

CIVIL ENGINEERING
M.E. (SOIL MECHANICS AND FOUNDATION ENGINEERING)
 SMFE – Four Semester Course
 SCHEME OF INSTRUCTION AND EXAMINATION

I-SEMESTER

Code No.	Course title	Scheme of Instruction		Scheme of Examination			Total	Credits
		Lec.	Tut/drw.	Duration of Exam. (hrs)	Theory/Lab./Viva	Sess.		
SMFE 1.1	Advanced Mathematics	4	--	3	70	30	100	4
SMFE 1.2	Advanced Soil Mechanics	4	--	3	70	30	100	4
SMFE 1.3	Advanced Foundation Engineering	4	--	3	70	30	100	4
SMFE 1.4	Sub-Surface Exploration and Soil Testing	4	--	3	70	30	100	4
SMFE 1.5	Soil Science	4	--	3	50	30	100	4
SMFE 1.6	Soil Engineering lab	--	3	-	50	50	100	2
SMFE 1.7	Computational lab	--	3	-	50	50	100	2
Total		20 + 6 = 26			450	250	700	24

II – SEMESTER

Code No.	Course title	Scheme of Instruction		Scheme of Examination			Total	Credits
		Lec.	Tut/drw.	Duration of Exam. (hrs)	Theory/Lab./Viva	Sess.		
SMFE 2.1	Soil Dynamics	4	--	3	70	30	100	4
SMFE 2.2	Ground Improvement Techniques	4	--	3	70	30	100	4
SMFE 2.3	Earth & Earth Retaining Structures	4	--	3	70	30	100	4
SMFE 2.4	Soil Reinforcement and Geosynthetics	4	--	3	70	30	100	4
SMFE 2.5	Rock Mechanics / Pavement Design	4	--	3	70	30	100	4
SMFE 2.6	Geosynthetics lab	--	3	--	50	50	100	2
SMFE 2.7	Seminar	--	3	--	50	50	100	2
Total		20 + 6 = 26			450	250	700	24

III – SEMESTER

Code No.	Course title	Scheme of Instruction		Scheme of Examination			Total	Credits
		Lec.	Tut/drw.	Duration of Exam. (hrs)	Theory/Lab./Viva	Sess.		
SMFE 3.1	Problematic Soils & Stabilization	4	--	3	70	30	100	4
SMFE 3.2	Geo-Environmental Engg.	4	--	3	70	30	100	4
SMFE 3.3	Design Project	--	3	--	50	50	100	4
SMFE 3.4	Thesis	--	2	--	--	--	--	--
Total		8 + 5 = 13			190	110	300	12

IV- SEMESTER

SMFE -4.1	Thesis/Dissertation	100 marks					Credits: 20
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GRAND TOTAL

1800

80

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I - SEMESTER

SMFE 1.1 ADVANCED MATHEMATICS

Special functions (2 questions):

Bessel functions of order n of first and second kind - values of $J_n(X)$ and $Y_n(X)$ for large and small values of X - expression for $J_n(X)$ when n is half or an odd integer - Bessel function of order n of their kind or Hankel functions of order n - modified Bessel functions - Legendre polynomials - Legendre functions of second kind - generating function of $P_n(X)$ - orthogonality of $P_n(X)$.

Partial differential equations (1 question):

Fourier transforms - sine and cosine transform - transforms of derivatives - finite fourier transforms - multiple fourier transforms - application of transform techniques to solve differential equations.

Numerical analysis (3 questions):

Approximate solutions of first order ordinary differential equations - Euler's method - error propagation - Runge Kutta method - simultaneous ordinary differential equations - multistep method - predictor corrector methods - boundary value problems - simple parabolic differential equations - types of boundary conditions - explicit form of the difference equation - convergence of the explicit form - implicit form of the difference equation - convergence of the implicit form - solution of equations resulting from implicit method - consistency - Crank Nicolsin scheme for time stepping.

Stochastic process (3 questions):

Concept of random variable - distributions and density functions conditional distribution and density functions - functions of one and two random variables - many random variables - concept of stochastic process - stationary and ergodic process - transformation of stochastic processes.

Statistical methods and stochastic process - correlation - regression analysis, Axioms of probability, addition & multiplication theories with random concept, Discrete distributions - Binomial, Poisson distribution, Theoretical distribution - Normal distribution.

Reference books:

1. Applied mathematics for engineers and physicists by Louis A. Pipes
2. The use of integral transforms by I. N. Sneedon
3. Probability (SI (metric)) edition Schaums out line series by Semmour Lipschutz
4. Numerical methods by S. Arumugam, A. Thangapandi Isaac & A. Somasundaram - Scitech publications
5. Engineering mathematics by S. Arumugam, A. Thangapandi Isaac & A. Somasundaram

SMFE 1.2 ADVANCED SOIL MECHANICS

Elements of elasticity: State of stress at a point, stress function, equilibrium equation, compatibility equation, boundary conditions, Hooke's law, two dimensional problems, principle stress and strain, octahedral stresses, stress invariants, Mohr's representation.

Elements of plasticity: ideal plastic substance, strain hardening, yield criteria – Tresca, Hises and Mohr, Coulomb theories of failure and failure envelops in cohesionless and cohesive soils.

Rheological models–Hookean, Newtonian, rigid plastic, Elastios–plastic, Kelvin–Voigt and Maxwell models.

Soil strength: Effective stress law for saturated and partially saturated soil, pore pressure measurements in partially saturated soils, effective stress concept, effect of intermediate principal stress, effect of rate of stress, stress dilatancy theory, plane strain and stress path Hvorslov shear strength parameters

Three-dimensional consolidation – consolidation equation its solution, vertical sand drains.

Reference books:

1. Soil mechanics and foundation by B. C. Punmia, Standard book house
2. Foundation of theoretical soil mechanics by M. E. Harr, Mcgraw Hill book co.
3. Selected topics in soil mechanics by I. K. Lee, Butler Warth
4. Sukhje: Rheological aspect of soil behaviour
5. I. K. Lee: New horizons in soil mechanics

SMFE 1.3 ADVANCED FOUNDATION ENGINEERING

Bearing capacity of shallow foundations, application of bearing capacity theories, methods – Terzaghi, Mayerhof, Brinch Hanson, Skempton, Balla. Field methods – Standard penetration test, factors effecting N value, plate load test, coefficient of sub grade reaction and its determination.

Settlement analysis – Elastic and consolidation settlement, settlement estimates from penetration test, plate load test, construction period correction, permissible total and differential settlement, causes of settlement, control of settlement, remedial measures, proportion of footings, contact pressure and active zone from pressure bulb concept.

Factors effecting failure of foundations, case studies, remedial measures.

Pile foundations – selection of pile foundation, load carrying capacity – dynamic formula, static formula, pile load test – pull out test, lateral load test, initial load test, routine load test, cyclic load test, settlement of pile and pile groups, negative skin friction, laterally loaded piles – Brooms analysis, IS code method. Under reamed piles, methods and design.

Caissons and well foundations – design aspects of caissons, open caissons, pneumatic caissons, floating caissons, well foundations, monoliths, design and constriction aspects of well foundations.

Reference books:

1. Foundation analysis and design by Bowles, McGraw Hill Inc. II edition
2. Geotechnical engineering by C. Venkatramayya, New age international publications
3. Soil mechanics and foundation engineering vol. 2 by V. N. S. Murthy.

SMFE 1.4 SUBSURFACE EXPLORATION AND SOIL TESTING

Problems and phases of foundation investigations. Geophysical, sounding, drilling and accessible explorations. Sample requirements, sampling methods and equipment. Handling, preservation and transportation of samples. Sample preparation, laboratory tests – Triaxial (UU/CU), Consolidation, Swelling pressure. Analysis of results and interpretation, importance of in-situ testing. Performing various in situ tests – Plate load test, Pile load test, SPT, SCPT, DCPT. Precautions and interpretation. Site evaluation and reporting.

Reference books:

1. Head, K. H., Manual of soil laboratory testing, volume 1 to 3, 1981

2. Compendium of Indian standards on soil engineering parts I and II, 1987 – 1988

SMFE 1.5 SOIL SCIENCE

Origin, formation, classification, structure and properties of clay minerals, identification of clay minerals – x-ray diffraction – electron microscope and differential thermal analysis.

Clay water systems – absorbed water, capillary water, free water, soil suction, bonding forces – primary and secondary bonds, crystalline state, ion exchange, dehydration and rehydration shrinkage and swelling behaviour, sensitivity and thixotropy, electro-osmosis applications. Chemical composition analysis, PH of soils, mineralogy of sand and silt, inter particle force in soils.

Dewatering – methods of dewatering and pressure relief, well point systems, deep well drainage, vacuum dewatering, electro osmosis, capacity of pumps and pumps design, installation and operation of dewatering systems – single line, two line, flow to a single well, multiple well systems.

Reference books:

1. Clay mineralogy by Ralph, E. Grim, McGraw hill book co.
2. Soil mechanics for read engineers by H. M. S. O.
3. Relevant I. S. codes
4. Mitchell: Soil behaviour, Wisley, 1976
5. Young Winterkorn: soil behaviour, 1975.

SMFE 1.6 SOIL ENGINEERING LAB.

Classification of coarse grained and fine-grained soils, compaction test, field density test, shear test – shear box, unconfined compression, triaxial compression, consolidation, shrinkage and swelling permeability. Modeltest foundations.

Reference books:

1. Head, K. H., Manual of soil laboratory testing, volume 1 to 3, 1981
2. T.W. Lamb, Laboratory testing.

SMFE 1.7 .COMPUTATIONAL LAB

C-Programming for Design of Deep and Shallow Foundations

II - SEMESTER

SMFE 2.1 SOIL DYNAMICS

Theory of vibration: free and forced vibration with and without damping for single mass system with single degree freedom, elastic half space theory, natural frequency of foundation soil system – Barkon, bulb of pressure concept, Pauw's analogy.

Wave propagation: Waves in rods, waves in half space, elements of seismic methods, steady state vibration.

Dynamic soil properties: Field and laboratory methods, stress-strain characteristics of soil under dynamic loads, vibro-viscous resistance, damping properties, vibration behaviour of soil under small and large amplitudes, bearing capacity of soil, measuring and recording instruments.

Design of machine foundation: Empirical methods, design criteria and procedures for reciprocating machines, impact machine turbo generators, impulse type, construction details of machine foundations, vibration isolation, a seismic design beneficiary aspect of vibration.

Reference books:

1. Handbook of machine foundation by P. Srinivasulu and C. V. Vidyanatham, Tata McGraw Hill book Co.,
2. Foundation engineering by G. A. Leonard, McGraw Hill book Co.,
3. Dynamics of bases and foundation by Barken, McGraw Hill book Co.,
4. Vibration of soil and foundation by Reihart F. E., Hall J. A., Woodes R. E., Prentice Hall
5. Relevant IS codes
6. T. Wh. : Soil dynamics
7. Winterkorn and Fang: Foundation engineering handbook.

SMFE 2.2 GROUND IMPROVEMENT

Principles of ground improvements, mechanical modification – Principles of densification, properties of compacted soil, compaction control tests, specification for compaction.

Hydraulic modification – Dewatering and filtration, drainage and seepage control with geosynthetics, preloading and vertical drains, electro kinetic dewatering.

Chemical modification, modification by admixtures, modification by inclusions and confinement, insitu ground reinforcement, ground anchorage, rock bolting, nailing.

Reference Books:

1. Manfred R. Hausmann, 1990, McGraw Hill Publishing Co.,
2. IS Code 13094-1992, Selection of ground improvement techniques for foundation in weak soils-guidelines

SMFE 2.3 EARTH AND EARTH RETAINING STRUCTURES

A. Earth Retaining Structures

Lateral Pressure:

Basic concepts, Rankine and Coulomb earth pressure theories, graphical methods. Determining active and passive pressures: Culmann's, Rehban's, logarithmic spiral methods, friction circle method. Consideration of surcharge, seepage, earth quake, wave effect, stratification, type of backfill, wall friction and adhesion.

Retaining structures:

- a. Uses, types, stability and design principles of retaining walls, backfill drainage, settlement and tilting.
- b. Classification of anchored bulkheads, free and fixed earth support methods. Rowe's theory for free earth supports and equivalent beam methods for fixed earth supports. Design of anchored rods and dead man.
- c. Braced excavations and stability of vertical cuts, lateral pressures in sand and clay.
- d. Braced and cellular cofferdams: uses, types, components, stability, piping and heaving. Stability of cellular cofferdams, cellular cofferdams in rock and in deep soils.

Reference books:

1. Foundation design by W. C. Teng, Prentice Hall
2. Terzaghi. K. theoretical soil mechanics, John Willey 1965
3. Terzaghi. K. and Peck R. B. Soil mechanics in engineering and practice 2nd edition, John Wiley 1968.
4. Bowles. J. W. analysis and design of foundations, McGraw Hill, 4th edition 1955.

B. Earth dams

Classification, seepage control in embankments and foundations, seepage analysis, stability analysis: upstream and down stream for steady seepage, rapid draw down, end of construction, method of slices and Bishop's method.

Slope protection, filters, embankment construction materials and construction, quality control, grouting techniques.

Instrumentation and performance observations in earth dams.

Reference books:

1. Embankment dams by Bharat Shing and S. D. Sharma
2. Earth and rock fill dams by Shearard, John Willey
3. Design of small dams by U. S. B. R.
4. Earth manual by U. S. B. R.
5. Relevant IS codes.

SMFE 2.4 SOIL REINFORCEMENT AND GEOSYNTHETICS

History and development of earth reinforcement, geosynthetic materials, functions, properties, characterization. Testing methods for geotextiles and geomembranes, application areas. Principles of earth reinforcement. Mechanical and analytical considerations. Factors affecting the performance and behaviour of reinforced soil, construction, durability.

Designing with geotextiles, geogrids, geomembranes and geocomposites for functions such as separation, reinforcement, filtration, drainage and moisture barrier.

Reference books:

1. keorner, R. M. Designing with geosynthetics, Prentice Hall
2. Jones "Earth reinforcement and soil structure" Butter Worths 1996.

SMFE 2.5 ROCK MECHANICS / PAVEMENT DESIGN

A - Rock mechanics

Exploration and laboratory tests on intact rock - classification of rock and rock masses, mechanical properties and behaviour of rock static, time dependent, planes of weaknesses, moisture and pore pressure, apparent specific gravity, tensile, compressive and flexural strength, stability of natural and excavated rock slopes, rock as a structural foundation, rock bursts and rock bolting.

Reference books:

1. Rock mechanics on the design of structures in rock by Oberti and Duval, W. L. John Wiley.
2. Rock mechanics edited by Miller.
3. Rock mechanics and engineering by C. Jaeger

B - Pavement design

Pavement types - comparison of highway and airport pavement structural components, design factor.

Flexible pavements - Design - Group index, C. B. R., F. A. A. methods

Rigid pavement - Curvature and bending, relative stiffness, stress due to warping and friction, modular of sub grade reaction, equivalent wheel and axle loads, joints in rigid pavements, design of tie bars and temperature reinforcement, strengthening of existing pavements.

Reference books:

1. Soil mechanics for road engineers by H. M. S. O.
2. Concrete roads by H. M. S. O.
3. Principles of pavement design by Yoder, E. J.

SMFE 2.6 GEOSYNTHETICS LAB

1. Determination of physical properties of Geotextiles, Geogrids and Geomembranes
2. Determination of Grab and wide width tensile strengths of geotextiles
3. Determination of Tensile strength of Geogrids and Geomembranes
4. Determination of Interfacial frictional characteristics of Geotextiles with Fill material
5. Determination of in plane and cross plane permeability of geotextiles
6. Determination of Puncture Resistance of geotextiles
7. Determination of A.O.S of geotextiles
8. Evaluation of long term flow ability of geotextiles by Gradient ratio test
9. Cone Drop Test on geotextiles

SMFE 2.7 SEMINARS

Each student has to deliver two seminars in the semester under the direction of teacher.

III – SEMESTER

SMFE 3.1 PROBLEMATIC SOILS AND STABILIZATION

Expansive Soils:

Geology, engineering properties, swelling, swelling pressure, strength and compressibility, permeability stabilization methods, foundation types.

Soft Clays:

Geology of soft marine clays, mineralogy, physical properties, shear strength and compressibility, foundation types.

Organic and Peety Soils, Collapsible soils:

Geotechnical properties, foundation types

Soil Stabilization:

Principles of soil stabilization; Role of admixtures; Purpose based classification of soils; Methods of stabilization – Lime, cement, bitumen and special chemicals – Mechanisms, uses and limitation; use of fly ash and other waste materials

Reference books: -

1. Tropical soils in engineering practice by S. A. Ola, Balkema publications, Holland
2. Soil stabilization principles and practice by Ingles, O. G. and metcaff, J. B., Butterworth,1972

SMFE 3.2 GEO-ENVIRONMENTAL ENGINEERING

Wastes: source, production and classification of wastes, soil pollution processes, waste characterization.

Waste disposal facilities such as landfills and impoundments, slurry walls, landfill planning and design. Barrier systems – basic concepts, design and construction, stability, compatibility and performance contaminant transformation and transport in subsurface. Monitoring surface contamination, stabilization, and modification of wastes. Reuse of waste materials, contaminated site remediation. Case studies in waste handling.

Soil erosion and conservations – causes of soil erosions, factors contributing to erosion – climatic factors, topographical factors, vegetation factors. Erosion control – cropping systems, gullies, check dams, contouring, wind striping, ridging, bank protection.

Note:

1. Student is expected to give at least one seminar on the subject from journal.
2. Preparation of paper involving case studies where the topics covered were incorporated in practice.

Reference books:

1. Daniel, D. E. Geotechnical practice for waste disposal, Chapman and Hall, London 1993
2. Rowe, R. K., Quigley, R. M. and Booker, Clay barrier systems for waste disposal facilities, J.R., E & FN Spon, London, 1995
3. Reddi, L. N., and Inyang, H. F. Geoenvironmental Engineering – principles and applications, Marcel Dekker, 2000
4. Bagchi, A. Design, construction and monitoring of landfills, John Wiley & Sons, New York 1994
5. Sharma, H. D. and Lewis, S. P., Waste containment systems, Waste stabilization and landfills: Design and evaluation John Wiley & Sons, New York 1994

SMFE 3.3 DESIGN PROJECT

The student will carried out typical foundation design under varying soil conditions or revision of IS codes & IRC guidelines or any project suggested by course instructor.