

Department of Civil Engineering

**SCHEME OF INSTRUCTION & SYLLABUS
FOR**

**M.Tech. (SOIL MECHANICS AND
FOUNDATION ENGINEERING)**

(with effect from 2019-20 Admitted Batch)



Department of Civil Engineering

A.U. College of Engineering (A)

Visakhapatnam

Department of Civil Engineering
M.Tech. (SOIL MECHANICS AND FOUNDATION ENGINEERING)
Scheme of Instruction and Examination
(with effect from 2019-20 Admitted Batch)

I – SEMESTER

Code No.	Course Title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam (hrs)	Ext.	Sess.		
SMFE1.1	Advanced Soil Mechanics	4	--	4	3	70	30	100	3
SMFE1.2	Advanced Foundation Engineering	4	--	4	3	70	30	100	3
SMFE1.3	Geosynthetics and Reinforced Soil Structures	4	--	4	3	70	30	100	3
Program Elective –I	(a) Analysis and Design of Pavements	4	--	4	3	70	30	100	3
	(b) Rock Mechanics								
SMFE1.4	(c) Remote Sensing and GIS Applications								
Program Elective–II	(a) Advanced Concrete Technology	4	--	4	3	70	30	100	3
SMFE1.5	(b) Subsurface Exploration								
SMFE1.6	Soil and Rock Engineering Lab.	-	3	3	Viva	50	50	100	1.5
SMFE1.7	Geosynthetics Lab.	-	3	3	Viva	50	50	100	1.5
Total		20	6	26		450	250	700	18

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam. (hrs)	Ext.	Sess.		
SMFE2.1	Soil Dynamics and Machine Foundations	4	--	4	3	70	30	100	3
SMFE2.2	Earth and Earth Retaining Structures	4	--	4	3	70	30	100	3
SMFE2.3	Geotechnical Earthquake Engineering	4	--	4	3	70	30	100	3
Program Elective –III	(a) Disaster Management								
	(b) Ground Improvement Techniques	4	--	4	3	70	30	100	3
SMFE2.4	(c) Reliability Analysis and Design								
Program Elective –IV	(a) Geotechnics of Underground Structures								
SMFE2.5	(b) Finite Element Method of Analysis	4	--	4	3	70	30	100	3
SMFE2.6	Design Project	--	3	3	Viva	50	50	100	1.5
SMFE2.7	Case Studies	--	3	3	Viva	50	50	100	1.5
SMFE2.8	Seminar	--	3	3	Viva	50	50	100	2
Total		20	9	29		500	300	800	20

III – SEMESTER

Code No.	Course Title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Exam. (hrs)	Ext.	Sess		
Program Elective –V SMFE3.1	(a) Problematic Soils (b) Geotechnics of Industrial Wastes	4	--	4	3	70	30	100	3
Program Elective –VI SMFE3.2	(a) Forensic Geotechnical Engineering (b) Geoenvironmental Engineering	4	--	4	3	70	30	100	3
SMFE3.3	Dissertation (Preliminary)	--	--	--	Viva	-	100	100	8
Total		8	--	8		140	160	300	14

IV- SEMESTER

Code No.	Course Title	Scheme of Examination			Total	Credits
		Exam. (hrs)	Ext.	Sess.		
SMFE4.1	Dissertation (Final)	Viva	100	--	100	16
Total						16

Department of Civil Engineering
M.Tech. (SOIL MECHANICS AND FOUNDATION ENGINEERING)
Syllabus

(with effect from 2019-20 Admitted Batch)

I – SEMESTER

SMFE1.1 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 envelopes in cohesionless and cohesive soils.

Rheological models–Hookean, Newtonian, rigid plastic, Elasto–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

Clay Minerals: Classification, Structure, properties; Identification of clay minerals - X ray Diffraction, Electron Microscope and Differential Thermal Analysis.

Text book

1. *Soil Behaviour by James K Mitchell, John Wiley & Sons Inc*

Reference books

1. *Foundation of theoretical soil mechanics by M. E. Harr, Mc Graw Hill book co.*
2. *Selected topics in soil mechanics by I. K. Lee, Butler Warth*
3. *Rheological aspect of Soil Behaviour by Sukhje, Thomas Telford Publishing*

SMFE 1.2 ADVANCED FOUNDATION ENGINEERING

Common Syllabus for SMFE1.2, CTPM1.4(a), TE1.4(a) and ST1.4(a)

Introduction

Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity.

Shallow Foundations

Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.

Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesionless soils by Schemmertmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing.

Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

Deep Foundations

Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Brom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis

Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and ‘CNS’ concepts.

Foundations of Transmission Line Towers

Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Text Books

1. *Analysis and Design of Substructures by Swami Saran, Oxford & IBH Publishing Co. Pvt. Ltd.*
2. *Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications*

Reference Books

1. *Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.*
2. *Foundation Design by W.C. Teng, John Wiley, New York.*
3. *Analysis and Design of Substructures by Swami Saran, Oxford & IBH Publishing Co.*
4. *Foundation Engineering by P.C. Vargheese, Prentice Hall of India*

SMFE1.3 GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

Reinforced Earth: Concept, Effects of Reinforcement on soils – Equal Confining and Psuedo Cohesion Concepts, Materials, Friction Coefficient – Definition, Laboratory determination, Factors affecting fiction coefficient; Application of Reinforced Earth

Geosynthetics: Types, Functions, Tests on Geosynthetics, Durability aspects, Applications

Reinforced Earth Retaining Walls: Introduction, Stability Mechanisms, Design of Reinforced Earth Retaining Wall, Advantages over conventional Retaining Walls

Reinforced Embankments: Introduction, Design of Reinforced Embankment, Foundation mattress below the embankment, Design of Reinforced Mattress

Reinforced Soil Beds: Introduction, Factors affecting the Behaviour of Reinforced Soil Beds, Analysis and Design

Reinforced Pavements: Benefits of placing reinforcement in flexible pavement layers, design of reinforced pavements by Giroud and Noiray approach and modified CBR Method.

Text Book

1. *An Introduction to Soil Reinforcement and Geosynthetics*” By G.L. Siva Kumar Babu, University Press

Reference Books

1. *Designing with Geosynthetics* by Robert M Koerner,
2. *Advances in Geosynthetics* by G. Venkatapparao, Sai Master Geoenvironmental Services Pvt. Ltd. Publications

SMFE1.4(a) ANALYSIS AND DESIGN OF PAVEMENTS

Pavement Types, Design Factors: Definition, Comparison of pavements. Types of pavements based on structural behavior – Flexible and Rigid Pavements, Comparison, components and their functions, Soil subgrade, sub-base, Base course and wearing course. Design wheel loads – Equivalent Single Wheel Load (ESWL), Repetitions of loads. Strength characteristics of pavement materials – subgrade modulus, Elastic moduli of base course and sub-base materials, Traffic and Loading, Environment, Materials, Failure criteria. Climatic Variations

Stresses in Flexible Pavements: Layered System Concepts: One Layer System - Boussinesq Theory. Two Layer Theory - Burmister’s Theory. Three Layer System.

Stresses in Rigid Pavements: Relative Stiffness of Slabs, Modulus of Subgrade Reaction, Stresses due to Warping, Stresses due to Friction, Stresses due to Wheel Load, Stresses due to temperature variation (temperature differential).

Pavement Design:

Design of Flexible pavements – Group-Index method, California Bearing Ratio(CBR) method, McLeod method, Burmister Method, IRC Method of Flexible Pavement Design as per IRC 37 –2001, AASHTO Method of Flexible Pavement. Design of Air field Pavements – Corps of Engineers method

Design of Rigid pavements – Design of Joints, Expansion Joints, Contraction Joints, Design of Dowel and Tie bars. IRC recommendations for Rigid pavements as per IRC 58-1988. Design of Airfield Rigid pavements– LCN System of Pavement design.

Pavement Failures: Flexible pavements – Alligator cracking, Longitudinal cracking, Frost heaving, lack of binder to lower course, formation of waves on corrugation, Reflection cracking.

Pavement Inventories: Serviceability Concepts, pavement serviceability index, Roughness for measuring unevenness, Profilograph, profilometer, road roughometer, Benkelman beam deflection method, Skid resistance measurement.

Pavement Evaluation: Structural Evaluation of Benkelman beam. Evaluation of Pavement surface measurement condition using instruments (Profilograph, bump Integrator)

Overlays: Types of overlays – Flexible overlay over Flexible Pavements, Rigid overlay over Flexible Pavements, Flexible overlay over Rigid Pavements, Rigid overlay over Rigid Pavements. Design of overlay using Benkelman beam using IRC 81-1997.

Concrete Block Pavements – Types and shapes, Construction and maintenance.

Text Books:

1. *Principles of Pavement Design* by Yoder and Witzorack, John Willey and Sons.
2. *Highway Engineering*, S.K. Khanna and C.E.G Justo and A. Veeraragavan, Nemchand Brothers publications.
3. *Airport Planning and Design* by S.K. Khanna and S. Arora, Nemchand and brothers publications.

Reference Books

1. Yang, H. Huang, "Pavement Analysis and Design", Prentice Hall Publication, Englewood Cliffs, New Jersey.
2. Sargious, M.A. *Pavements and Surfacing for Highways and Airports*– Applied science Publishers limited
3. Ralphs Hass and Hudson, W.R. "Pavement Management System" Mc-Graw Hill Book Company.
4. *Guidelines for the use of Interlocking concrete block Pavement*, IRC:SP:63-2004
5. *IRC codes of practice*.
6. *Principles of Transportation Engineering*, Partha Chakraborty and Animesh Das, PHI Learning.

SMFE1.4(b) ROCK MECHANICS

Introduction : Geological formation of rocks, Structural Geology, classification of rocks, Defects in rock, Physical, mechanical properties of rocks, Exploration techniques – RQD and RMR, Laboratory tests for shear strength, tensile strength, flexural strength, elastic constants, Field tests – test for deformability, shear tests and strength tests

Engineering classification of Rock mass, Stress-strain behaviour, Failure criteria for rock masses - Yield criteria for failure theories: maximum stress theories, maximum elastic strain theories etc, and Griffith's theory of fracture initiation, stresses around open flaw and equation defining fracture

Tunnelling in rocks - different phases and methods of tunnelling, Instrumentation in tunnels, Rock freezing, Rock fall, Improvement techniques for rock – Grouting, Rock bolting

Rock reinforcement - Mechanism, types of reinforcement, steps involved in installation, Foundations on rock, Rock blasting- explosives, Selection criteria for explosives, steps involved in blasting

Text book

1. Singh, B. and Goel, R. K. "Rock Mass Classification Systems – A Practical Approach in Civil Engineering" Elsevier Publisher

Reference Books

1. Verma, B. P., "Rock Mechanics for Engineers" Khanna Publishers
2. Brown, E.T., "Rock Characterisation, Testing and Monitoring", Pergamon Press, London, U.K
3. Rock mechanics on the design of structures in rock by Oberti and Duval, W. L. John Wiley.

SMFE1.4(c) REMOTE SENSING AND GIS APPLICATIONS

Common Syllabus for HCH1.4(c), SMFE1.4(c) and EEM1.4(c)

Introduction - Definition- Principle of Remote Sensing- History of Development of Remote Sensing- Stages in Remote Sensing- Electromagnetic Radiation and the Electromagnetic Spectrum- Interactions With the Atmosphere- Atmospheric Scattering- Atmospheric Absorption- Atmospheric Windows- Refraction- Interaction of EMR with the Earth's Surface- Reflection- Transmission- Spectral Signature.

Platforms & Sensors- Remote Sensing Systems- Remote Sensing From Space- Remote Sensing Sensors- Resolution- Imaging Sensors- Optical Infrared (OIR) Imagers- Optical Sensors- Thermal Sensors- Microwave Sensors- Active Microwave Sensors- Data Preprocessing- Remote Sensing in India.

Introduction to Image Interpretation- Basic Principles of Image Interpretation- Elements of Image Interpretation- Techniques of Image Interpretation- Interpretation Keys- Introduction to Digital Image Processing- Digital Image- Image Rectification and Registration- Geometric Correction- Image Enhancement Techniques (Only Concepts)- Image Classification -

Unsupervised Classification and Supervised Classification- Digital Photogrammetry - Stereo Images from Satellites - Data Merging .

Geographic Information Systems (GIS)- Definitions and Related Technology- GIS Operations- GIS Elements- GIS Concepts and Practice- Map Projection and Coordinate System.

Vector Data Model- Introduction- Vector Data Representation- Geometric Objects- Topology.

Vector Data Analysis- Introduction- Buffering- Applications of Buffering- Map Overlay- Feature Type and Map Overlay- Map Overlay Methods- Slivers- Error Propagation in Map - Overlay- Distance Measurement- Map Manipulation-

Raster Data Analysis- Introduction- Analysis Environment- Local Operations- Local Operations With a Single Grid- Local Operations With Multiple Grids- Neighborhood Operations- Zonal Operations.

Terrain Mapping and Analysis- Introduction- Data for Terrain Mapping and Analysis- Surface Models-DEM- TIN.

GIS Models and Modeling- Introduction- GIS Modeling- Binary Models- Index Models

Remote Sensing & GIS Application in Civil Engineering – Some Case Studies from Literature.

Text Books

1. *Fundamentals of Remote Sensing 2nd Ed* by George Joseph- University Press- New Delhi.
2. *Introduction to Geographic Information Systems* by Kang Tsung Chang- Tata Mc.G.H. Publications- New Delhi.
3. *Remote Sensing and Image Interpretation* by Lillesand- T.M. and Kieffer- Joh Wiley and Sons- New York- 1987.

Reference Books

1. *Remote Sensing of the Environment – An Earth Resource Prespective* by John R. Jensen- Pearson Education- New Delhi.
2. *Geographic Information Systems: A Management Perspective* by Aronoff- S. Ottawa: Wdl Publications- 1989.

3. *Geographic Information Systems For Geoscientists: Modeling with GIS* by Bonham Carter- G-F.- New York: Pergamon Press- 1994.
4. *Principles Of Geographical Information Systems* by Burrough- P.A And R.A. Mcdonnell.. Oxford: Oxford University Press- 1998.
5. *Concepts and Technologies of Geographic Information Systems* by Lo- C.P.- and Albert K.W. Young- Prentice Hall Of India (Pvt) Ltd- New Delhi.
6. *Introductory Digital Image Processing* by John R Jensen- Prentice Hall- New Jersey.
7. *Application of Remote Sensing to Hydrology Including Groundwater* by Farsworth- R.K.- Bawetl- E.C. & Dhanju- M.S.-- IHP- UNESCO- 1984.

SMFE1.5(a) ADVANCED CONCRETE TECHNOLOGY

Common Syllabus for ST1.5(a), CTPM1.5(a) and SMFE1.5(a)

Durability of concrete and concrete construction: Durability concept, pore structure and transport processes, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, methods of providing durable concrete, short-term tests to assess long-term behavior.

Mix design: Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes. Acceptance criteria for compressive strength of concrete

Special concretes: Lightweight concrete, autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, High strength concrete, refractory concrete, high density and radiation-shielding concrete, polymer concrete, fibre-reinforced concrete, mortars, renders, recycled concrete, Ferro Cement, Self Compacting Concrete.

Special processes and technology for particular types of structure: Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments.

Test methods: Analysis of fresh concrete, Accelerated testing methods, Tests on hardened concrete, Core cutting and testing, partially destructive testing, Non-destructive testing of concrete structures

Text Book

1. *Properties of Concrete*, A.M.Neville, Longman 1995.
2. *Concrete Technology Theory and Practice*, M.S.Shetty, S.Chand & Company Ltd, New Delhi.

Reference Book

1. *Concrete micro-structure, Properties and Materials*, P.K.Mehta, J.M.Monteiro, Printice Hall INC & McGraw Hill, USA.

SMFE1.5(b) SUBSURFACE EXPLORATION

Objectives of Soil Exploration, Methods of Soil Exploration, Depth and Extent of Soil Exploration in Different Civil Engineering Projects

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 – File Vane Shear Test, Plate load test, Pile load test, SPT, SCPT, DCPT. Precautions and interpretation. Site evaluation and reporting.

Exploration in Rock and Marine Soil Exploration

Text Book

1. *Basic and Applied Soil Mechanics* by Gopal Ranjan and A.S.R. Rao, New Age International Publications

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

SMFE1.6. SOIL AND ROCK ENGINEERING LAB

Experiments on Soil

1. Index and Engineering Properties Of soils
2. Quick Determination of Water content – Rapid Moisture Meter, Proctor’s Needle.
3. Determination of Compression Index, Coefficient of consolidation of clays
4. Determination of Swell Parameters – Differential Free Swell, Swell Pressure Tests.
5. Determination of Shear Parameters – Tri-axial Test, Direct Shear Test, Vane Shear test, Unconfined Compression Test.
6. Determination of Relative Density of granular soils.

Experiments on Rock

1. Determination of Specific Gravity.
2. Determination of Unconfined Compression Strength.
3. Determination of Porosity.
4. Determination of Water absorption.
5. Determination of point load Index of Rocks.

Demonstration Tests:

1. Plate Load Test.
2. Pile Load Test.
3. Standard Penetration Test.

Reference Book: Relevant IS Codes of Practice

SMFE1.7 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

Reference Books: Relevant ASTM Standards

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Syllabus

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II – SEMESTER

SMFE2.1 SOIL DYNAMICS AND MACHINE FOUNDATIONS

Theory of Vibration: Free and forced vibrations with and without damping for single mass system with single degree freedom, Logarithmic Decrement and Damping Ratio, Principles of Design of Vibration measuring Devices, Transmissibility of force, vibrations of Two degree freedom system, vibrations of Systems under transient loads.

Natural frequency of foundation soil system- Barkan's Method, Pressure Bulb Concept, Pauw's Analogy, Tschebetorloff's concept of reduced natural Frequency.

Dynamic Soil Properties: Tests for determination of dynamic soil properties - Cyclic Plate load test, Block vibration test, Up Hole, down Hole and Cross Hole wave Propagation tests, Hammer Test, Resonant Column Test, Seismic Reflection and Refraction tests.

Design of Machine Foundation: Types of Machine Foundations, design criteria, Degrees of Freedom of Block foundation, Analysis of Block foundations under sliding, rocking, yawing and Coupled motions, Design Aspects and Construction details of foundations for reciprocating and Impact, vibration isolation: active and passive isolation, vibration isolation materials.

Text Book

1. *Soil Dynamics by Shamsher Prakash, Shamsher Prakash Foundation*

Reference books

1. *Hand Book of Machine Foundations by P. Srinivasulu and C.V. Vaidyanathan, Tata Mc Graw Hill Book Co.*
2. *Dynamics of Bases and Foundation by Barken, Mc Graw Hill Book Co.*
3. *Vibration of soil and Foundation by Richart F.E., Hall J.A., Woodes R.E., Prentice Hall*

SMFE2.2 EARTH AND EARTH RETAINING STRUCTURES

Earth Pressure:

Basic concepts, Rankine and Coulomb earth pressure theories, Determination of active and passive pressures: Culmann's Graphical method, logarithmic spiral methods, friction circle method. Consideration of surcharge, seepage, earth quack, 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. Sheet Pile Walls: Types, Design of cantilever sheet pile walls in granular and Cohesive soils; Design of anchored sheet pile walls by free and fixed earth support methods, Rowe's theory of moment Reduction, Design of anchors.
- c. Braced excavations: Types of sheeting and Bracing systems, lateral earth pressure on sheeting in sand and clay, Design components of braced cuts.
- d. Cellular cofferdams: Types – Diaphragm and Circular type, Design by TVA method. Stability of cellular cofferdams, cellular cofferdams in rocks and soils.

Text Books

1. *Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications*
2. *Foundation design by W. C. Teng, Prentice Hall*

Reference books

1. *Theoretical soil mechanics by Karl Terzaghi, John Willey 1965*
2. *Soil mechanics in engineering and practice by K. Terzaghi. And R.B. Peck 2nd edition, John Wiley 1968.*
3. *Analysis and design of foundations by J.E. Bowles, McGraw Hill, 4th edition 1955.*

SMFE2.3 GEOTECHNICAL EARTHQUAKE ENGINEERING

Seismology and Earth Quakes: Introduction, Seismic Hazards, seismic waves, internal structure of earth, Continental Drift and plate tectonics, faults, elastic rebound theory, geometric notations, location of earthquakes, size of earthquakes.

Strong Ground Motion: Strong ground motion measurement, Ground motion parameters, Estimation of ground motion parameters.

Seismic Hazard Analysis: Identification and evaluation of earthquake sources, Deterministic Seismic Hazard Analysis, Probabilistic seismic Hazard analysis.

Wave Propagation: Waves in Rods, one dimensional wave equation, Effect of end condition on wave propagation, Mode vibrations of rods of finite length, Wave propagation through elastic infinite medium, Waves in Semi infinite elastic medium.

Dynamic Soil Properties: Measurement of Dynamic Soil Properties using field and laboratory tests (overview), Strength and Stress-strain behavior of cyclically loaded soils.

Ground Response Analysis: One dimensional ground response analysis – Linear and Non-linear approaches.

Local Site Effects: Effect of local site conditions on ground motion, Design parameters, Development of design parameters.

Liquefaction: Flow liquefaction, cyclic mobility, liquefaction hazards, liquefaction susceptibility, Initiation of liquefaction, Effects of liquefaction, liquefaction Control measures

Text Book

1. *Geotechnical Earthquake Engineering* by Steven L. Kramer, Prentice Hall

Reference Book

1. *Geotechnical Earthquake Engineering Handbook* by Robert W. Day, McGraw-Hill Publishing Co., New York

SMFE2.4(a) DISASTER MANAGEMENT

Types of Disasters:

Disaster - concept and definitions of disaster, causes of disasters, types – natural disasters – floods, droughts, cyclones, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold wave, global warming, sea level rise, ozone depletion. Man-made disasters: Sociological – political – industrial and human disasters.

Risk Assessment and Analysis

Concept and elements of Hazards, Risks and Vulnerability – Policies of Disaster Management, Identification of Crisis Situation, strategic developments, roles and responsibilities of recovery team, importance of team building in disaster management.

Disaster Preparedness:

Prevention and Preparedness – Plan, Action and Accountability, Concept and Nature of Disaster Preparedness, Plan of Disaster Preparedness for People with Special Needs/Vulnerable Groups, with Relevance to Housing, Infrastructure and Livestock, Community Based Disaster Preparedness Plan, Role of Information technology, Education, Communication and training. Medical and health preparedness plan.

Disaster Damage Assessment and Response:

Needs and Damage Assessment– Control process and measurement – modern and traditional methods of response, Disaster Response Plan – roles of response teams and forces. Epidemiological Study of Disasters - Medical and Health Response to Different Disasters - Role of Information and Communication Technology in Health Response

Disaster Mitigation and Recovery:

Disaster Mitigation – meaning and concept – structural mitigation and non-structural mitigation – mitigation strategies and emerging trends. Reconstruction and rehabilitation for development, Medium and long-term recovery aspects, Participative Rehabilitation Process: Community involvement and development of infrastructure.

Reference Books:

1. *Disaster Management* by Dr. Mrinalini Pandey, Wiley India Pvt. Ltd.
2. *Natural Hazards & Disaster Management* by R.B.Singh
3. *Disaster Management: Future Challenges and opportunities* by Jagbir Singh
4. *Natural Disaster Management*, Jon Ingleton
5. *Disaster Management*, Rajib Shaw and RR Krishnamurthy, Universities Press, Hyderabad.

SMFE2.4(b) GROUND IMPROVEMENT TECHNIQUES

Common Syllabus for SMFE2.4(b), CTPM2.4(b), ST2.4(b) and TE2.4(a)

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction: Methods - Vibrofloatation, Terra probe method, Pounding, Blasting, Compaction piles; Compaction Control.

Vertical Drains: Sand drains, Sand wicks, Rope drains, Design of vertical drains, Stone columns, application of the techniques to Marine clays.

Stabilization: Introduction, objectives, Methods of stabilization – Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods – Soil lime Columns and Cement Lime Columns, applications

Dewatering: Definition, necessity, Methods of dewatering – Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro-osmosis. Permanent drainage by Foundation drains and Blanket drains.

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Ascending, Descending and Stage Grouting in Soils, Hydrofracture, Grouting Equipment, Post grouting tests.

In-situ Reinforcement: Ground Anchors, Tiebacks and Soil Nailing, Micropiles.

Text Book

1. *Ground Improvement Techniques* by P. Purushothama Raj, Laksmi Publications, New Delhi.

Reference Books

1. *Engineering Principles of Ground Modification* by Monfred R Hausmann, Mc Graw Hill Publishing Co.
2. *Reinforced Soil and Its Engineering Applications* by Swami Saran, I.K. International Pvt. Ltd.

SMFE2.4(c) RELIABILITY ANALYSIS AND DESIGN

Common Syllabus for ST2.4(c) and SMFE2.4(c)

Concepts of Structural Safety: General, Design methods.

Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

Probabilistic Analysis of Loads: Gravity loads, Wind load.

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.

Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of

results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

Text Book

1. *Structural Reliability Analysis and Design by R.Ranganatham, Jaico Publishing House.*

Reference Book

1. *Structural Reliability by R.EMelchers, John Wiley and Sons Ltd.*

SMFE2.5(a) GEOTECHNICS OF UNDERGROUND STRUCTURES

Arching in soils, prerequisites and features of arching, Theory of arching in soils, Application of arching in cohesive frictional and cohesive-frictional soils.

Soil pressures on conduits- Loads on ditch, negative and positive projecting conduits, Bedding conditions for conduits and types of conduits, Pressures in silos, Janssen's theory for pressures in silos

Stresses in Vicinity of Vertical Shafts, Tunnels, Construction of Erath Tunnels

Retaining Systems for Underground Excavations

Braced Cuts: Lateral Earth pressure on Sheet piling, Types of Sheet piling and Bracing Systems, Design of Braced Cuts

Tie Backs: Components, advantages over Braced Cuts, Design concepts

Soil Nailing: Components of nailing system, Driven and Grouted Nails, Design of nailing system, anchored Spider Netting

Types of Anchorage Systems for anchored Sheet pile walls, Design of anchorages, considerations in positioning of anchorages

Text Book

1. *Shamsher Prakash, Gopal Ranjan and Swami Saran (1987) "Analysis and Design of Foundations and Retaining Structures", Sarita prakasha.*

Reference books

1. *Leonards, G.A (1962) "Foundation Engineering", Mc Graw Hill Co.*
2. *Design of Foundation Systems by Nainan P Kurian, Narosa Publishing House.*

SMFE2.2 FINITE ELEMENT METHOD OF ANALYSIS

Common Syllabus for ST2.2, SMFE2.5(b), WRE2.5(b), HCH2.5(b) and TE2.5(b)

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM: Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoparametric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

Text Books

1. *Finite Element Analysis by C.S.Krishnamoorthy, (2002), Tata McGraw Hill Publishing Co. Ltd.*
2. *Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.*

Reference Books

1. *Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu*
2. *The Finite Element Method in Engineering Science” by Zienkiewicz, P., McGraw Hill, 1971.*

SMFE2.6 DESIGN PROJECT

The students should carry out typical foundation design under varying soil conditions or revision of IS codes & IRC guidelines or any project suggested by course instructor. The design project may consist of

1. Soil and Structural Design of Combined footings, rafts
2. Design of Pile Groups
3. Design of Laterally loaded Piles
4. Design of well Foundations
5. Landfill Design
6. Reinforced Soil Structures
7. Design of Bulk heads
8. Case studies.

SMFE2.7 CASE STUDIES

Students should select a case study in any of the following areas and prepare a comprehensive report and present the case study

1. Foundation design
2. site characterization
3. ground improvement
4. Slope Instability
5. Soil Contamination and remediation
6. Foundation failures
7. Embankment construction on weak subgrades.

SMFE2.8 SEMINAR

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end of the semester

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III – SEMESTER

SMFE3.1(a) PROBLEMATIC SOILS

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 Peaty Soils, Collapsible soils: Geotechnical properties, foundation types

Liquefiable Soils: Identification, Factors affecting Liquefaction, Methods for improving resistance of soils to Liquefaction

Filled up Soils: Characterization, Methods for Strengthening Filled up material for supporting structures, Foundation practices in Filled up areas.

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

Text Book:

1. *Ground Improvement Techniques by P. Purushothama Raj, Lakshmi Publications*

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 Metcalf, J. B., Butterworth, 1972*

SMFE3.1(b) GEOTECHNICS OF INDUSTRIAL WASTES

Wastes from Thermal Power Plants: Fly ash, bottom ash and Pond Ash, availability, Properties, classification, scope for use in civil engineering projects, Present applications

Agriculture Waste: Rice Husk Ash, Physical, Chemical and Engineering Properties, Potential uses based on its properties.

Wastes from Steel Plants: Blast Furnace Slag, Granulated Blast Furnace Slag and Ground Granulated Blast Furnace Slag, Material properties, potential applications.

Quarry Dust: Production, Properties, comparison with sand, potential uses.

Potential for use of Industrial wastes in stabilization of soils.

Underground Pollution Risk of using Industrial wastes as construction materials and Mitigation. Evaluation methods for studying the leaching effect of industrial wastes on underground.

Text Book

1. *Ground Improvement Techniques* by P. Purushothama Raj, Lakshmi Publications, New Delhi.

Reference Book

1. A. Sridharan and K. Prakash (2009), “*Geotechnical Engineering Characterization of Coal Ashes*”, CBS Publishers

SMFE3.2(a) FORENSIC GEOTECHNICAL ENGINEERING

Concept of Forensic Investigation, Necessity, Objectives of Forensic Geotechnical Investigation, Methods of Forensic Investigation.

Project reconnaissance and characterization of the distress, including document search such as plans, codes, and other technical specifications followed in the original design.

Diagnostic tests – Analysis of field data – selection of laboratory tests based on actual field parameters to evaluate the behaviour of soil/ground.

Scope and extent of application of Forensic Engineering techniques in geotechnical and foundation failure investigations, settlement of structures, expansive soils, lateral movement, other geotechnical and foundation problems, groundwater and moisture problems.

Back analysis: Selection of theoretical model - methods of analysis, Instrumentation and Monitoring Development of the most probable failure hypothesis - cross-check with original design.

Performing reliability checks, Legal issues involving jurisprudence system, insurance, repairs, reducing potential liability, responsibility of geotechnical engineers and contractors.

Text Book

1. *Forensic Geotechnical and Foundation Engineering* by Robert W. Day, Mc Graw Hill

Reference Book

1. Malcolm D. Bolton, "A Guide to Soil Mechanics "Universities Press.
2. Saxena, D.S., "Technical, Ethical, and Legal Issues with Forensic Geotechnical Engineering - A Case History", *Proceedings, 13th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, Kolkata, India, 11 December 2007.*

SMFE3.2(b) GEOENVIRONMENTAL ENGINEERING

Common Syllabus for SMFE3.2(b) and TE3.2(b)

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

Waste disposal facilities: Landfills and impoundments, Slurry walls, Types of landfills, 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 conservation: 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, Erosion control with vegetation mats and Silt fences.

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.

Text Book

1. *Geoenvironmental Engineering – principles and applications* by L.N. Reddi and H.F. Inyang, Marcel Dekker, 2000

Reference books

1. *Geotechnical practice for waste disposal* by D.E. Daniel, Chapman and Hall, London 1993
2. *Clay barrier systems for waste disposal facilities* by R.K. Rowe, R.M. Quigley and J.R. Booker, E & FN Spon, London, 1995
3. *Design, construction and monitoring of landfills* by Bagchi, A, John Wiley & Sons, New York 1994
4. *Waste containment systems, Waste stabilization and landfills Design and evaluation* by H.D. Sharma, H. D. and S.P. Lewis, John Wiley & Sons, New York 1994

SMFE3.3 DISSERTATION (Preliminary)

The student shall submit a brief report on the selected topic of his/her thesis work and attend for a formal viva-voce examination before a Committee comprising the Chairman, BOS, Head of the Department and the Guide.

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IV – SEMESTER

SMFE4.1 DISSERTATION (Final)

The student shall submit his/her thesis work and attend for a formal viva-voce examination before a Committee comprising the Chairman, BOS, Head of the Department, the Guide and the External Examiner.