AFFILIATED INSTITUTIONS

ANNA UNIVERSITY :: CHENNAI 600 025

REGULATIONS - 2013

M.E. SOIL MECHANICS AND FOUNDATION ENGINEERING

I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA7154	Advanced Mathematical Methods	3	1	0	4
2.	SF7101	Theoretical Soil Mechanics	4	0	0	4
3.	SF7102	Strength and Deformation Behaviour of Soils	3	0	0	3
4.	SF7103	Soil properties and Behaviour	3	0	0	3
5.	SF7104	Subsurface Investigation and Instrumentation	3	0	0	3
6.		Elective I	3	0	0	3
		TOTAL	**19**	**1**	**0**	**20**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	SF7201	Shallow Foundations	3	0	0	3
2.	SF7202	Deep Foundations	3	0	0	3
3.	SF7203	Ground Improvement	3	0	0	3
4.	SF7204	Dynamics of Soils and Foundations	3	0	0	3
5.		Elective II	3	0	0	3
6.		Elective III	3	0	0	3
PRACTICAL						
7.	SF7211	Advanced Soil Mechanics Laboratory I	0	0	4	2
		TOTAL	**18**	**0**	**4**	**20**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective IV	3	0	0	3
2.		Elective V	3	0	0	3
PRACTICAL						
3.	SF7311	Advanced Soil Mechanics Laboratory II	0	0	4	2
4.	SF7312	Practical Training (4 weeks)	-	-	-	1
5.	SF7313	Project Work (Phase I)	0	0	12	6
		TOTAL	**6**	**0**	**16**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	SF7411	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 67

LIST OF ELECTIVES

SEMESTER I (Elective -I)

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	SF7001	Earth Pressure and Earth Retaining Structures	3	0	0	3
2.	SF7002	Rock mechanics in engineering practice	3	0	0	3

SEMESTER II (Elective - II & III)

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
3.	SF7003	Earth and Rock Fill Dams	3	0	0	3
4.	SF7004	Reinforced Soil Structures	3	0	0	3
5.	SF7005	Finite Element Method and Applications	3	0	0	3
6.	SF7006	Geotechnical Earthquake Engineering	3	0	0	3

SEMESTER III (Elective - IV & V)

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
7.	SF7007	Pavement Engineering.	3	0	0	3
8.	SF7008	Geo environmental Engineering	3	0	0	3
9.	SF7009	Soil Structure Interaction	3	0	0	3
10.	SF7010	Mechanics of Unsaturated Soils	3	0	0	3

MA7154 ADVANCED MATHEMATICAL METHODS L T P C
3 1 0 4

OBJECTIVES:

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

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9+3

Laplace transform, Definitions, properties – Transform error function, Bessel's function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation.

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9+3

Fourier transform: Definitions, properties – Transform of elementary functions, Dirac Delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poison's equations.

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 – Problems with constraints – Direct methods – Ritz and Kantorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 9+3

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

UNIT V TENSOR ANALYSIS 9+3

Summation convention – Contravariant and covaraiant vectors – Contraction of tensors – Innerproduct – Quotient law – Metric tensor – Chrirstoffel symbols – Covariant differentiation – Gradient, divergence and curl.

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

OUTCOME:

- On completion of the course the students will enable to solve boundary value problems using Laplace and Fourier transform techniques. They will also solve Fluid flow and heat flow problems using conformal mapping.

REFERENCES:

1. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
2. James, G., "Advanced Modern Engineering Mathematics, 3rd Edition, Pearson Education, 2004.
3. Ramaniah.G. "Tensor Analysis", S.Viswanathan Pvt. Ltd., 1990.
4. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
5. Spiegel, M.R., "Theory and Problems of Complex Variables and its Application (Schaum's Outline Series)", McGraw Hill Book Co., 1981.

SF7101 THEORETICAL SOIL MECHANICS L T P C
4 0 0 4

OBJECTIVES:

- To impart knowledge required for computing stress and settlement at any point in the semi-infinite elastic soil medium, anisotropic medium and layered deposits due to foundation loads and evaluation of stability of foundations, slopes, cuts and retaining structures both for the conditions of undrained and drained loading through theorems of plastic collapses.

UNIT I THEORY OF ELASTICITY 12

Material behavior – Basic Concepts – Elastic, Viscous and Plastic idealization, Mechanics of Continua: Stress and strain - concept of stress and strain – Three dimensional and Two dimensional state of stress – Plane stress, plane strain and axisymmetric problems – equilibrium and compatibility conditions, constitutive relations, stress functions – Two dimensional problems in Cartesian and polar co-ordinates.

UNIT II STRESS AND DISPLACEMENT IN EASTIC – HALF SPACE MEDIUM 14

Elastic half-space medium – Stress by external loads – Isotropic, anisotropic and non-homogeneous elastic continuum – Boussinesq, Frochlich, Westergaard solutions for force on the surface of semi-infinite medium – Kelvin, Cerruti and Mindlin's method for force in interior of semi-infinite medium, solutions by influence charts – Elastic displacement – Layered soil – Burmister method.

UNIT III THEOREMS OF PLASTIC COLLAPSE AND THEIR APPLICATIONS 10

Perfect plastic material- theory of plasticity – Hardening law, flow rule. Theorem of plastic collapse – bound theorems – Mechanism for plane plastic collapse – slip fans, stress fans – discontinuities – Simple solutions for undrained and drained loading – Stability of foundations, retaining walls, slopes and cuts.

UNIT IV STABILITY OF SOIL STRUCTURE BY SLIP LINE METHOD AND LIMIT EQUILIBRIUM ANALYSIS 14

Introduction – stress – strain relationship in a perfectly plastic material – discontinuous slipping – stress and displacement field calculations – associated field calculation – Slip line solutions for undrained and drained conditions – limit equilibrium solutions for stability of foundation, retaining walls and slopes.

UNIT V FLOW THROUGH POROUS MEDIA 10

Flow through porous media – Darcy's law – General equation of flow, seepage through isotropic anisotropic and non-homogeneous conditions – Steady state condition, confined and unconfined flow – solution by flow net – seepage pressure – piping.

TOTAL : 60 PERIODS

OUTCOME:

- At the end of the course students will have the capacity to estimate the stresses in soil medium of any type due to foundation load and settlement of foundation. Further they will be in a position to evaluate bound and true collapse loads of soil structures.

REFERENCES:

1. Aysen, A., Problem solving in Soil Mechanics, Taylor & Francis, London, First Indian Print, 2011.
2. Chowdhury, I., Dasgupta S.P., Dynamics of Structure and Foundations, Taylor & Francis Group, London, 2009.
3. Bolton, M.D; A Guide to Soil Mechanics, University press (India) Pvt.Ltd., 2009
4. Atkinson, J.H; The Mechanics of Soils and Foundations, Taylor and Francis, London, 2007.
5. Aysen, A., Soil Mechanics, Basic concepts and Engineering Applications, A.A.Balkema Publishers, 2002.
6. Ulrich Smoltc, YK, Geotechnical Engineering Handbook (Vol.1), Ernot & Sohn, 2002.
7. Muni Budhu, Soil Mechanics and Foundations, John Wiley and Sons, Inc., Network, 2000.
8. Cedergren, H.R., Seepage, Drainage and Flownets, John Wiley, 1997.

9. Davis, R.O and Selvadurai, A.P.S., Elasticity and Geomechanics, Cambridge University Press, 1996.
10. Wai-Fah Chen, and Liu, X.L., Limit Analysis in Soil Mechanics, Elsevier Science Ltd., 1991.
11. Atkinson, J.H., Foundations and Slopes, McGraw Hill, 1981.

SF7102 STRENGTH AND DEFORMATION BEHAVIOUR OF SOILS L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I SHEAR STRENGTH OF COHESIONLESS SOILS 9

Introduction-Shear strength of soil-cohesion-angle of internal friction-Shear strength of granular soils - Direct shear - Triaxial Testing- Drained and undrained Stress-strain behaviour - Dilation, contraction and critical states - Liquefaction and cyclic mobility of saturated sands. Factors influencing shear strength.

UNIT II SHEAR STRENGTH OF COHESIVE SOILS 9

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

UNIT III FAILURE THEORIES 9

Concepts of yield and failure in soils- Failure theories of Von Mises, Tresca and their extended form, their applicability to soils - Detailed discussion of Mohr - Coulomb failure theory.

UNIT IV CONSTITUTIVE LAW FOR SOIL 9

Constitutive law for soil – linear, non linear model- hyperbolic idealisation – Mohr-Columb model-Hardening law-Hardening soil model- Hardening soil model with small strain stiffness- Soft soil creep model-Soft soil model-limitation of all models- Modulus for different type of loading – Poisson's ratio.

UNIT V CRITICAL STATE SOIL MECHANICS 9

The critical state line- Roscoe's surface- Hvorslev's surface- Behavior of sand- Effects of dilation-Limitations of Taylor model- Elastic and plastic deformation-Camclay critical state model- Modified Camclay model- Parameters for design

TOTAL: 45 PERIODS

OUTCOME:

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

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. Graham Barnes, Soil Mechanics Principles and Practices, Macmillan Press Ltd., London, 2002.
7. Shear Strength of Liquefied Soils, Final Proceedings of the workshop, National Science Foundation, Urbane, Illinois, July 1998.

8. Braja, M. Das, Principles of Geotechnical Engineering, Brooks/Cole, Thomson Learning Academic Resource, Center, Fifth Edition, 2002.
9. Keedwell, M.J., Rheology and Soil Mechanics, Elsevier applied science Publishers Ltd., 1984.
10. Malcolm D. Bolton, A guide to soil mechanics, Universities Press (India) Private Ltd., Hyderabad, India, 2003.

SF7103 SOIL PROPERTIES AND BEHAVIOUR L T P C
3 0 0 3

OBJECTIVES:

- To impart 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 – different soil deposits and their engineering properties – 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 9

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

UNIT III SWELLING, SHRINKAGE AND COMPACTION BEHAVIOUR OF SOILS 10

Problems associated with swelling and shrinkage behaviour of soils –Causes, consequences and mechanisms – factors influencing swell – shrink characteristics – swell potential – osmotic swell pressure – soil fabric and measurement – sensitivity, thixotrophy of soils – soil suction – soil compaction – factors affecting soil compaction.

UNIT IV COMPRESSIBILITY, SHEAR STRENGTH AND PERMEABILITY BEHAVIOUR OF SOILS 10

Compressibility, shear strength and permeability behaviour of fine and coarse grained soils – mechanisms and factors influencing engineering properties – liquefaction potential – causes and consequences.

UNIT V CONDUCTION PHENOMENA AND PREDICTION OF SOIL BEHAVIOUR 8

Conduction in soils – hydraulic, electrical, chemical and thermal flows in soils – applications - coupled flows – Electro-kinetic process – thermo osmosis - electro osmosis – prediction of engineering behaviour of soils using index properties – empirical equations and their applicability.

TOTAL: 45 PERIODS

OUTCOME:

- Students are able to select suitable soils for various geotechnical applications based on the factors governing the Engineering behaviour of soils.

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.
10. Robert D. Holtz and William D. Kovacs, “An Introducion to Geotechnical Engineering”, Prentice Hall (UK) International, London, 1981.

SF7104 SUBSURFACE INVESTIGATION AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES:

- 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 PLANNING OF EXPLORATION AND GEOPHYSICAL METHODS 8

Scope and objectives, planning an 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, cross bore hole, single bore hole – up hole -down hole methods.

UNIT II EXPLORATION TECHNIQUES 7

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

UNIT III SOIL SAMPLING 8

Sampling Techniques – quality of samples – factors influencing sample quality - 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, Field vane shear, Insitu shear and bore hole shear test, pressuremeter test, dilatometer test - plate load test–monotonic and cyclic; field permeability tests – block vibration test. Procedure, limitations, correction and data interpretation of all methods.

UNIT V INSTRUMENTATION 10

Instrumentation in soil engineering, strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies.

TOTAL: 45 PERIODS

OUTCOME:

- Students are capable of planning and executing the sub soil investigation programme. They are also capable of interpreting the investigated data and can design suitable foundation system.

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.

SF7201 **SHALLOW FOUNDATIONS** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart knowledge to select, analyse and geotechnical and structural design of shallow foundation depending on ground condition.

UNIT I SHALLOW FOUNDATIOS 6

Types of foundations – Types of shallow foundation – Design concept - General requirements - Additional consideration - selection of type of foundation - hostile environment.

UNIT II BEARING CAPACITY 9

Theories of bearing capacity – Ultimate Bearing capacity - Homogeneous - Layered soils – Rocks - Evaluation of bearing capacity from in-situ tests – Safe bearing capacity – Bearing capacity of foundations in slope – Bearing capacity under eccentric loading – Codal provisions.

UNIT III SETTLEMENT AND ALLOWABLE BEARING PRESSURE 9

Component of settlement-immediate, primary and secondary consolidation settlement-stress path method of settlement evaluation-layered soil - construction period correction. evaluation from in-situ tests – Allowable settlement – Allowable bearing pressure - codal provisions.

UNIT IV INTERACTIVE ANALYSIS AND DESIGN OF FOUNDATIONS 12

Analysis of foundation - isolated - strip - combined footings and mat foundations. Conventional - elastic approach - Soil Structure Interaction Principles - Application - Numerical techniques - finite element method - Software applications

UNIT V FOUNDATION FOR SPECIAL CONDITIONS 9

Structural Design of shallow foundations – Limit state method-codal provisions- Special foundations - Foundation design in relation to ground movements - Foundation on compressible fills – Foundation for tower-Design of Foundation for seismic forces - Codal Provisions

TOTAL: 45 PERIODS

OUTCOME:

- Students are able to select, analyse and design shallow foundation based on both the type of soil and loading.

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.

SF7202 **DEEP FOUNDATIONS** **L T P C**
3 0 0 3

OBJECTIVES:

- 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 & LOAD TRANSFER PRINCIPLE 10

Necessity of pile foundation – classification of piles – Factors governing choice of type of pile – Load transfer mechanism – piling equipments and methods – effect of pile installation on soil condition – criteria for pile socketing - responsibility of engineer and contractor.

UNIT II AXIAL LOAD CAPACITY PILES AND PILE GROUPS 10

Allowable load of piles and pile groups – Static and dynamic methods – for cohesive and cohesionless soil – negative skin friction – group efficiency – pile driving formulae - limitation – Wave equation application – Interpretation of field test and pile load test results – Settlement of piles and pile group - codal provisions.

UNIT III LATERAL AND UPLIFT LOAD EVALUATION OF PILES 10

Piles under Lateral loads – Broms method, elastic, p-y curve analyses – Batter piles – response to moment – piles under uplift loads – under reamed piles – Drilled shaft – Lateral and pull out load tests – codal provision – case studies.

UNIT IV STRUCTURAL DESIGN OF PILE AND PILE GROUPS 9

Structural design of pile – structural capacity – pile and pile cap connection – pile cap design – shape, depth, assessment and amount of steel – truss and bending theory- Reinforcement details of pile and pile caps – pile raft system – basic interactive analysis – pile subjected to vibration – codal provision.

UNIT V CAISSONS 6

Necessity of caisson – type and shape - Stability of caissons – principles of analysis and design – tilting of caisson – construction - seismic influences - codal provision.

TOTAL: 45 PERIODS

OUTCOME:

- Students are able to select, analyse and design individual pile, group piles and caissons for different subsoil conditions.

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. Varghese P.C.," Foundation Engineering", PHI Learning Private Limited, New Delhi, 2005.
8. Varghese P.C.," Design of Reinforced Concrete Foundations", PHI Learning Private Limited, New Delhi, 2009

SF7203 **GROUND IMPROVEMENT** **L T P C**
3 0 0 3

OBJECTIVES:

- Students will be exposed to various problems associated with soil deposits and methods to evaluate them. The different techniques will be taught to them to improve the characteristics of difficult soils as well as design techniques required to implement various ground improvement methods.

UNIT I DEWATERING 9

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

UNIT II COMPACTION AND SAND DRAINS 9

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 various methods – Case studies.

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 - Soil liquefaction mitigation methods - case studies.

UNIT IV EARTH REINFORCEMENT 9

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

UNIT V GROUTING 9

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 - Stabilization of expansive clays – case studies.

TOTAL : 45 PERIODS

OUTCOME:

- Based on the knowledge gained student will be in a position to identify and evaluate the deficiencies if any in the deposits of the given project area and capable of providing alternative methods to improve its quality so that the structures built on it will be stable and serve the intended purpose.

REFERENCES

1. Pappala, A.J., Huang,J., Han, J., and Hoyos, L.R., Ground Improvement and Geosynthetics; Geotechnical special publication No.207, Geo Institute, ASCE, 2010
2. Cox, B.R., and Grifiths S.C., Practical Recommendation for Evaluation and mitigation of Soil Liquefaction in Arkansas, (Project Report), 2010.
3. Day, R.W., Foundation Engineering Handbook, McGraw – Hill Companies, Inc. 2006.
4. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
5. Das, B.M., Principles of Foundation Engineering, Fourth Edition, PWS Publishing, 1999.
6. Moseley, M.P., Ground Treatment, Blackie Academic and Professionals, 1998.
7. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall 1997.
8. Hehn, R.W., Practical Guide to Grouting of Underground Structures, ASCE, 1996.
9. Jewell, R.A., Soil Reinforcement with Geotextiles, CIRIA, London, 1996.
10. Koerner, R.M. and Welsh, J.P., Construction and Geotechnical Engineering using Synthetic Fabrics, John Wiley, 1990.
11. Jones, J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1985.

SF7204 DYNAMICS OF SOILS AND FOUNDATIONS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of dynamics – dynamic behaviour of soils – effects of dynamic loads 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 9

Dynamic stress – strain characteristics – principles of measuring dynamic properties – Laboratory Techniques – Field tests – Factors affecting dynamic properties - Typical values- Dynamic bearing capacity – Dynamic earth pressure.

UNIT III FOUNDATIONS FOR 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 Provisions

UNIT IV FOUNDATION FOR IMPACT AND ROTARY MACHINES 9

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 Turbo Generator Foundation – method of analysis – Design; Dynamic soil – structure – Interaction, Codal Provisions.

UNIT V INFLUENCE OF VIBRATION AND REMEDIATION 9

Mechanism of Liquefaction–Influencing factors--Evaluation of Liquefaction potential based on SPT-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

OUTCOME:

- Students are able to design foundation for different machines, access the influence of vibrations and selection of remediation methods based on the nature of vibration, properties and behaviour of soil.

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.

SF7211 ADVANCED SOIL MECHANICS LABORATORY I L T P C
0 0 4 2

OBJECTIVES:

- At the end of the course student attains adequate knowledge in assessing index properties, compaction, CBR, Compressibility, Swell characteristics and permeability of soils by conducting laboratory tests.

LIST OF EXPERIMENTS

UNIT I INDEX TESTS 12

sSpecific gravity of soil solids-Grain size distribution (Sieve analysis and Hydrometer analysis) - Liquid limit and Plastic limit tests - Shrinkage limit and Differential free swell tests - Field density Test

UNIT II CHEMICAL TESTS 12

Chemical analysis – pH – Conductivity – quantification of ions through flame Photometer – Determination of organic, sulphate and chlorite content.

UNIT III COMPACTION AND CBR TESTS 12

Compaction tests - Determination of moisture – density relationship – Influence of compaction energy – CBR Test.

UNIT IV COSOLIDATION AND PERMEABILITY TESTS 12

One dimensional consolidation test, Cv , Cc and mv determination. Permeability of soil – constant and falling head methods.

UNIT V SWELLTESTS 12

Determination of percent swell – swell pressure, constant volume method; expanded - loaded method.

TOTAL: 60PERIODS

OUTCOME:

- Students will be capable of assessing various properties of soils by conducting appropriate tests.

REFERENCES:

1. Alam Singh and Chowdary, G.R., Soil Engineering in Theory and Practice (Vol.2) Geotechnical Testing and Instrumentation, CBS Publishers and Distributors, New Delhi, 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. Das, B.M., Soil Mechanics Laboratory Manual, Engineering Press, Austin, 1997
6. Al-Khataji, A.W. and Anderstand, O.B., Geotechnical Engineering & Soil Testing, Sounders College Publishing, Fort Worth, 1992.
7. “Soil Engineering Laboratory Instruction Manual”, Published by the Engineering College Co-operative Society, Chennai, 1996.
8. Lambe T.W., Soil Testing for Engineers”, John Wiley and Sons, New York, 1990.
9. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

SF7311 ADVANCED SOIL MECHANICS LABORATORY II L T P C
0 0 4 2

OBJECTIVES:

- At the end of the course student attains adequate knowledge in assessing Shear Strength, dynamic properties of soil and Shear strength, indirect tensile strength and compressive strength of Rocks. Student learns to as sess the different properties of geosynthetics. Student is trained to gain knowledge in assessing the properties of soils through field tests and also by conducting model tests.

UNIT I SHEAR STRENGTH TESTS 12

Direct shear – Triaxial compression (UU and CU) test – Unconfined compression test –Vane shear test.

UNIT II SUCTION TESTS 8

Soil water characteristic curves of soil by Pressure Plate apparatus – Filter paper technique.

UNIT III TEST ON GEOSYNTHETICS 12

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

UNIT IV TEST ON ROCKS 12

Point load index – Brazilian test – Direct shear test – Uniaxial compressive strength test

UNIT V MODEL AND FIELD TESTS 16

Model test on foundation elements - strain gauges - load cells. Field tests - Plate load test – static cone penetration test – standard penetration test – pressuremeter test - Block vibration test.

TOTAL: 60PERIODS

OUTCOME:

- Students will be capable of assessing shear strength, dynamic properties of soils by conducting appropriate tests. They will be in a position to assess the properties of geosynthetics and rocks. They can also supervise different field tests.

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.
9. “Soil Engineering Laboratory Instruction Manual”, Published by the Engineering College Co-operative Society, Chennai, 1996.
10. Lambe T.W., Soil Testing for Engineers”, John Wiley and Sons, New York, 1990.
11. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

SF7312 **PRACTICAL TRAINING (4 Weeks)** **L T P C**
- - - 1

OBJECTIVES:

- To train the students in field work so as to have a first hand knowledge of practical problems in carrying out Soil Mechanics and Foundation engineering tasks. To develop skills in facing and solving the geotechnical engineering field problems.

SYLLABUS:

The students individually undertake training in reputed Soil Mechanics and Foundation Engineering Companies during the summer vacation for a specified period of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:

- Students are able to solve Soil Mechanics and Foundation engineering problems in the field either individually or in team.

SF7313 **PROJECT WORK (PHASE I)** **L T P C**
0 0 12 6

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

SF7411 **PROJECT WORK (PHASE II)** **L T P C**
0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

OUTCOME:

- On completion of the project work students will be in a position to take up any research and challenging practical problem for finding better solutions.

SF7001 EARTH PRESSURE AND EARTH RETAINING STRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- 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. – Stability analysis of retaining structure both for regular and earthquake forces.

UNIT III SHEET PILE WALLS 8

Types of sheet piles - Analysis and design of cantilever and anchored sheet pile walls – free earth support method – fixed earth support method. Design of anchor systems - isolated and continuous.

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 –Basic design concepts.

UNIT V SLURRY SUPPORTED TRENCHES 9

Basic principles – Slurry characteristics – Specifications - Diaphragm and bored pile walls – stability Analysis and design

TOTAL: 45 PERIODS

OUTCOME:

- Students will be capable of analysing and designing rigid, flexible earth retaining structures, slurry supported trenches and deep cuts.

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.
11. Petros P. Xanthakos., Slurry walls as structural systems, 1993

SF7002 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 12 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

OUTCOME:

- Students are capable of classifying the rock. They can understand stares-strain characteristics, failure criteria, and influence of insitu stress in the stability of various structures. They also know various technique to improve the insitu strength of rocks.

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.

SF7003 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 of analysis of slopes and remedial techniques to protect the slopes.

UNIT I DESIGN CONSIDERATION 9

Design consideration, Factors influencing design, Types of earth and rock fill 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, Flow nets, 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 SLOPE PROTECTION MEASURES 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

OUTCOME:

- Students are capable of reasoning out the causes of failure and damages of embankments and slopes. They can carry out slope stability analysis using various methods. They are also capable of carrying out remedial measures and protection of slopes.

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.

SF7004 REINFORCED SOIL STRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- To understand the mechanism of the reinforcement , its influence in the shear strength and design concept for various applications in geotechnical engineering. Students are able to analyse and design the geotechnical reinforced structures based on interaction mechanism of reinforcement and influence on the shear strength of soil.

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-Railway reinforcement-slope stabilization-Seismic aspects

UNIT IV DESIGN FOR SEPARATION, FILTRATION AND DRAINAGE 10

Geotextiles - requirement for design of separation – Filtration – General behaviour - filtration behind retaining wall, under drains, erosion control and silt fence – drainage design – Liners for liquid containment – Geomembrane 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

OUTCOME:

- Students are able to analyse and design the geotechnical reinforced structures based on interaction mechanism of reinforcement and soil.

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 Geomembranes 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.

SF7005 FINITE ELEMENT METHOD AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- Students are focused on acquiring the basic knowledge and computational skills in terms of finite element formulation with respect to various kinds of Geotechnical Engineering problems.

UNIT I BASIC CONCEPTS 9

Introduction – basic concepts - discretization of continuum, typical elements, the element characteristic matrix, element assembly and solution for unknowns – applications. Variational principles, variational formulation of boundary value problems, variational methods of approximation such as Ritz and weighted residual (Galerkin) methods.

UNIT II DISPLACEMENT MODELS 9

Displacement based elements - element equations, convergence requirements, shape functions – element stresses and strains – element stiffness matrix - global equations – boundary conditions – solution of global equations – finite elements for axi-symmetric problem – one dimensional problem of stresses and strains – finite element analysis for two – dimensional problems.

UNIT III ISOPARAMETRIC FORMULATION 8

Isoparametric element - Local and Natural Co-ordinates systems, Line, Triangular, Quadrilateral and Tetrahedral Element-Interpolation - Displacement Models Formulation of Isoparametric - Finite element matrices in Local and Global Coordinate system – refined elements – numerical integration techniques.

UNIT IV GEOTECHNICAL CONSIDERATION 9

Introduction – total stress analysis – pore pressure calculation – FEM to model structural components, strain definitions, constitutive equation, finite element formulation, membrane elements – Finite elements to model interfaces – basic theory – finite element formulation – boundary conditions – finite element theory for nonlinear behavior of soils.

UNIT V APPLICATION IN GEOTECHNICAL ENGINEERING 10

Use of FEM to problems in soils – description and application to consolidation – seepage - FEM to simulate soil – structure interaction problems – software package use for simulating and analyzing the real foundation problem using FEM such as footing, pile foundation and deep excavations.

TOTAL: 45 PERIODS

OUTCOME

- Students will have the capacity to use advanced numerical techniques like FEM in various Geotechnical Engineering applications and in a capacity to use FEM based software programs for arriving solutions to various practical design problems in Geotechnical Engineering.

REFERENCE BOOKS

1. Concepts and applications of finite element analysis by Cook, R.D., Malkus, D.S., and Plesha, M.E., John Wiley, New York., 1989.
2. Introduction to the finite element method by Desai and Abel, Van Nostrand Reinhold Company, New York, 1972.
3. Finite element analysis Theory and Programming by Krishnamoorthy.C.S., Tata McGraw-Hill, New Delhi, 1990.
4. Finite element in geotechnical engineering by Naylor, Pande, Simpson and Tabb., Pineridge Press Ltd, Swansea, U. K, 1981.
5. The Finite Element Method by Zienkiewicz, O.C., 3rd Edition, Tata McGraw-Hill publishing Co., New Delhi, 1983.
6. Finite element analysis in geotechnical engineering – theory by Potts, D.M. and Zdravkovic, L., Published by Thomas Telford, London, 1999.
7. An introduction to the finite element method by Reddy, J.N., McGraw Hill, New York, 1984.
8. The Finite Element Methods in Engineering by Rao, S.S., Pergamon, New York, 1998.
9. Soil-machine introduction – A finite element perspective by Shen, J. and Kushwahs, R.L., Moral Dikker, Inc., 1998.
10. Programming the Finite Element Method with application to Geomechanics by Smith, I.M., John Wiley and Sons, New Delhi, 2000.

SF7006 GEOTECHNICAL EARTHQUAKE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To understand the dynamics of earth and its response, effect on earth structure and measures to mitigate the effects. Students are able to develop the design ground motion for a site by suitable response analysis to analyse and design geotechnical structures. Students are able to prepare a hazard and risk map.

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 10

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 12

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 - Lateral Deformation - codal provisions.

UNIT V EARTHQUAKE HAZARD MITIGATION 7

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

OUTCOME:

- Students are able to perform seismic stability analysis of geotechnical structures and in-situ soil by developing the design ground motion for an area based on bed rock motion and types of soils.

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.

SF7007 PAVEMENT ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I BASIC CONCEPTS 9

Historical development of pavements – types, classification, components and principle of load transfer – 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 – AASHO, CBR, group index methods – Importance of 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 – Slab thickness, dowel bar, tie bar, spacing of joints – IRC guidelines – Airfield pavements – Comparison of highway and airfield pavements.

UNIT IV PAVEMENT EVALUATION AND REHABILITATION 9

Pavement evaluation – surface and structural - causes and types of failures in flexible and rigid pavements – Presents serviceability index of roads – Overlay design - pavements maintenance, management and construction – Drainage and its importance in pavements.

UNIT V STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS 9

Need for a stabilized soil – Design criteria – Mechanisms - factors influencing choice of stabilizers - Testing and field control – Applications of Geosynthetics in road construction - Case studies.

TOTAL: 45 PERIODS

OUTCOME:

- Students are able to design different new pavements and rehabilitate the existing roads using recent technology.

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., Highways – The location, Design, Construction & Maintenance of Pavements, Fourth Edition, Elsevier, 2006
9. Bell. P.S., Developments in Highway Engineering, Applied Sciences publishers, 1978.

SF7008 GEOENVIRONMENTAL ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- 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 – WASTE INTERACTION 8

Role of Geoenvironmental Engineering – sources, generation and classification of wastes – causes and consequences of soil pollution – case studies in soil failure -factors influencing soil-pollutant interaction – modification of index, chemical and engineering properties – physical and physio-chemical mechanisms – Environmental laws and regulations.

UNIT II CONTAMINANT TRANSPORT AND SITE CHARACTERISATION 9

Transport of contaminant in subsurface – advection, diffusion, dispersion – chemical process – biological process, sorption, desorption, precipitation, dissolution, oxidation, complexation, ion exchange, volatization, biodegradation – characterization of contaminated sites – soil and rock data – hydrological and chemical data – analysis and evaluation – risk assessment – case studies.

UNIT III WASTE CONTAINMENT AND REMEDIATION OF CONTAMINATED SITES 9

Insitu containment – vertical and horizontal barrier – surface cover – ground water pumping system on subsurface drain – soil remediation – soil vapour extraction, soil waste stabilization, solidification of soils, electrokinetic remediation, soil heating, vitrification, bio remediation, phyto remediation – ground water remediation – pump and treat , Insitu flushing, permeable reacting barrier, Insitu air sparging - case studies.

UNIT IV LANDFILLS AND SURFACE IMPOUNDMENTS 9

Source and characteristics of waste - site selection for landfills – components of landfills – liner system – soil, geomembrane, geosynthetic clay, geocomposite liner system – leachate collection – final cover design – monitoring landfill.

UNIT V STABILISATION OF WASTE 10

Evaluation of waste materials – flyash, municipal sludge, plastics, scrap tire, blast furnace slag, construction waste, wood waste and their physical, chemical and biological characteristics – potential reuse – utilization of waste and soil stabilization – case studies.

TOTAL: 45 PERIODS

OUTCOME:

- Students are able to assess the contamination in the soil and to select suitable remediation methods based on contamination. Also they are able to prepare the suitable disposal system for particular waste.

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.

SF7009 SOIL STRUCTURE INTERACTION L T P C
3 0 0 3

OBJECTIVES:

- Focus is on idealization of soil response to closely represent continuum behavior and interaction analysis between the soil-structure with reference to relative stiffness of beams, slabs and piles under different loading conditions.

UNIT I SOIL RESPONSE MODELS OF INTERACTION ANALYSIS 9

Introduction to soil – Foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, soil-foundation interaction analysis, soil response models, Elastic continuum, Winkler, Two parameter elastic models, Elastic – plastic behavior, Time dependent behavior.

UNIT II INFINITE AND FINITE BEAMS ON ELASTIC FOUNDATIONS 9

Infinite beam, General solution of the elastic line – concentrated and distributed loads on beams – Idealization of semi-infinite and finite beams. Classification of finite beams, different end conditions and loads – solutions by general method, finite difference and application packages.

UNIT III PLATE ON ELASTIC MEDIUM 9

Infinite plate, elastic continuum, Winkler, Two parameters, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, simple solution, ACI method, Numerical analysis of finite plates, Analysis of highway and airfield pavements – Application packages.

UNIT IV ANALYSIS OF PILE AND PILE GROUPS 9

Elastic analysis of single pile – Methods of analysis for settlement of pile – Solutions for settlement and load distribution in pile – Pile tip load – settlement of pile groups – Analysis – Interaction between piles – end bearing and floating piles – Effect of pile cap – Piled raft – Application packages.

UNIT V LATERALLY LOADED PILE 9

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

TOTAL : 45 PERIODS

OUTCOME:

- At the end of this course students will have the capacity to idealize soil response in order to analyze and design foundation elements subjected to different loadings.

REFERENCE

1. Salgado,R., The Engineering of Foundations, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2. Murthy, V.N.S., Advanced Foundation Engineering, CBS Publishers, New Delhi, 2007.
3. Saran, S, Analysis and Design of Substructures, Taylor & Francis Publishers, 2006
4. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, Basic Geotechnics, Sixth Edition, Prenticce Hall, 2002.
5. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.
6. ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Dehit, 1988.
7. Scott, R.F. Foundation Analysis, Prentice Hall, 1981.
8. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980.
9. Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier 1979.
10. Kurien, N.P., Design of Foundation Systems: Principles and Practices Narosa Publishing House, New Delhi, 1999.

SF7010 MECHANICS OF UNSATURATED SOILS L T P C
3 0 0 3

OBJECTIVES:

- To impart 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

OUTCOME:

- Students are able to assess the engineering behaviour of unsaturated soil, and understand the modeling and measurement techniques.

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.