile groups.

UNIT III LATERAL AND UPLIFT LOAD EVALUATION 10

Piles subjected to Lateral loads – Broms method, elastic –p-y curve analyses – Batter piles – response to moment – pile subjected to uplift loads – load –deformation behaviour – Lateral and uplift load test data interpretation. Foundation on week compressible – collapsible soil – case studies.

UNIT IV STRUCTURAL DESIGN OF PILE AND PILE GROUPS 9

Pile foundation – structural design – pile cap analysis, pile – raft system basic interactive analysis – pile and pile groups subjected to vibrations – fundamental solutions.

UNIT V CAISSONS 6

Caissons types – Stability of caissons – principles of analysis and design, seismic influences - IRC Guidelines.

TOTAL: 45 PERIODS

REFERENCES:

1. Das, B.M., Principles of Foundation Engineering, Design and Construction, Fourth Edition, PWS Publishing, 1999.
2. Poulos, H.G., Davis, E.H., Pile foundation analysis and design, John Wiley and Sons, New York, 1980.
3. Tomlinson, M.J. Foundation engineering, ELBS, Longman Group, U.K. Ltd., England 1995.
4. Cernica, J.N. Geotechnical Engineering Foundation Design, John Wiley and Sons, Inc. 1995.
5. Bowles, J.E., Foundation Analysis and Design, Fifth Edition, McGraw Hill, New York, 1996.
6. Donald, P., Coduto, Foundation Design Principles and Practices, Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1996.
7. Winterkorn, H.F. and Fang, H.Y, Foundation Engineering Handbook, Von Nostrand Reinhold, 1994.
8. Grigorian, Pile Foundation for Buildings and Structures in collapsible Soil, Oxford & IBH Publishing Co, Pvt. Ltd., New Delhi, 1999.

SF 9123 **GROUND IMPROVEMENT** **L T P C**
3 0 0 3

OBJECTIVE:

- Students are expected to identify problematic soil and their associated problems, propose suitable remedial techniques and design.

UNIT I DEWATERING **10**

Introduction - Scope and necessity of ground improvement in Geotechnical engineering basic concepts and philosophy. Drainage - Ground Water lowering by well points, deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques.

UNIT II COMPACTION AND SAND DRAINS **8**

Insitu compaction of granular and cohesive soils, Shallow and Deep compaction methods - sand piles – concept, design, factors influencing compaction. Blasting and dynamic consolidation – Preloading with sand drains, fabric drains, wick drains etc. – Theories of sand drain – design and relative merits of above methods.

UNIT III STONE COLUMN, LIME PILES AND SOIL NAILING **9**

Stone column, lime piles – Functions – Methods of installation – design, estimation of load carrying capacity and settlement. Root piles and soil nailing - methods of installation – Design and Applications – case studies.

UNIT IV EARTH REINFORCEMENT **8**

Earth reinforcement – Principles and basic mechanism of reinforced earth, simple design, Synthetic and natural fibre based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.

UNIT V GROUTING **10**

Grouting – Types of grout – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – injection methods - jet grouting – grout monitoring – Electro – chemical stabilization – Stabilization with cement, lime etc. – Stabilization of expansive clays.

TOTAL: 45

REFERENCES:

1. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, 1997.
2. Jewell, R.A., Soil Reinforcement with Geotextiles, CIRIA, London, 1996.
3. Jones, J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1985.
4. Ramanatha Ayyar, T.S., Ramachandran Nair, C.L. and Balakrishnan Nair, N., Comprehensive Reference book on Coir Geotextiles, Centre for development of Coir Technology, 2002.
5. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001
6. Moseley, M.D., Ground Treatment, Blackie Academic and Professional, 1998.
7. Das, B.M., Principles of Foundation Engineering, Fourth Edition, PWS Publishing, 1999.
8. Koerner, R.M. and Welsh, J.P., Construction and Geotechnical Engineering using Synthetic Fabrics, John Wiley, 1990.
9. Hehn, R.W., Practical Guide to Grouting of Underground Structures, ASCE, 1996.
10. Shroff, A.V., Grouting Technology in Tunneling and Dam, Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi, 1999.
11. Lee. C.F., Lau, L.K.., Ng., C.W.W., Kwong A.K., Pang., P.L.R., Yin, J.K., and Yue, Z.Q., Soft soil engineering, Proceedings, Third international conference on soft soil engineering, A.A. Balkema Publishers, 2001.

SF 9125 ADVANCED SOIL MECHANICS LABORATORY

L	T	P	C
3	0	0	3

OBJECTIVE:

- Students will be trained in laboratory and field-testing methods to determine index, engineering and chemical properties of soils.

LIST OF EXPERIMENTS

UNIT I INDEX PROPERTIES AND CHEMICAL TESTS 10

Introduction – Index properties – Determination; Chemical analysis – pH – Conductivity – quantification of ions through flame Photometer.

UNIT II COMPACTION AND COMPRESSIBILITY 10

Compaction characteristics – Influence of compaction energy – CBR Test – One dimensional consolidation C_v , C_c and m_v determination.

UNIT III SWELL CHARACTERISTICS 8

Determination of percent swell – swell pressure – constant volume method ; expanded - loaded method – Soil water characteristic curves of soil by Pressure Plate apparatus.

UNIT IVPERMEABILITY AND SHEAR STRENGTH 10

Permeability of soil – constant and falling head methods.
Direct shear – Triaxial compression (UU and CU) test – Unconfined compression test –Vane shear test.

UNIT V DYNAMIC PROPERTIES 4

Determination of dynamic properties of soil – Block vibration test.

UNIT VI FIELD TESTS 10

Plate load test – static cone penetration test – standard penetration test – pressuremeter test.

UNIT VII TEST ON GEOSYNTHETICS 8

Opening size of Geotextiles – Tensile strength of Geosynthetic materials – Interfacial friction.

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS

1. Liquid limit and plastic limit apparatus – 4 sets
2. Shrinkage limit – Shrinkage cups – 12 cups and other accessories – 2 sets
3. Balance 200g (0.001g) – 2 Nos.
4. Balance 20 kg (100g) – 1 No.
5. Standard Proctor set – 4
6. Modified Proctor set – 4
7. CBR set – 4
8. Consolidation apparatus 3 gang – 2 set
9. Direct shear apparatus with Electronic out fit – 1 set
10. Direct shear apparatus – 1 set
11. Triaxial Equipment – 2 set
12. Permeameter (falling head and Constant head) – 2 sets
13. Vane shear apparatus – 1 Nos.
14. Set of IS sieves – 2
15. Sieve shaker (electrically operated) - 1
16. Hot air oven – 1
17. Hydrometer – 4
18. pH meter - 1
19. Conductivity meter – 1
20. Flame photometer – 1
21. Pressure plate apparatus – 1 (Demonstration only)
22. Block vibrator – 1 (Demonstration only)
23. Set up for plate load test – 1 (Demonstration only)
24. Static cone penetration test set up – 1 (Demonstration only)
25. Standard penetration test set up – 1 Demonstration only)
26. Pressuremeter – 1 Demonstration only)
27. UTM for testing geosynthetics –1 (Demonstration only)

REFERENCES:

1. Alam Singh and Chowdary, G.R., Soil Engineering in Theory and Practice (Vol.2) Geotechnical Testing and Instrumentation, CBS Publishers and Distributors, NewDelhi,2006.
2. Head, K.H., Manual of Soil Laboratory Testing Vol.I and II, Pentech Press, London 1990.
3. Head, K.H., Manual of Soil Laboratory Testing Vol.III, Second Edition, John Wiley & Sons, 1998.
4. Bowles, J.E., Engineering properties of soils and their measurements, McGraw Hill, 1992.
5. Kameswara Rao, N.S.V., Dynamics Soil Tests and Applications, Wheeler Publishing, New Delhi, 2000.
6. Das, B.M., Soil Mechanics Laboratory Manual, Engineering Press, Austin, 1997
7. Al-Khataji, A.W. and Anderstand, O.B., Geotechnical Engineering & Soil Testing, Sounders College Publishing, Fort Worth, 1992.
8. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, 1997.

SF 9124	DYNAMICS OF SOILS AND FOUNDATIONS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To understand the basics of dynamics – dynamic behaviour of soils – effects of dynamic kids and the various design methods.

UNIT I THEORY OF VIBRATION 9

Introduction – Nature of dynamic loads – vibrations of single degree freedom system – free vibrations of spring – mass systems – forced vibrations – viscous damping,Transmissibility – Principles of vibration measuring instruments effect of Transient and Pulsating loads – vibrations of multi degree freedom system.

UNIT II DYNAMIC SOIL PROPERTIES AND BEHAVIOUR 12

Dynamic stress – strain characteristics – principles of measuring dynamic properties – Laboratory Techniques – Field tests – Factors affecting dynamic properties - Typical values. Mechanism of Liquefaction–Influencing factors--Evaluation of Liquefaction potential – Analysis from SPT test – Dynamic bearing capacity – Dynamic earth pressure.

UNIT III FOUNDATIONS OF RECIPROCATING MACHINES 9

Types of Machines and Foundations – General requirements – Modes of vibration of a rigid foundation, block method of analysis – Linear Elastic weightless spring method – Elastic half – space method – Analog models ; Design of Block foundation -- Codal Recommendations.

UNIT IV FOUNDATION FOR IMPACT AND ROTARY MACHINES 8

Dynamic analysis of impact type machines – Design of Hammer foundations – use of vibrator Absorbers – design – Codal recommendation. Special consideration for Rotary machines – Design criteria – Loads on T.G. Foundation – method of analysis – Design; Dynamic soil – structure – Interaction, Codal Recommendations.

UNIT V VIBRATION – ISOLATION 7

Force Isolation – Motion Isolation – use of spring and damping materials – vibration control of existing machine foundation – screening of vibration – open trenches – Pile Barriers – salient construction aspects of machine Foundations.

TOTAL: 45 PERIODS

REFERENCES:

1. Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing , New Delhi, 2000.
2. Moore, P.J., Analysis & Design of Foundations for Vibrations, Oxford & IBH, 2006.
3. Krammer S.L., Geotechnical Earthquake Engineering, Prentice hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
4. Prakash, S and Puri, V.K., Foundations for machines, McGraw Hill, 1987.
5. Vaidyanathan, C.V., and Srinivasalu, P., Handbook of Machine Foundations, McGraw Hill, 1995.
6. Arya, S., O'Neil, S., Design of Structures and Foundations for Vibrating Machines, Prentice Hall, 198UNIT - I
7. Major, A., Vibration Analysis and Design of Foundations for Machines and Turbines, Vol. I, II and III, Budapest, 1964.
8. Barkon, D.D., Dynamics of Basis of Foundation, McGraw Hill, 1974.
9. Swami Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd., New Delhi 1999.
10. Das B.M., Principles of Soils Dynamics, McGraw Hill, 1992.
11. Kameswara Rao, "Vibration Analysis and Foundation Dynamics", Wheeler Publishing, New Delhi, 1998.

SF 9151 EARTH PRESSURE AND EARTH RETAINING STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- At the end of this course, students are expected to analyse and design rigid, flexible earth retaining structures, slurry supported trenches and deep cuts.

UNIT I EARTH PRESSURE THEORIES 12

Introduction – State of stress in retained soil mass – Earth pressure theories – Classical and graphical techniques – Active and passive cases – Earth pressure due to external loads, empirical methods. Wall movement and complex geometry.

UNIT II COMPACTION, DRAINAGE AND STABILITY OF RETAINING STRUCTURES 8

Retaining structure – Selection of soil parameters - Lateral pressure due to compaction, strain softening, wall flexibility, drainage arrangements and its influence. Earth pressure due to earthquake forces – Stability of retaining structure.

UNIT III SHEET PILE WALLS 8

Analysis and design of cantilever and anchored sheet pile walls. Deadman and continuous anchors.

UNIT IV SUPPORTED EXCAVATIONS 8

Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving. Earth pressure around tunnel lining, shaft and silos – Soil anchors – Soil pinning – Soil nailing – Basic design concepts.

UNIT V SLURRY SUPPORTED TRENCHES 9

Basic principles - Diaphragm and bored pile walls – stability Analysis and design – specification of slurry.

TOTAL: 45 PERIODS

REFERENCES:

1. Clayton, C.R.I., Militisky, J. and Woods, R.I., Earth pressure and Earth-Retaining structures, Second Edition, Survey University Press, 1993.
2. Das, B.M., Principles of Geotechnical Engineering, Fourth Edition, The PWS series in Civil Engineering, 1998.
3. Militisky, J. and Woods, R., Earth and Earth retaining structures, Routledge, 1992.
4. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Handbook, Galgotia Book- source, 2000.
5. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
6. Koerner, R.M., Design with Geosynthetics, Third Edition, Prentice Hall, 1997.
7. Day, R.W., Geotechnical and Foundation Engineering: Design and Construction, McGraw Hill, 1999.
8. Mandal, J.N., Reinforced Soil and Geotextiles, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1993.
9. McCarthy, D.F., Essentials of Soil Mechanics and Foundations: Basic Geotechnics, Sixth Edition, Prentice Hall, 2002.
10. Hajnal, I., Marton, J. and Regele, Z., Construction of diaphragm walls, A Wiley – Interscience Publication, 1984.

SF 9152 EARTH AND ROCK FILL DAMS L T P C
3 0 0 3

OBJECTIVE:

- Students are expected to learn reasons for failure and damages of embankments and slopes, various methods analysis of slopes and remedial techniques to protect the slopes.

UNIT I DESIGN CONSIDERATION 9

Design consideration, Factors influencing design, Types of earth and rockfill dams, Design details, Provisions to control pore pressure.

UNIT II STABILITY OF SLOPES 12

Introduction, Stability of infinite and finite slopes, Limit Equilibrium method, Wedge analysis, Method of Slices, Bishop's method, Janbu's method etc. Special aspects of slope analysis, stability charts. Role of geosynthetics in stabilization of slopes.

UNIT III SEEPAGE ANALYSIS 5

Seepage analysis, Flownets, Stability conditions during construction, Full reservoir and drawdown - cut off walls – Trenches – Importance of drainage and filters.

UNIT IV FAILURE AND DAMAGES 9

Failure and damages, Nature and importance of failures in embankment and foundation - Piping, Differential settlement, Foundation slides, Earthquake damage, creep and anisotropic effects, Reservoir wave action, Dispersive piping.

UNIT V SPECIAL DESIGN PROBLEM 10

Special design problems, Slope protection, Filter design, Foundation treatment, Earth dams on pervious soil foundation, Application of Geosynthetic materials in filtration. Treatment of rock foundation, Construction Techniques, Quality control and performance measurement.

TOTAL: 45 PERIODS

REFERENCES:

1. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kulwer Academic Publishers, 2001.
2. Anderson, M.G., and Richards, K.S., Slope Stability, John Wiley, 1987.
3. Sherard, J.L., Woodward, R.J., Gizienski, R.J. and Clevenger, W.A., Earth and Earth rock dam, John Wiley, 1963.
4. Chowdhury, D.F., Slope analysis, Prentice Hall, 1988.
5. McCarthy, R.N., Essentials of Soil Mechanics and Foundations: Basic Geotechnics,Sixth Edition, Prentice Hall, 2002.
6. Bramhead, E.N., The Stability of Slopes, Blacky Academic and Professionals Publications, Glasgow, 1986.
7. Chandhar, R.J., Engineering Developments and Applications, Thomas Telford, 1991
8. Koerner, R.M. Designing with Geosynthetics, Third Edition, Prentice Hall, 1997.

SF 9153 GEOENVIRONMENTAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- The student acquires the knowledge on the Geotechnical engineering problems associated with soil contamination, safe disposal of waste and remediate the contaminated soils by different techniques thereby protecting environment.

UNIT I SOIL – POLLUTANT INTERACTION 8

Introduction to Geoenvironmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction – failures of foundations due to pollutants – case studies.

UNIT II SITE SELECTION AND SAFE DISPOSAL OF WASTE 10

Safe disposal of waste – site selection for land fills – characterization of land fill sites and waste - Risk assessment - . Stability of land fills – current practice of waste disposal – monitoring facilities - passive containment system – application of geosynthetics in solid waste management – rigid or flexible liners.

UNIT III TRANSPORT OF CONTAMINANTS 8

Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – foundation for waste fill ground – pollution of aquifers by mixing of liquid waste – protecting aquifers.

UNIT IV WASTE STABILIZATION AND DISPOSAL 10

Hazardous waste control and storage system – stabilization/ solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation - detoxification – mechanism of stabilization – organic and inorganic stabilization – utilization of solid waste for soil improvement – case studies.

UNIT V REMEDIATION OF CONTAMINATED SOILS 9

Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation – exsitu and insitu remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, vetrification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well – case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Daniel B.E, Geotechnical Practice for waste disposal, Chapman & Hall, London, 1993.
2. Hari D. Sharma and Krishna R.Reddy, Geo-Environmental Engineering – John Wiley and Sons, INC, USA, 2004.
3. Westlake, K., Landfill Waste pollution and Control, Albion Publishing Ltd., England, 1995.
4. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
5. Proceedings of the International symposium of Environmental Geotechnology (Vol.I and II), Environmental Publishing Company, 1986 and 1989.
6. Ott, W.R., Environmental Indices, Theory and Practice, Ann Arbor, 1978.
7. Fried, J.J., Ground Water Pollution, Elsevier, 1975.
8. ASTM Special Tech. Publication 874, Hydraulic Barrier in Soil and Rock, 1985.
9. Lagrega, M.d., Buckingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.

SF 9154 ROCK MECHANICS IN ENGINEERING PRACTICE L T P C
3 0 0 3

OBJECTIVE:

- Students are expected to classify, understand stares-strain characteristics, failure criteria, and influence of insitu stress in the stability of various structures and various technique to improve the insitu strength of rocks.

UNIT I CLASSIFICATION OF ROCKS 9

Rocks of peninsular India and the Himalayas - Index properties and classification of rock masses, competent and incompetent rock - value of RMR and ratings in field estimations.

UNIT II STRENGTH CRITERIA OF ROCKS 9

Behaviour of rock under hydrostatic compression and deviatric loading - Models of rock failure - planes of weakness and joint characteristics - joint testing, Mohr - Coulomb failure criterion and tension cut-off. Hoek and Brown Strength criteria for rocks with discontinuity sets.

UNIT III DESIGN ASPECTS IN ROCKS 10

Insitu stresses and their measurements, Hydraulic fracturing, flat jack, over coring and under coring methods - stress around underground excavations - Design aspects of openings in rocks - case studies.

UNIT IV SLOPE STABILITY OF ROCKS 9

Rock slopes - role of discontinuities in slop failure, slope analysis and factor of safety - remedial measures for critical slopes - case studies.

UNIT V REINFORCEMENT OF ROCKS 8

Reinforcement of fractured and joined rocks - shotcreting, bolting, anchoring, installation methods - case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Goodman, R.E., Introduction to rock mechanics, John Willey and Sons, 1989.
2. Hudson, A. and Harrison, P., Engineering Rock mechanics – An introduction to the principles, Pergamon publications, 1997.
3. Hoek, E and Bray, J., Rock slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.
4. Hoek, E and Brown, E.T., Underground Excavations in Rock, Institute of Mining and Metallurgy, U.K. 1981.
5. Obvert, L. and Duvall, W., Rock Mechanics and the Design of structures in Rock, John Wiley, 1967.
6. Bazant, Z.P., Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.
7. Wittke, W., Rock Mechanics. Theory and Applications with case Histories, Springerverlag, Berlin, 1990.
8. Waltham, T, Foundations of Engineering Geology, Second Edition, Spon Press, Taylor & Francis Group, London and New York, 2002.

SF 9155 FINITE ELEMENT METHOD AND APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To understand the basic concepts, principles and other formulation in finite element method and its application in geotechnical engineering through software.

UNIT I BASIC CONCEPTS **9**

Basic concepts - Discretization of continuum, typical elements, the element characteristic matrix, element assembly and solution for unknowns - Applications.

UNIT II VARIATIONAL PRINCIPLES **9**

Variational principles, variational formulation of boundary value problems, variational methods approximation such as Ritz and weighted residual (Galerkin) methods, Applications.

UNIT III DISPLACEMENTS BASED ELEMENTS **9**

Displacements based elements, finite elements for axial symmetry. One-dimensional problems of stress, deformation and flow, assembly, convergence requirements, Finite elements analysis of two-dimensional problems. The linear and quadratic triangle, Natural coordinates.

UNIT IV ISOPARAMETRIC FORMULATION **9**

Isoparametric formulation – Isoparametric bar element – plane bilinear isoparametric element – refined elements – Numerical integration techniques.

UNIT V APPLICATIONS IN GEOTECHNICAL ENGINEERING **9**

Use of FEM to Problems in soils and rocks, Introduction to non-linearity. Description and application to consolidation, seepage and soil – structure interaction problems.

TOTAL: 45 PERIODS

REFERENCES:

1. Cook, R.D., Malkus, D.S., and Plesha, M.E., Concepts and Applications of Finite Element Analysis, John Wiley, 1989.
2. Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill, 1984.
3. Chadrupatla, R.T., and Belegundu. A.D, Introduction to Finite Elements in Engineering, Third Edition, Prentice- Hall, 2006.
4. Rockey, K.C., Erans, H.R., Griffiths, D.W., and Nethercot, D.A., The Finite Element method, Grostry Lockwood Staples, London, 1975.
5. Rajasekaran, S., Finite Element Analysis in Engg Design, Wheller Publishing, Allahabad, 1993.
6. Smith, I.M., Programming the Finite Element Method with Application to Geomechanics, John Wiley and sons, New Delhi, 2000.
7. Gupta, O.P. Finite and Boundary Element Methods in Engineering, Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi, 2000.
8. Rao, S.S. The finite element method in Engg, Butterworth - Heinemann., 1998.
9. Potts, D.M. and Zdramcovic, L., Finite Element analysis in Geotechnical Engineering - Application, Thomas Telford, 2001.
10. Shen, J. and Kushwaha. R.L., Soil-Machine Interaction - A finite element perspective, Moral Dikker, Inc. 1998.

SF 9156 PAVEMENT ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- Student gains knowledge on designing rigid and flexible pavements for different serviceability conditions of roads.

UNIT I BASIC CONCEPTS 9

Pavements types – Historical developments - Approaches to pavement design – vehicle and traffic considerations – behaviour of road materials under repeated loading – Stresses and deflections in layered systems**.**

UNIT II FLEXIBLE PAVEMENT 9

Factors affecting flexible pavements – material characterization for analytical pavement design – CBR and stabilometer tests – Resilient modulus – Fatigue subsystem – failure criteria for bituminous pavements – IRC design guidelines.

UNIT III RIGID PAVEMENT 9

Factors affecting rigid pavements - Design procedures for rigid pavement – IRC guidelines – Airfield pavements. Highway pavements – CRC pavements.

UNIT IV PAVEMENT EVALUATION AND REHABILITATION 9

Pavement evaluation and rehabilitation, condition and evaluation surveys causes and types of distress – in flexible and rigid pavements – PSI models – Serviceability index of rural roads – Overlay design, pavements maintenance management and construction.

UNIT V STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS 9

The need for a stabilized soil – Design criteria and choice of stabilizers – Testing and field control – Stabilisation in India for rural roads – Use of Geosynthetics in road construction - Case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Wright, P.H., Highway Engineers, John Wiley & Sons, Inc., New York, 1996.
2. Khanna S.K and Justo C.E.G, Highway Engineering, Eighth Edition, New Chand and Brothers, Roorkee, 2001.
3. Yoder R.J and Witchak M.W., Principles of Pavement Design, John Wiley, 2000.
4. Croney, D., Design and Performance of Road Pavements, HMO Stationary Office, 1979.
5. Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.
6. Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.
7. Guideline for the Design of Rigid Pavements for Highways, IRC:58-1998, The Indian Roads Congress, New Delhi.
8. O' Flaherty, C.A., Highway Engineering (Vol. 2), Edward Arnold Cp., 1978.
9. Bell. P.S., Developments in Highway Engineering, Applied Sciences publishers, 1978.

SF 9157 SOIL STRUCTURE INTERACTION L T P C
3 0 0 3

OBJECTIVE:

- To understand the mechanism of soils, their interactive behaviour, analysis, its influences in the design parameters through design charts and software packages.

UNIT I SOIL-FOUNDATION INTERACTION 6

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 behaviour.

UNIT II BEAM ON ELASTIC FOUNDATION - SOIL MODELS 10

Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness – Analysis through application packages.

UNIT III PLATE ON ELASTIC MEDIUM 10

Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions, Analysis of braced cuts - Application packages.

UNIT IV ELASTIC ANALYSIS OF PILE 10

Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap - pile raft - Application packages

UNIT V LATERALLY LOADED PILE 9

Load deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, and pile raft system, solutions through influence charts and Application packages.

TOTAL: 45 PERIODS

REFERENCES:

1. Saran, S, Analysis and desaign of substructures, Taylor & Francis Publishers, 2006
2. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.
3. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980.
4. Murthy, V.N.S., Advanced Foundation Engineering, CBS Publishers, New Delhi, 2007
5. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, Basic Geotechnics, Sixth Edition, Prentice Hall, 2002.
6. Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier, 1979.
7. Scott, R.F. Foundation Analysis, Prentice Hall, 1981.
8. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978.
9. ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Dehit, 1988.

SF 9158 SUBSURFACE INVESTIGATION AND INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVE:

- Students are expected to understand the importance of site investigation, planning of sub soil investigation, interpretation of investigated data to design suitable foundation system.

UNIT - I SCOPE AND OBJECTIVE:S OF EXPLORATION 8

Scope and objectives, planning and exploration program, methods of exploration, exploration for preliminary and detailed design, spacing and depth of bores, data presentation. Geophysical exploration and interpretation, seismic and electrical methods.

UNIT - II EXPLORATION TECHNIQUES 7

Methods of boring and drilling, non-displacement and displacement methods, drilling in difficult subsoil conditions, stabilization of boreholes, bore logs.

UNIT - III SOIL SAMPLING 8

Sampling, disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation and handling of samples.

UNIT - IV FIELD TESTING IN SOIL EXPLORATION 12

Field tests, penetration tests, procedures and methods, data interpretation, Field vane shear, Insitu shear and bore hole shear test, pressuremeter test, utility, correction and data interpretation, plate load test–monotonic and cyclic; field permeability test.

UNIT - V INSTRUMENTATION 10

Instrumentation in soil engineering, strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, piezometers and slope indicators, inclinometer, case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Hunt, R.E., Geotechnical Engineering Investigation Manual, McGraw Hill, 1984.
2. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Hand Book, a Nostrand Reinhold 1994.
3. Alam Singh and Chowdhary, G.R., Soil Engineering in Theory and Practice, Volume-2, Geotechnical testing and instrumentation, CBS Publishers and Distributors, New Delhi, 2006.
4. Nair, R.J. and Wood, P.M., Pressuremeter Testing Methods and Interpretation, Butter-worths, 1987.
5. Dunnicliff, J., and Green, G.E., Geotechnical Instrumentation for Monitoring Field Performance, John Wiley, 1993.
6. Hanna, T.H., Field Instrumentation in Geotechnical Engineering, Trans Tech., 1985.
7. Day, R.N., Geotechnical and Foundation Engineering, Design and Construction, McGraw-Hill, 1999.
8. Bowles, J.E., Foundation Analysis and Design, Fifth Edition The McGraw-Hill companies, Inc., New York, 1995.

SF 9159 REINFORCED SOIL STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To understand the mechanism of the reinforcement, its influence in the shear strength and design concept for various applications in geotechnical engineering.

UNIT I PRINCIPLES AND MECHANISMS OF SOIL REINFORCEMENT 7
Historical Background, Principles, Concepts and Mechanisms of reinforced earth.

UNIT II REINFORCING MATERIALS AND THEIR PROPERTIES 10
Materials used in reinforced soil structures, fill materials, reinforcing materials metal strips, Geotextile, Geogrids, Geomembranes, Geocomposites and Geojutes, Geofoam, Natural fibers - facing elements – Properties and methods of Testing.

UNIT III DESIGN OF SOIL REINFORCEMENT 13
Reinforcing the soil-Geotextiles and Geogrids – Embankments and slopes – reinforced walls – bearing capacity – Road way reinforcement – slop stabilization.

UNIT IV DESIGN FOR SEPARATION, FILTRATION AND DRAINAGE 10
Geotextiles - requirement for design of separation – Filtration – General behaviour - filtration behind retaining walll, under drains, erosion control and silt fence – drainage design – Liners for liquid containment – Geomembrance and Geosynthetic clay liners.

UNIT V DURABILITY OF REINFORCEMENT MATERIALS 5
Measurement of corrosion factors, resistivity - redox potential, water content, pH, electrochemical corrosion, bacterial corrosion – influence of environmental factors on the performance of Geosynthetic materials.

TOTAL : 45 PERIODS

REFERENCES:

1. Jewell, R.A., Soil Reinforcement with Geotextile, CIRIA, London, 1996.
2. Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Earthworks, London, 1982.
3. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, 1997.
4. Muller, W.W. HDPE Geomembrances in Geotechnics, Springer, New York 2007.
5. John, N.W.M., Geotextiles, John Blackie and Sons Ltd., London, 1987.
6. Gray, D.H., and Sotir, R.B., Biotechnical and Soil Engineering Slope Stabilization: A practical Guide for Erosion control, John Wiley & Son Inc., New York, 1996.
7. Ramanatha Ayyar , T.S., Ramachandran Nair, C.G. and Balakrishna Nair, N., Comprehensive Reference Book on Coir Geotextile, Centre for Development for Coir Technology, 2002.
8. Sivakumar Babu, G.L., An Introduction to Soil Reinforcement and Geosynthetics, University Press (India), Pvt. Ltd., Hyderabad, 2006.

SF 9160 GEOTECHNICAL EARTHQUAKE ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- The objective of this course is to understand the dynamics of earth and its response, effect on earth structure and measures to mitigate the effects.

UNIT - I ELEMENTS OF EARTHQUAKE SEISMOLOGY AND DYNAMICS 6

Mechanism of Earthquakes - Causes of earthquake - Earthquake Fault sources - Elastic Rebound theory - Seismic wave in Earthquake shaking - Definition of earthquake terms - Locating an earthquake - Quantification of earthquakes.

UNIT - II GROUND MOTION CHARACTERISTICS 9

Strong Motion Records -characteristics of ground motion - Factors influencing ground motion - Estimation of frequency content parameters - Seismic site investigations - Evaluation of Dynamic soil properties.

UNIT - III GROUND RESPONSE ANALYSIS - LOCAL SITE EFFECTS AND DESIGN GROUND MOTION 10

Wave propagation Analysis - Site Amplification, Ground Response Analysis - Method of analysis - One Dimensional Analysis - Equivalent linear Analysis – shear beam Analysis - site effects - Design Ground Motion - Developing Design Ground Motion. Application of software package - codal recommendations.

UNIT - IV SEISMIC STABILITY ANALYSIS 14

Earthquake Resistant Design of foundation of buildings - Design considerations - Geotechnical - Architectural - Structural - Capacity Design - Seismic analysis. Earthquake Response of slopes - Evaluation of slope stability - Pseudostatic Analysis - Newmark's Study of Block Analysis - Dynamic Analysis - Earth pressure due to ground shaking valuation. Liquefaction-Susceptibility-Evaluation Cyclic stress approach - Liquefaction Resistance - Field Tests with interpretation - Lateral Deformation - codal recommendations.

UNIT - V EARTHQUAKE HAZARD MITIGATION 6

Seismic risk vulnerability and hazard - Risk mapping - scale – changing percept of risk – vulnerability Atlas of India. Hazard assessment - Maintenance and modifications to improve hazard resistance; Seismic microzonation – methodology – scale of mapping - Different type of foundation and its impact on safety.

TOTAL: 45 PERIODS

REFERENCES:

1. Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing - New Delhi, 2000.
2. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall,Iinternational Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
3. Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.
4. Mc Guire, R.K. Seismic Hazard and Risk Analysis Earthquake Engineering Research Institute, 2004.
5. Mahanti, N.C. Samal, S.K. Datta, P. Nag.N.K., Diaster Management, Narosa Publishing House, New Delhi, India, 2006.
6. Wai-Fah Chen and Cgharles Scawthem, Earthquake Engineering Hand book, Caspress,2003.
7. Robert W. Day, Geotechnical Earthquake Engineering Hand book, McGraw Hill, 2002.

SF 9161 MECHANICS OF UNSATURATED SOILS L T P C
3 0 0 3

OBJECTIVE:

- At the end of this course students attains adequate knowledge in assessing both physical and engineering behaviour of unsaturated soils, measurement and modeling of suction – water content and suction – hydraulic conductivity of unsaturated soils.

UNIT I STATE OF UNSATURATED SOIL 6

Definition – Interdisciplinary nature of unsaturated soil – soil classification – Nature and practice – stress profiles, stress state variables - material variables – constitutive law – suction potential of soil water

UNIT II PHYSICS OF SOIL WATER SYSTEM 9

Physical properties of Air and water – partial pressure and relative Humidity Density of moist air – surface Tension – cavitations of water. Solubility of Air in water – Air – water solid interface – vapor pressure lowering – soil water characteristic-curve. Capillary tube model – contacting sphere model. Young Laplace equation – Height of capillary rise – Rate of capillary rise – capillary pore size distribution – theoretical basis – determination – laboratory method.

UNIT III STRESS STATE VARIABLES AND SHEAR STRENGTH 12

Effective-stress – stress between two spherical particles – Hysteresis in SWCC – stress parameter, stress tensor – stress control by Axis Translation - analytical representation of stress – volume change characteristics. Extended Mohr – Coulomb criterion – shear strength parameters – Interpretation of Direct shear test results and Tri axial test results – unified representation of failure envelope – Influence of suction in earth pressure distribution.

UNIT IV STEADY AND TRANSIENT FLOWS 9

Driving mechanism – Permeability and Hydraulic conductivity – capillary barriers – steady infiltration and evaporation – Vapor flow – Air diffusion in water. Principles for pore liquid flow – Rate of infiltration, Transient suction and moisture profiles. Principles for Pore Gas flow – Barometric pumping Analysis.

UNIT V MATERIAL VARIABLE MEASUREMENT AND MODELLING 9

Measurement of total suction – psychrometers – Filter paper measurement of matric suction – High Air Entry disks – Direct measurements – Tensiometers – Air-translation technique – Indirect measurements – Thermal conductivity sensors – measurement of osmotic suction – squeezing technique – soil water characteristic curves and Hydraulic conductivity models.

TOTAL: 45 PERIODS

REFERENCES:

1. Fredlund, D.G. and Rahardjo, H. Soil Mechanics for unsaturated soils, John Wiley & Sons, INC, New York.2003.
2. Ning Lu and William, J. Likes, Unsaturated Soil Mechanics, John Wiley & sons, INC. New Jersey, 2004
3. Ng Charles, W.W., Menzies Bruce, Advanced unsaturated Soil Mechanism and Engineering, Taylor & Francis Group, 2007.
4. Ning Lu, Laureano R. Hoyes and Lakshmi Reddi, Advances in unsaturated soil, seepage and Environmental Geotechnics, ASCE., Geotechnical special publication No.148.