



# **GOVERNMENT COLLEGE OF TECHNOLOGY**

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

**Regulations, Curriculum And Syllabi For  
M.E. (GEOTECHNICAL ENGINEERING)  
(Full Time / Part Time)**

**2012**  
**Regulations**

**OFFICE OF THE CONTROLLER OF EXAMINATIONS,  
GOVERNMENT COLLEGE OF TECHNOLOGY  
THADAGAM ROAD, COIMBATORE - 641 013**

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# Curriculum



**CURRICULUM FOR CANDIDATES ADMITTED  
DURING 2012-2013 AND ONWARDS  
BRANCH: M.E. (GEOTECHNICAL ENGINEERING) - (FULL TIME)**

**FIRST SEMESTER**

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE01	APPLIED MATHEMATICS	25	75	100	3	0	0	3
2.	12GE02	SHALLOW FOUNDATIONS	25	75	100	3	0	0	3
3.	12GE03	SITE EXPLORATION AND SOIL INVESTIGATION	25	75	100	3	0	0	3
4.	12GE04	STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS	25	75	100	3	0	0	3
5.		ELECTIVE I	25	75	100	3	0	0	3
6.		ELECTIVE II	25	75	100	3	0	0	3
		<b>TOTAL</b>			<b>600</b>				<b>18</b>

**SECOND SEMESTER**

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE05	THEORETICAL SOIL MECHANICS	25	75	100	3	0	0	3
2.	12GE06	DEEP FOUNDATIONS	25	75	100	3	0	0	3
3.	12GE07	SOIL DYNAMICS AND MACHINE FOUNDATIONS	25	75	100	3	0	0	3
4.	12GE08	SLOPE STABILITY AND LANDSLIDES	25	75	100	3	0	0	3
5.		ELECTIVE III	25	75	100	3	0	0	3
6.		ELECTIVE IV	25	75	100	3	0	0	3
		<b>TOTAL</b>			<b>600</b>				<b>18</b>

### THIRD SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE09	PAVEMENT ENGINEERING	25	75	100	3	0	0	3
2.		ELECTIVE V	25	75	100	3	0	0	3
3.		ELECTIVE VI	25	75	100	3	0	0	3
4.	08GE10	PROJECT -I	50	150	200	0	0	12	6
		TOTAL			500				15

### FOURTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12GE11	PROJECT -II	100	300	400	0	0	24	12
		TOTAL			400				12

**CURRICULUM FOR CANDIDATES ADMITTED  
DURING 2012-2013 AND ONWARDS  
BRANCH: M.E. (GEOTECHNICAL ENGINEERING) -(PART TIME)**

**FIRST SEMESTER**

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12GE01	APPLIED MATHEMATICS	25	75	100	3	0	0	3
2.	12GE02	SHALLOW FOUNDATIONS	25	75	100	3	0	0	3
3.	12GE03	SITE EXPLORATION AND SOIL INVESTIGATION	25	75	100	3	0	0	3
		<b>TOTAL</b>			300				9

**SECOND SEMESTER**

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12GE05	THEORETICAL SOIL MECHANICS	25	75	100	3	0	0	3
2.	12GE06	DEEP FOUNDATIONS	25	75	100	3	0	0	3
3.	12GE07	SOIL DYNAMICS AND MACHINE FOUNDATIONS	25	75	100	3	0	0	3
		<b>TOTAL</b>			300				9

**THIRD SEMESTER**

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12GE04	STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS	25	75	100	3	0	0	3
2.		ELECTIVE I	25	75	100	3	0	0	3
3.		ELECTIVE II	25	75	100	3	0	0	3
		<b>TOTAL</b>			300				9

### FOURTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE08	SLOPE STABILITY AND LANDSLIDES	25	75	100	3	0	0	3
2.		ELECTIVE III	25	75	100	3	0	0	3
3.		ELECTIVE IV	25	75	100	3	0	0	3
		<b>TOTAL</b>			300				9

### FIFTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE09	PAVEMENT ENGINEERING	25	75	100	3	0	0	3
2.		ELECTIVE V	25	75	100	3	0	0	3
3.		ELECTIVE VI	25	75	100	3	0	0	3
4.	12GE10	PROJECT - I	50	150	200	0	0	12	6
		<b>TOTAL</b>			500				15

### SIXTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12GE11	PROJECT - II	100	300	400	0	0	24	12
		<b>TOTAL</b>			400				12

### LIST OF CORE SUBJECTS

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE01	APPLIED MATHEMATICS	25	75	100	3	0	0	3
2.	12GE02	SHALLOW FOUNDATIONS	25	75	100	3	0	0	3
3.	12GE03	SITE EXPLORATION AND SOIL INVESTIGATION	25	75	100	3	0	0	3
4.	12GE04	STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS	25	75	100	3	0	0	3
5.	12GE05	THEORETICAL SOIL MECHANICS	25	75	100	3	0	0	3
6.	12GE06	DEEP FOUNDATIONS	25	75	100	3	0	0	3
7.	12GE07	SOIL DYNAMICS AND MACHINE FOUNDATIONS	25	75	100	3	0	0	3
8.	12GE08	SLOPE STABILITY AND LANDSLIDES	25	75	100	3	0	0	3
9.	12GE09	PAVEMENT ENGINEERING	25	75	100	3	0	0	3
10.	12GE10	PROJECT-I	50	150	200	0	0	12	6
11.	12GE11	PROJECT - II	100	300	400	0	0	24	12

### LIST OF ELECTIVE SUBJECTS

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		<b>THEORY</b>							
1.	12GE12	EARTH RETAINING STRUCTURES	25	75	100	3	0	0	3
2.	12GE13	GEOLOGY IN GEOTECHNICAL ENGINEERING	25	75	100	3	0	0	3
3.	12GE14	PHYSICAL AND GEOTECHNICAL PROPERTIES OF SOILS	25	75	100	3	0	0	3
4.	12GE15	FINITE ELEMENT ANALYSIS	25	75	100	3	0	0	3
5.	12GE16	REINFORCED SOIL STRUCTURES	25	75	100	3	0	0	3
6.	12GE17	GROUND IMPROVEMENT TECHNIQUES	25	75	100	3	0	0	3
7.	12GE18	SOIL STRUCTURE INTERACTION	25	75	100	3	0	0	3
8.	12GE19	EARTH AND ROCK FILL DAMS	25	75	100	3	0	0	3
9.	12GE20	ROCK MECHANICS IN ENGINEERING PRACTICE	25	75	100	3	0	0	3
10.	12GE21	GEOTECHNICAL EARTHQUAKE ENGINEERING	25	75	100	3	0	0	3
11.	12GE22	ADVANCED SOIL MECHANICS LABORATORY	25	75	100	3	0	0	3
12.	12GE23	ENVIRONMENTAL GEOTECHNOLOGY	25	75	100	3	0	0	3

**12GE01 APPLIED MATHEMATICS**

(Common to 12SE01 M.E. Structural Engineering)

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**UNIT I CALCULUS OF VARIATION**

**(09)**

Maxima and minima of functions of two or more independent variables – Lagrange’s method of multipliers – Functional – Euler’s equation for one independent variable – Variation problems involving several independent variables – functional dependent on higher order derivatives-Isoperimetric problems-Ostrogradsky equation.

**UNIT II NUMERICAL METHODS**

**(09)**

Lagrange, Cubic Spline, Hermite Interpolation – Least squares method to fit  $y = ax+b$ ,  $y=ax^2+bx+c$ ,  $y=ae^{bx}$ ,  $y=ax^b$ ,  $y=ab^x$  – Numerical Integration – Gauss, Legendre quadrature – Double Integration using Trapezoidal and Simpson’s rule.

**UNIT III EIGEN VALUE PROBLEMS**

**(09)**

Power method of finding the dominant eigen values and eigen vectors of a matrix. Eigen values and eigen vectors of a real symmetric matrix: Jacobi method, Given’s method, House-Holder’s method, Rayleigh-Ritz method, Lanczos method.

**UNIT IV SINGLE VARIABLE OPTIMIZATION**

**(09)**

Exhaustive search method – Bounding Phase method – Interval halving Method – Fibonacci search method – Golden section search method – Successive quadratic estimation method – Newton Raphson method – Bisection method – Secant method.

**UNIT V PARTIAL DIFFERENTIAL EQUATION**

**(09)**

Classification of second order PDE – Characteristic Curves – Canonical reduction of PDE – Fourier series solutions for 2D wave equation of vibration membrane (Cartesian Co-ordinates) – Finite difference approach application to one and two dimensional problems.

**TOTAL: 45**

**Reference Books:**

1. Venkataraman M.K., *Higher mathematics for Engineering and Science*, National Publishing Company, 1998.
2. Grewal B.S., *Higher Engineering Mathematics (40<sup>th</sup> Edition)*, Khanna Publishers, New Delhi, 2007.
3. Bali N.P., and Dr. N.Ch.S. NarayanaIyengar, *A text book of Engineering Mathematics*, Laxmi Publications (P) Ltd., New Delhi, 2009.
4. *Applied Mathematics for Engineering*, NAD Physicists, McGraw Hill, 1990.
5. Rajasekaran S., *Numerical Methods in Science and Engineering – A Practical Approach*, S.Chand and Company Ltd. 2003.
6. Kandasamy P., Thilagavathy K., and Gunavathy K., *Numerical Methods*, S.Chand and Co., New Delhi 2010.
7. Kalyamoy Deb., *Optimization for Engineering Design – Algorithm and Examples*, Prentice Hall of India Pvt Ltd, 2000.

## 12GE02 SHALLOW FOUNDATIONS

L T P C  
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### UNIT I FOUNDATIONS – GENERAL

(09)

Developments – Need of foundation Engineering – Responsibility of foundation engineer – Shallow and deep foundations – Classification - Requirements of good foundations – Selection of type of foundation – Additional consideration – Hostile environment – Structural integrity – Economy.

### UNIT II BEARING CAPACITY

(09)

Introduction – Criteria for computing Bearing Capacity – Theoretical methods – Terzaghi’s formula – Meyerhoff’s method – Effect of compressibility of soil, water table, shape and width of foundation, inclination of load, eccentricity of load, stratification, sloping ground and adjacent footing – Vesic’s approach – Allowable bearing pressure – Evaluation of bearing capacity from in-situ tests - I.S. code provisions.

### UNIT III SETTLEMENT EVALUATION

(09)

Introduction – Immediate and time dependant settlement – Determination – Causes of settlement – Prediction of settlement – Minimizing settlement – Uniform, tolerable and allowable settlement – Differential settlement – Causes and effects – Factors influencing – I.S. Code provisions – Special considerations for expansive and collapsible soils.

### UNIT IV DESIGN OF FOUNDATIONS

(09)

Analysis of foundation – Isolated – Strip – Combined footings and mat foundations. Conventional – Elastic approach – Soil Structure Interaction Principles – Application – Structural design of shallow foundations – Working stress method – Limit state method – Codal recommendations-Software applications.

### UNIT V SPECIAL FOUNDATIONS

(09)

Introduction to special foundations – Floating foundation – Foundation in expansive soils – Foundation on recent refuse fills – Design of foundation for seismic forces – Methods of improving bearing capacity.

**TOTAL: 45**

#### **Reference Books:**

1. Peck, R.B. Hansen, V.E., and Thornburn, W.H., **Foundation Engineering**, John Wiley, 1974.
2. Winterkorn, H.F and Fang, Y.F., **Foundation Engineering Handbook**, Van Nostrand Reinhold, 1994.
3. Bowles, J.E. **Foundation Analysis and Design**, McGraw Hill, New York, 2001.
4. Tomlinson, M.J., **Foundation Engineering**, ELBS, Long man Group, UK Ltd, England, 1995.
5. Swami Saran, **Soil Dynamics and Machine Foundation**, Galgottia Publications Pvt. Ltd., New Delhi, 2010.
6. Day, R.W., **Geotechnical and Foundation Engineering, Design and Construction**, McGraw Hill, 2010.
7. Donald P. Coduto, **Geotechnical Engg, Principles and Practices**, Pearson Education, 2010.
8. Robert Wade Brown, **Practical Foundation Engineering Handbook**, McGraw Hill, New York, 1996.
9. Vargheese, P.C., **Limit State Design of Reinforced concrete**, Prentice-Hall of India 2009.
10. Muni Budhu, **Soil Mechanics and Foundation**, John Wiley and Sons, INC, 2000.

**12GE03 SITE EXPLORATION AND SOIL INVESTIGATION**

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**UNIT I SCOPE AND OBJECTIVES OF SITE INVESTIGATION AND SUBSURFACE EXPLORATION (09)**

Site investigation – definition – Scope and objectives – activities involved in site investigation – Preliminary desk studies. Subsurface exploration – Definition – General considerations – Objectives – Planning an exploration programme – Location – Spacing and depth of borings – Stabilization of bore holes – Cleaning of bore hole – Soil Profile – Bore logs – Data Presentation – Soil investigation and exploration reports.

**UNIT II EXPLORATION TECHNIQUES (09)**

Different methods of boring and drilling – Geophysical exploration and interpretation – Seismic refraction and electrical resistivity methods – Non-displacement and displacement methods – Drilling in difficult subsoil conditions.

**UNIT III SOIL SAMPLING TECHNIQUES (09)**

Different type of samples – sample disturbance – measurement of sample disturbance – Area and recovery ratio – RQD – Types of samplers – Undisturbed sampling technique – Drive sampling – Design criteria for drive samplers – Methods for preventing loss of samples – Surface and control sampling in site testing – Advanced sampling techniques – Offshore sampling – Preservation and handling of samples.

**UNIT IV FIELD TESTING IN SOIL EXPLORATION (09)**

Field tests – Importance of field tests in soil exploration – Penetration testing – Standard Penetration Test – Static Cone Penetration Test – Dynamic cone penetration test – Plate load test – Field Vane shear test – Pressuremeter testing – Data interpretation – Cyclic load test – Block vibration test – Field Permeability test.

**UNIT V INSTRUMENTATION (09)**

Field instrumentation – Pore pressure – Ground water table – Strain gauges – Resistance and induction type – Load cells – Earth pressure cells – Settlement and heave gauges – Piezometers and slope indications – Inclinator.

**TOTAL: 45**

**Reference Books:**

1. *Site Investigation* by CRI clayton, N.E. Simon's and M.C.Mathews – Cranada, 1976.
2. *Surface exploration and sampling of soils for Civil Engineering – Purposes* – M.JundHvorslev – Waterways Experiment Station, MISSISSIPPI, 1978.
3. *Hunt R.E. Geotechnical Engineering Investigation Manual*, McGraw Hill, 1984.
4. *Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Hand Book*, Van Nostrand Reinhold 1994.
5. *Nair, R.J. and Wood, P.M., Pressuremeter Testing Methods and Interpretation*, Butter worths, 1987.
6. *Dunnicliff, J., and Green, G.E., Geotechnical Instrumentation for Monitoring Field Performance*, John Wiley, 1993.
7. *Hanna T.H., Field Instrumentation in Geotechnical Engineering*, Trans Tech., 1985.
8. *Bowles J.E., Foundation Analysis and Design*, The McGraw Hill companies, inc., New York, 2001.

**12GE04 STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS**

**L T P C**

**3 0 0 3**

**UNIT I SHEAR STRENGTH OF COHESIONLESS SOILS**

**(09)**

Shear strength of granular soils – Direct shear – Triaxial Testing – Drained and undrained – Stress-strain behaviour – Dilatation – Contraction and critical states – Liquefaction and Liquefaction potential. Factors influencing – Stress-strain – Volume change behaviour of soils.

**UNIT II SHEAR STRENGTH OF COHESIVE SOILS**

**(09)**

Shear strength of clays – Stress-strain behaviour – Vane shear – UCC – 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 – Drained and undrained – Factors influencing stress-strain and shear strength.

**UNIT III YIELD CRITERION**

**(09)**

Concepts of yield and failure in soils – Yield criteria of von Mises, Tresca, Kvik Patriak, Drucker and Prager and their extended form – their applicability to soils – Detailed discussion of Mohr – Coulomb failure criterion.

**UNIT IV STRESS PATH AND STRESS – STRAIN LAWS**

**(09)**

Lambe's stress path for different cases – Stress path tests – Stress-strain laws for soils – Hyperbolic law – Linear visco-elastic and Elasto – Plastic laws – Yield functions, hardening law, flow rules and plastic strain computation – Elastic module – Cyclic loading – Limitation of linearity elastic model – Hyperbolic stress-strain model.

**UNIT V CRITICAL STATE SOIL MECHANICS AND RHEOLOGICAL MODELS**

**(09)**

Introduction to critical state soil mechanics – boundary Surface – Roscoe and Hvorslev's – Rheological models of Kelvin, Maxwell and Burger as applied to soils.

**TOTAL: 45**

**Reference Books:**

1. *Lambe, T.W. and Whitman R.V., Soil Mechanics in S.I. Units, John Wiley, 1979.*
2. *Hotz, R.D. and Kovais, W.D., Introduction of Geotechnical Engineering, Prentice – Hall 1981.*
3. *Atkinson, J.H and Brandsby, P.L., Introduction to critical state soil mechanics, Cambridge University Press, New York, 1990*
4. *Braja, M. Das, Fundamentals of Geotechnical Engineering, Brooks/Cole, Thomson Learning Academic Resource, Center, ISBN-00534-37114-0.*
5. *Keedwell, M.J., Rheology and Soil mechanics, Elsevier Applied Science Publishers Ltd. 1984, ISBN 0-85334-285-7.*
6. *Braja, M. Das, Advanced soil mechanics, McGraw Hill, 1997.*
7. *Wood. D.M., Soil behaviour and Critical State Soil Mechanics, Cambridge University Press New York, 1990.*

8. *Bazant, Z.P., Mechanics of Geo-materials, Rocks, Concrete and Soil, John Willey and Sons, Chilchester, 1985.*
9. *Graham Barnes, Soil Mechanics Principles and Practices, Macmillan Press Ltd., London ISBN 0-33-77776x-2002.*
10. *Shear Strength of Liquefied Soils, Final Proceedings of the workshop, National Science Foundation, Urbane, Illinois, July 1998.*
11. *Malcolm D. Bolton, A guide to soil mechanics, Universities Press (India) Private Ltd., Hyderabad, India, 2003, ISBN 81 7371-245-8.*

**12GE05 THEORETICAL SOIL MECHANICS**

**L T P C**  
**3 0 0 3**

**UNIT I THEORY OF ELASTICITY**

**(09)**

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)**

**(09)**

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**

**(09)**

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**

**(09)**

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. Centrifuge model – Principles and scale effects, practical considerations.

**UNIT V FLOW THROUGH POROUS MEDIA**

**(09)**

Flow through porous media – Darcy's law – General equation of flow – Steady state condition – Solution by flow net – Fully saturated conditions – Flownet in anisotropic soils – construction of flownet for different cases.

**TOTAL: 45**

**Reference Books:**

1. Aysen, A., *Soil Mechanics : Basic concepts and Engineering Application*, A.A.Balkema Publishers, 2002.
2. Ulrich Smoltc, YK, *Geotechnical Engineering Handbook (Vol. 1)*, Ernot&Sohn, 2002.
3. Aysen, A., *Problem Solving in Soil Mechanics*, A.A.Balkema Publisher, 2003.
4. Davis, R.O., and Selvadurai, A.P.S., *Elasticity and Geomechanics*, Cambridge University Press, 1996.
5. Taylor, R.N., *Geotechnical Centrifuge Technology*, Blackie Academic and Professional 1995.
6. Wai-Fah Chen, and Liu, X.L., *Limit Analysis in Soil Mechanics*, Elsevier Science Ltd., 1991.
7. Muni Budhu, *Soil Mechanics and Foundations*, John Wiley and Sons, Inc, Network, 2000.
8. Atkinson, J.H., *Foundations and Slopes*, McGraw Hill, 1981.
9. Harr, M.E., *Foundations of Theoretical Soil Mechanics*, McGraw Hill, 1966.
10. Cedergren, H.R., *Seepage Drainage and Flownets*, John Wiley, 1997.
11. Winterkorn, H.F., and Fang, H.Y., *Foundation Engineering Handbook*, Galgottia, Booksource, 2000.

**12GE06 DEEP FOUNDATIONS**

**L T P C**  
**3 0 0 3**

**UNIT I PILE FOUNDATIONS**

**(09)**

General considerations – Function – Classification – Piling equipments and methods – Pile driving – Pile installation – Load tests on piles – Cyclic load tests – Indian Standard method – Uses and limitations of load tests – Model studies and their limitation. Pile spacing – Bearing capacity of groups of piles – Distribution of loading on piles – Culmann’s method – Stress distribution under pile foundation – Settlement of pile foundation - elastic and consolidation settlements – Negative skin friction.

**UNIT II DESIGN OF PILE FOUNDATIONS**

**(09)**

Length of piles – Type and structural design – Design of pile caps – Uplift and lateral forces – Batter piles – Damage to adjacent structural alignment of piles – Wave equation analysis – Problem on pile foundation in sands, clay, silt, loose and non uniform soils.

**UNIT III PIERS AND CAISSONS**

**(09)**

Piers – Drilled caissons – Large bored piles – Types – Design – Bearing capacity – Skin friction – Caisson – Classification – Design aspects – Design loads – Skin friction and sinking effort - Design of various components of caisson – Open, Pneumatic and floating caissons – Construction aspects of caissons.

**UNIT IV WELL FOUNDATIONS**

**(09)**

Well foundations – Advantages – Elements of a well foundation – Design aspects – Grip length – Forces acting – Design of various components of well foundation – Stability of well – Terzaghi’s analysis – IRC method – Construction of well foundation.

**UNIT V COFFER DAMS AND UNDER PINNING**

**(09)**

Coffer Dams – Problems of Foundations in bad ground and under water – Types of coffer dams- Braced coffer dam – Cellular coffer dams - design – Lateral pressures stability – Piping – Average width of coffer dam – Cofferdam on rock – Cofferdam in deep soil deposit – Interlock stresses in cellular coffer dams – Construction of different types of coffer dams. Reasons for underpinning – Preliminary support columns and footings – Pier underpinning.

**TOTAL: 45**

**Reference Books:**

1. Peck, R.B. Hansen, V.E., and Thornburn, W.H., *Foundation Engineering*, John Wiley, 1974.
2. Tomlinson, M.J., *Foundation Engineering*, ELBS, Long man Group, UK Ltd, England, 1995.
3. Bowles, J.E., *Foundation Analysis and Design*, McGraw Hill, New York, 2001.
4. Cemica, J.N., *Geotechnical Engineering Foundation Design*, John Wiley and Sons, Inc. 1995.
5. Das, B.M., *Principles of Foundation Engineering, Design and Construction*, PWS., Publishing, 1999 (Fourth Edition).
6. Donald, P.Coduto, *Foundation Design Principles and Practices*, Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1996.
7. Grigorian, *Pile Foundation for Buildings and structures in collapsible Soil*, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 1999.
8. Poulos, H.G., Davis E.H., *Pile foundation analysis and designs*, John Wiley and Sons, New York, 1980.
9. Winterkorn, H.F. and Fang, H.Y., *Foundation Engineering Handbook*, Van Nostrand Reinhold, 1994.

**12GE07 SOIL DYNAMICS AND MACHINE FOUNDATIONS**

**L T P C**  
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**UNIT I THEORY OF VIBRATION**

**(09)**

Introduction – Nature of dynamic loads – Basic definitions – Simple harmonic motion – Fundamentals of vibration – Single degree and multi degree of freedom systems – Free vibrations of spring – Mass systems – Forced vibrations – Resonance – Viscous damping – Principles of vibrations measuring systems – Effect of transient and pulsating loads.

**UNIT II DYNAMIC SOIL PROPERTIES**

**(09)**

Dynamic stress – Strain characteristics – Principles of measuring dynamic properties – Laboratory techniques – Field tests – Block vibration test – 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 MACHINE FOUNDATIONS**

**(09)**

Introduction – Types of machine foundations – General requirements for design of machine foundations – Design approach for machine foundation – Vibration analysis – Elastic Half – Space theory – Mass-spring-dashpot model – Permissible amplitudes – Permissible bearing pressures.

**UNIT IV DESIGN OF MACHINE FOUNDATION**

**(09)**

Evaluation of design parameters – Types of Machines and foundations – General requirements – their importance - Analysis and design of block type and framed type machine foundations – Modes of vibration of a rigid foundation – Foundations for reciprocating machines, impact machines, Two – Cylinder vertical compressor, Double-acting steam hammer – Codal recommendations. Empirical approach - Barken's method – Bulb of pressure concept – Pauw's analogy – Vibration table studies.

**UNIT V VIBRATION ISOLATION**

**(09)**

Vibration isolation – Types of isolation – Transmissibility – Passive and active isolation – Methods of isolation – Use of springs and damping materials – Properties of isolating materials – Vibration control of existing machine foundation.

**TOTAL: 45**

**Reference Books:**

1. KameswaraRao, N.S.V., *Dynamics soil tests and applications*, Wheeler Publishing, New Delhi, 2000.
2. Prakash, S and Puri, V.K., *Foundations for machines*, McGraw Hill, 1987.
3. Moore, P.J., *Analysis and Design of Foundations for Vibrations*, Oxford and IBH, 1985.
4. Vaidyanathan, C.V., and Srinivasalu, P., *Handbook of Machine Foundations*, McGraw Hill, 1995.
5. Arya, S., O'Nelt; S., *Design of Structures and Foundations for Vibrating Machines*, Prentice Hall, 1981.
6. Major, A., *Vibration Analysis and Design of Foundations for Machines and Turbines*, Vol. I, II and III Budapest, 1964.
7. Barkan, D.D., *Dynamics of Basis of Foundation*, McGraw Hill, 1974.
8. Swami Saran, *Soil Dynamics and Machine Foundation*, Galgotia publications Pvt. Ltd. New Delhi 2010.
9. Das B.M., *Principles of Soil Dynamics*, McGraw Hill, 1992.
10. Krammer S.L., *Geotechnical Earthquake Engineering*, Prentice Hall, International series, Pearson Education (Singapore) Pvt Ltd, 2004.
11. KameswaraRao, *Vibration Analysis and Foundation Dynamics*, Wheeler Publishing, New Delhi, 1998.

**12GE08 SLOPE STABILITY AND LAND SLIDES**

**L T P C**

**3 0 0 3**

**UNIT I STABILITY OF SLOPES**

**(09)**

Introduction – Importance – General characteristics - Types of failures – Causes of failures – Purpose of stability computation – Investigation of failures – Procedure – Case studies.

**UNIT II STABILITY ANALYSIS**

**(09)**

Stability analysis – Method of slices – Friction circle method – Soils with cohesion – Soils with cohesion and angle of internal friction. Critical states for design for embankments – Stability computations – Evaluation of pore water pressure.

**UNIT III IRREGULAR SLOPES**

**(09)**

Non-uniform soils – Janbu’s analysis – Taylor’s analysis – Bishop’s analysis – Total stress and effective stress approaches – composite surfaces of sliding – Block sliding.

**UNIT IV LAND SLIDES**

**(09)**

General Characteristics-sources – Stability of Hill side slopes – Open cuts – Engineering problems involving the stability of slopes – Cuts in sand – Cuts in loess – Homogeneous and soft clay slopes – Sudden spreading of clay slopes – Clay flows - Clays containing pockets and sand masses – Slides in stiff clay slopes on shale – Slopes on weathered rock; talus slopes, slopes on over consolidated clays – Slides along coastal areas and tropically weathered residual soils – long term stability of clay slopes.

**UNIT V FIELD OBSERVATIONS AND SLOPE STABILIZATION**

**(09)**

Field instrumentation – Observation studies during construction – Post construction, piezometers – Settlement plates – Inclinometer – Case histories. Compaction of new embankments – Compaction of natural masses of soil and existing fills – Compaction of deep deposits of sand – Vibroflotation – Compaction of compressible soils – Drainage as a means of stabilization – Use of Geotextiles – Soil nailing.

**TOTAL: 45**

**Reference Books:**

1. Chowdhury, D.F., *Slope analysis*, Prentice Hall, 1988.
2. Winterkorn, H.F. and Fang, H.Y., *Foundation Engineering Handbook*, Van Nostrand Reinhold, 1994.
3. Bramhead, E.N., *The Stability of Slopes*, Blacky Academic and Professionals Publications, Glasgow 1986.
4. Anderson, M.G., and Richards, K.S., *Slope Stability*, John Wiley, 1987.

**12GE09 PAVEMENT ENGINEERING**

**L T P C**

**3 0 0 3**

**UNIT I BASIC CONCEPTS**

**(09)**

Pavement-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**

**(09)**

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**

**(09)**

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

**UNIT IV PAVEMENT EVALUATION AND REHABILITATION**

**(09)**

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**

**(09)**

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

**TOTAL: 45**

**Reference Books:**

1. Wright, P.H., *Highway Engineers*, Johwiley& Sons, Inc. New York, 2009.
2. Yoder, R.J and Witchak, M.W., *Principles of Pavment Design*, John wiley, 2000.
3. Khanna, S.K and Justo C.E.G., *Highway Engineering*, New Chand and Brothers, Roorkee, 1998.
4. *Design and specification of Rural Roads (Manual)*, Ministry of rural roads, Government of India, New Delhi, 2001.
5. *Guidelines for the Design of Flexible Pavements, IRC : 37 – 2001*, The Indian Roads Congress, New Delhi.
6. *Guidelines for the Design of Rigid Pavements, IRC : 58 – 1998*, The Indian Roads Congress, New Delhi.
7. O' Flaherty, C.A., *Highway Engineering, (Vol.2)*, Edward Arnold Cp. 1978.
8. Kadiyali, L.R., *Transport planning & Traffic Engineering*, Khanna Publishers, 2008.

**12GE12 EARTH RETAINING STRUCTURES**

**L T P C**

**3 0 0 3**

**UNIT I EARTH PRESSURE THEORIES**

**(09)**

Introduction – state of stress in retained soil mass – Classical earth pressure theories – Active and Passive earth pressures – Earth pressure at rest- Earth pressure due to external loads – Empirical methods – Wall movements and complex geometry – Graphical method of computing earth pressure – Rehbann’s and Culmann’s approach.

**UNIT II RETAINING WALLS**

**(09)**

Retaining walls – Uses and types – forces on retaining walls – design of retaining walls by limit state method – general principles – design and construction details – Design of solid gravity walls, Semi – gravity walls, cantilever walls, counterfort walls – Stability of retaining walls – Drainage arrangements and its influence.

**UNIT III SHEET PILE WALLS**

**(09)**

Earth retaining structures – Selection of soil parameters – Analysis and design of cantilever and anchored sheet pile walls – Deadman and continuous anchor – Diaphragm and bored pile walls – design requirements.

**UNIT IV BRACED EXCAVATION**

**(09)**

Braced cuts in sand and clay – Lateral pressure on sheeting in braced excavation – Stability against piping and bottom heaving – Procedure for computation of lateral earth pressure for braced cuts and Flexible Bulk heads – Soil anchors – Soil nailing – Soil pinning – Methods of design.

**UNIT V REINFORCED EARTH RETAINING WALL**

**(09)**

Reinforced earth retaining wall – General principles, Concepts and mechanism of reinforced earth – Design consideration of reinforced earth – Geotextile, geogrids, metal strips and facing elements – Construction – Selection of type of retaining structures – construction practice – Field observations.

**TOTAL: 45**

**Reference Books:**

1. Winterkorn H.F. and Fang H.Y., *Foundation Engineering Hand book*, Galgotia Book-source, 2000.
2. Rowe R.K., *Geotechnical and Geo environmental Engineering Hand Book*, Kluwer Academic Publishers, 2001.
3. Militisky .J and Woods R., *Earth and earth retaining structures*, Routledge, 1992.
4. Das B.M., *Principles of Geotechnical Engineering (Fourth edition)*. The PWS series in Civil Engineering, 1998.
5. Clayton C.R.I. Militisky, J and Woods R., *Earth pressure and earth retaining structures (second edition)* Survey University Press, 1993.
6. McCarthy D.F., *Essentials of soil Mechanics and foundations; Basic Geotechnics (sixth Edition)* Prentice Hall, 2002.

**12GE13 GEOLOGY IN GEOTECHNICAL ENGINEERING**

**L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION**

**(09)**

Soil formation – Survey – Soils of India – Texture and structure of igneous, sedimentary and metamorphic rocks. Microscopic study – Microscopic study of rocks with particular reference to texture – microscopic study of unconsolidated sediments with reference to their grain size and mineral content.

**UNIT II GEOPHYSICAL INVESTIGATION**

**(09)**

Geotechnical Investigation – Geophysical methods of exploration –Electrical, Magnetic, gravitational, seismic, radioactive and geochemical methods – Influence of structure and texture of rocks, Engineering properties, foundation problems in igneous, sedimentary and metamorphic rocks including recent sediments- case histories. Investigations for foundation of dams and reservoirs – Problem encountered and treatment, case studies – Investigation of canals and deep cuts – Case studies.

**UNIT III LAND SLIDES**

**(09)**

Land Slides – Causes – Preventive and control measures – Engineering problems related to earthquakes, case studies.

**UNIT IV GROUND WATER**

**(09)**

Ground Water problems – Location of water tables, composition of ground water – Ground water surveys – Conservation of ground water – Scope of ground water investigation in Civil Engineering.

**UNIT V STRUCTURAL GEOLOGY**

**(09)**

Altitude of beds – Dip and Strike, Characteristics, Types, Causes and mechanism of folding, Classification, Causes and mechanism of faults- Field evidences and Recognition of faults. Joint systems – Classification and its types, Difference between faults and joints. Definition, importance and field recognition of unconformity.

**TOTAL: 45**

**Reference Books:**

1. ParbinSingh, *Engineering and General Geology*, Katson Publication House, 1987.
2. Blyth, *Geology for Engineering*, ELBS 1995.
3. Legget, *Geology and Engineering*, McGraw Hill Book Company, 1998.
4. Krynine and Judd, *Principles of Engineering Geology and Geo techniques*, 1998.

**12GE14 PHYSICAL AND GEOTECHNICAL PROPERTIES OF SOILS**

**L T P C**

**3 0 0 3**

**UNIT I FORMATION OF SOILS AND CLAY MINERALS**

**(09)**

Introduction – Soil Formation – Types of soils – Geological and pedological background – Various soil deposits and their engineering suitability – Composition and structure of clay minerals – Structure of allophone, kaolinite, hallosite, montmorillonite, illite, chlorite and vermiculite minerals, mixed layer minerals. Classification and identification of clay minerals – X – ray diffraction data – electron microscopic analysis – Differential thermal analysis – Anion and cation exchange capacity of clays – Specific surface area – Bonding in clays.

**UNIT II PHYSICAL AND PHYSIO-CHEMICAL BEHAVIOUR OF SOILS**

**(09)**

Physical and Physio – Chemical behaviour of Soils – Diffused double layer theory – Computation of double layer distance – Dielectric constant – Temperature on double layer – Ion Exchange – Cation exchange capacity – Causes of cation exchange effect – Fixation of cations – Determination of cation exchange capacity – Exchangeable cations.

**UNIT III EXPANSIVE AND SHRINKING SOIL**

**(09)**

Introduction – Swelling and shrinking behaviour of soils – Problems associated – Characteristics affecting shrinkage – Crack formation during shrinkage – Measurements of shrinkage for samples – Factors influencing swell – Shrink characteristics – Swelling pressure of soils – Swell pressure determination – Mechanism of swelling – Volume changes and engineering problems in the field – Osmotic swell pressure – Soil fabric and measurement – Sensitivity, activity, thixotrophy - Stress history – Identification of expansive clays.

**UNIT IV COMPRESSIBILITY AND COLLAPSIBLE SOIL**

**(09)**

Introduction – Compressibility – Permeability behaviours of soils and clays – Mechanism involved – Factors governing compressibility – Soil water – Consumption of soil water – Capillary tube, capillary potential – Soil moisture – Methods of determination of soil moisture – Physical behaviour of soil water systems – Liquefaction – Liquefaction potential – Soil suction – Determination of suction potential – Collapsible soil – its identification – Effect on foundation.

**UNIT V CONDUCTION PHENOMENON AND PREDICTION OF SOIL BEHAVIOUR**

**(09)**

Conduction in soils – Coupled flows – Electrical, Chemical, Hydraulic and Thermal flows in soils – Consolidation by Electro-osmosis – Clay mineralogy in relation to physical and engineering properties of clay minerals – Prediction of engineering behaviour of soils – Empirical correlations and their applicability - Granular soil structure – Clay structure models.

**TOTAL: 45**

**Reference Books:**

1. Bowles J.E., *Engineering properties of soils and their measurement*, McGraw Hill 1970.
2. Mitchell J.K., *Fundamentals of Soil Behaviour*, John Wiley, New York, 1993.
3. Yong R.N. and Warkentin, B.P., *Introduction of Soil Behaviour*, Macmillan, Limited, London, 1979.
4. Das B.M. *Principles of Foundation Engineering* , PWS Publishing company, Boston, 1999.
5. McCarthy D.F., *Essentials of Soil Mechanics and Foundations*, Prentice Hall, 2002.

## 12GE15 FINITE ELEMENT ANALYSIS

(Common to 12SE08 M.E. Structural Engineering)

L T P C  
3 0 0 3

### UNIT I INTRODUCTION TO ELASTICITY

(09)

Basic equations of solid mechanics – Review of equilibrium conditions – Strain Displacement relations – Stress strain relations – Equilibrium – Compatibility – Principle of virtual work and stationary, Potential energy principles – Variational principles – Rayleigh Ritz method.

### UNIT II DIRECT METHOD

(09)

Steps in direct method – Element stiffness matrix – Global stiffness matrix – Boundary conditions, Problems on simple beams, Trusses and plates.

### UNIT III ELEMENT PROPERTIES

(09)

Discretization – Displacement model – Element properties – Convergence and compatibility requirements – Node Numbering procedure – Natural coordinate system – Generalized Coordinates – Shape function – Lagrange elements – Stiffness matrix – Nodal load vector – Elements in plane stress and plane strain – Static condensation – Simple problems only.

### UNIT IV ISOPARAMETRIC ELEMENTS

(09)

Basic principles of Shape Functions – Mapping – Uniqueness of mapping – Sub – Iso – Super parametric elements – Numerical integration using Gaussian Quadrature – Examples in one dimension and two dimensions.

### UNIT V AXISYMMETRIC STRESS ANALYSIS

(09)

Analysis of solids of revolution under axisymmetric loading – Formulation of axisymmetric solid element – Simple examples.

### NONLINEAR ANALYSIS

Types of nonlinearities – Geometric nonlinearity – Material nonlinearity – Introduction to nonlinear solution techniques – Newton Raphson and Modified Newton Raphson methods.

**TOTAL: 45**

#### Reference Books:

1. Krishnamurthy, *Finite Element Analysis – Theory and programming*, Second edition, Tata McGraw Hill Publishing Co., 1994.
2. Desai C.S., *Elementary Finite Element Method*, Prentice Hall, IINC, 1979.
3. Rajasekaran S., *Finite Element Analysis in Engineering Design*, Wheeler publishing 1993.
4. Chandrapatla Tirupathi, R and Belegundu Ashok, D., *Introduction to Finite Elements in Engineering*, Second edition, Prentice Hall of India, 1997.

## 12GE16 REINFORCED SOIL STRUCTURES

L T P C

3 0 0 3

### UNIT I PRINCIPLES AND MECHANISMS

(09)

Historical background – Initial and recent developments – Principles – Concepts and mechanisms of reinforced soil – Factors affecting behaviour and performance of soil – Reinforcement interactions.

### UNIT II MATERIALS AND MATERIAL PROPERTIES

(09)

Materials used in reinforced soil structures- Fill materials, Reinforcing materials, Metal strips, Geotextile, Geogrids, Geomembranes, Geocomposites, Geojutes, Geofoam, Natural Fibres, Coir geotextiles – Bamboo – Timber – Facing elements – Properties – Methods of testing – Advantages and disadvantages – Preservation methods.

### UNIT III DESIGN PRINCIPLES AND APPLICATIONS

(09)

Design aspects of reinforced soil – Soil reinforcement function – Separator, Filtration, Drainage, Barrier function – Design and applications of reinforced soil of various structures – Retaining walls – Foundations - Embankments and slopes.

### UNIT IV GEOSYNTHETICS AND APPLICATIONS

(09)

Introduction – Historical background – Applications - Design criteria – Geosynthetics in roads – Design – Giroud and Noiray approach – Geosynthetics in landfills – Geosynthetic clay liner – Design of landfills – Barrier walls.

### UNIT V SOIL NAILING AND CASE HISTORIES

(09)

Soil nailing – Introduction – Overview – Soil – Nail interaction – Behaviour – Design procedure – Behaviour in seismic conditions. Performance studies of reinforced dams, embankments, Pavements, Railroads, Foundations - Case studies.

**TOTAL : 45**

#### **Reference Books:**

1. Jewell, R.A., *Soil Reinforcement with Geotextile*, CIRIA, London, 1996.
2. John, N.W.M., *Geotextiles*, John Blackie and Sons Ltd., London, 1987.
3. Jones, C.J.F.P., *Earth Reinforcement and Soil Structures*, Earthworks, London, 1982.
4. Koerner, R.M., *Designing with Geosynthetics*, (Third Edition), Prentice Hall, 1997.
5. *Proc. Conference on polymer and Reinforcement*, Thomas Telford Co., London, 1984.
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. RamanathaAyyar, T.S., Ramachandran Nair, C.G. and Balakrishna Nair, N., *Comprehensive reference book on Coir Geotextile*, Centre for Development for Coir Technology, 2002.

## 12GE17 GROUND IMPROVEMENT TECHNIQUES

L T P C

3 0 0 3

### UNIT I DEWATERING

(09)

Introduction – Scope and necessity of ground improvement – New Technologies – Basic concepts – Drainage methods – Ground water lowering by well points – Deep well, Vacuum and Electro – Osmosis methods.

### UNIT II COMPACTION AND SAND DRAINS

(09)

In-situ compaction of cohesionless and cohesive soils – Shallow and deep compaction – Vibration methods – Vibro-compaction, Blasting, Vibrating probe, Vibratory rollers, Vibro-displacement compaction, Vibroflotation – Concept, Factors influencing compaction – Heavy Tamping – Vertical drains – Preloading with sand drains, Fabric drains, Wick drains – Design of sand drains – Relative merits of different methods – Limitations.

### UNIT III STONE COLUMN AND CONSOLIDATION

(09)

Precompression and consolidation – Dynamic consolidation – Electro-osmotic consolidation – Stone column – Functions – Methods of installation – Design estimation of load carrying capacity of stone column – Settlement of stone column – Lime piles – Earth reinforcement – Soil Nailing – Types of reinforcement material – Applications.

### UNIT IV STABILIZATION

(09)

Introduction – Stabilization methods – Mechanical, Cement, Lime, Bitumen, Chemical stabilization – Electrical stabilization – Stabilization by Thermal and Freezing techniques – Ground improvement by excavating and replacing – Stabilization of expansive clays – Prewetting.

### UNIT V GROUTING

(09)

Introduction – Applications – Functions – Characteristics of grouts – Types of grout – Suspension and solution grouts – Basic requirements of grout – Displacement – Compaction grouting, displacement – Soil fracture grouting, Jet – Displacement grouting, Permeation grouting – Grouting equipment – Injection methods – Grout monitoring.

**TOTAL: 45**

#### **Reference Books:**

1. Purushothama Raj, P., *Ground Improvement Techniques*, Laxmi Publications (P) Ltd., New Delhi, 2005.
2. Moseley M.D., *Ground Treatment*, Blackie Academic and Professional, 1998.
3. Shroff, A.V., *Grouting Technology, in Tunneling and Dam*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2009.
4. Koerner, R.M., *Designing with Geosynthetics* (fourth edition), Prentice Hall, New Jersey, 1999.

**12GE18 SOIL STRUCTURE INTERACTION**

*(Common to 12SE30 M.E. Structural Engineering)*

**L T P C**

**3 0 0 3**

**UNIT I SOIL - FOUNDATION INTERACTION (06)**

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 BEAMS 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 (09)**

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

**TOTAL: 45**

**Reference Books:**

1. Saran, S., *Analysis and design 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, 2008.
4. Murthy, V.N.S., *Advanced Foundation Engineering*, CBS Publishers, New Delhi, 2007.
5. McCarthy, R.N., *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, Delhi, 1988.

## 12GE19 EARTH AND ROCK FILL DAMS

L T P C

3 0 0 3

### UNIT I DESIGN CONSIDERATION

(09)

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

### UNIT II STABILITY OF SLOPES

(09)

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

(09)

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

(09)

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

(09)

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**

#### **Reference Books:**

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*, BlackyTaylor and Francis Academic and Professionals Publications, Glasgow, 1998.
7. Chandhar, R.J., *Engineering Developments and Applications*, Thomas Telford, 1991.
8. Koerner, R.M., *Designing with Geosynthetics*, Third Edition, Prentice Hall, 1997.

**12GE20 ROCK MECHANICS IN ENGINEERING PRACTICE**

**L T P C**

**3 0 0 3**

**UNIT I CLASSIFICATION OF ROCKS**

**(09)**

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**

**(12)**

Behaviour of rock under hydrostatic compression and deviatoric loading – Modes 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**

**(05)**

In situ stresses and their measurements, flat jack - Over and under coring methods – stress around underground excavations – Design aspects of openings in rocks – Case studies.

**UNIT IV SLOPE STABILITY OF ROCKS**

**(09)**

Rock slopes – Role of discontinuities in slope failure, slope analysis and factor of safety – Remedial measures for critical slopes – Case studies.

**UNIT V REINFORCEMENT OF ROCKS**

**(10)**

Reinforcement of fractured and jointed rocks – Shotcreting – Bolting – Anchoring – Installation methods – Case studies.

**TOTAL: 45**

**Reference Books:**

1. Goodman, R.E., *Introduction to Rock Mechanics*, John Wiley and Sons, 1989.
2. Hool, E and Bray, J., *Rock Slope Engineering*, Institute of Mining and Metallurgy, U.K. 1981.
3. Hoek, E and Brown, E.T., *Underground Excavations in Rock*, Institute of Mining and Metallurgy, U.K. 1981.
4. Obvert, L. and Duvall, W., *Rock Mechanics and the Design of Structures in Rock*, John Wiley, 1967.
5. Bazant, Z.P., *Mechanics of Geomaterials Rocks, Concrete and Soil*, John Wiley and Sons, Chichester, 1985.
6. Wittke, W., *Rock Mechanics: Theory and Applications with Case Histories*, Springer-Verlag, Berlin, 1990.

**12GE21 GEOTECHNICAL EARTHQUAKE ENGINEERING**

**L T P C**

**3 0 0 3**

**UNIT I ELEMENTS OF EARTHQUAKE SEISMOLOGY AND DYNAMICS (09)**

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 – Case studies.

**UNIT II GROUND MOTION CHARACTERISTICS (09)**

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 (09)**

Wave propagation Analysis – Site Amplification – Need for Ground Response Analysis – Shear Beam analysis – Methods of analyses – One Dimensional Analysis – Equivalent linear Analysis - Site effects – Design Ground Motion – Developing Design Ground Motion. Application of software packages – Codal Recommendations.

**UNIT IV SEISMIC STABILITY ANALYSIS (09)**

Earthquake – resistant design of foundation of buildings – Design considerations – Geotechnical – Architectural – Structures – 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 - Liquefaction – Susceptibility – evaluation – Cyclic stress approach – Liquefaction Resistance – Laboratory and Field Tests – Interpretation – Lateral Deformation – Codal recommendations.

**UNIT V EARTHQUAKE HAZARD MITIGATION (09)**

Seismic risk vulnerability and hazard – Percept of risk – Risk mapping – Hazard assessment – Maintenance and modifications to improve hazard resistance – Different types of foundation and its impact on safety – Ground Improvement Techniques.

**TOTAL: 45**

**Reference Books:**

1. KameswaraRao, N.S.V., *Dynamics soil tests and applications*, Wheller Publishing – New Delhi, 2000.
2. Krammer S.L., *Geotechnical Earthquake Engineering*, Prentice hall, International series Pearson Education (Singapore) Pvt. Ltd., 2004.
3. KameswaraRao, *Vibration Analysis and Foundation Dynamics*, Wheeler Publishing, New Delhi, 1998.
4. McGuire, R.K., *Seismic Hazard and Risk Analysis*, Earthquake Engineering Research Institute. MNo – 10, ISBN 0-943198-01-1, 2004.
5. Mahanti, N.C., Samal, S.K., Datta, P., Nag N.K., *Disaster Management*, Narosa Publishing House, New Delhi, India ISBN : 81-7319-727X-2006.
6. Bharat Bhushan Prasad, *Fundamentals of Soil Dynamics and Earthquake Engineering*, PHI Learning Pvt.Ltd.,NewDelhi, 2009.
7. Bharat Bhushan Prasad, *Advanced Soil Dynamics and Earthquake Engineering*, PHI Learning Pvt.Ltd.,NewDelhi, 2011.

**12GE22 ADVANCED SOIL MECHANICS LABORATORY**

**L T P C**

**3 0 0 3**

**INDEX PROPERTIES AND CHEMICAL TESTS**

**(09)**

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

**COMPACTION AND COMPRESSIBILITY**

**(09)**

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

**SWELL CHARACTERISTICS**

**(08)**

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

**SHEAR STRENGTH**

**(09)**

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

**DYNAMIC PROPERTIES**

**(08)**

Determination of dynamic properties – Block vibration test.

**FIELD TESTS**

**(09)**

Plate load test – static cone penetration test – Standard penetration test – Pressuremeter Test.

**TEST ON GEOSYNTHETICS**

**(08)**

Opening size of Geotextiles – Tensile strength of Geogrids – Interfacial friction.

**TOTAL: 60**

**Reference Books:**

1. Alam Singh and Chowdary, G.R., *Soil Engineering in Theory and Practice (Vol.2)*, Geotechnical Testing and Instrumentation, CBS, 1999.
2. Bowles, J.E., *Engineering properties of soils and their measurements*, McGraw Hill 1970.
3. KameswaraRao, N.S.V., *Dynamics Soil Tests and Applications*, Wheeler Publishing, New Delhi, 2000.
4. Das, B.M., *Soil Mechanics Laboratory Manual*, Engineering Press, Austin, 1997.
5. Head, K.H., *Manual of Soil Laboratory Testing Vol. I and II*, Pentech Press, London 1990.
6. Al-Khatiji, A.W. and Anderstand, O.B., *Geotechnical Engineering & Soil Testing*, Sounders College Publishing, Fort Worth, 1992.
7. Head, K.H., *Manual of Soil Laboratory Testing Vol. III (Second Edition)*, John Wiley & Sons, 1998.
8. Koerner, R.M., *Designing with Geosynthetics (Third Edition)*, Prentice Hall, 1997.

**12GE23 ENVIRONMENTAL GEOTECHNOLOGY**

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**UNIT I SOIL – POLLUTANT INTERACTION**

**(09)**

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**

**(09)**

Safe disposal of waste – Site selection for landfills – Characterization of landfill sites– Risk assessment – Stability of landfills – Current practice of waste disposal – Monitoring facilities – Passive containment system – Application of geosynthetics in solid waste management – Rigid and flexible liners.

**UNIT III TRANSPORT OF CONTAMINANTS**

**(09)**

Contaminant transport in sub surface – Advection – Diffusion – Dispersion – Governing equations – Contaminant transformation – Sorption – Biodegradation – Ion exchange – Precipitation – Hydrological consideration in landfill design – Ground water pollution – Bearing capacity of compacted fills – Foundation for waste fill ground – Pollution of aquifers by mixing of liquid waste – Protection of aquifers.

**UNIT IV WASTE STABILIZATION AND DISPOSAL**

**(09)**

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**

**(09)**

Rational approach to evaluate and remediate contaminated sites – Monitored natural attenuation – Ex-situ and in-situ remediation – Solidification, Bio – remediation, incineration, soil washing, electro kinetics, soil heating, vitrification, bio-venting – Ground water remediation – Pump and treat, air sparging, reactive well –Case studies.

**TOTAL: 45**

**Reference Books:**

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