NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

Honors in

Geotechnical Engineering

SCHEME OF INSTRUCTION AND SYLLABI

(for students of B.Tech., Civil Engineering)

(Effective from 2021-22)

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF INSTRUCTION

Honours Program – Geotechnical Engineering

S. No.	Course Code	Name of the Course	L	T	P	Credits	Sem.
1	CE5402	Geotechnical Exploration and Instrumentation	3	0	0	3	V
2	CE5461	Earth Retaining Structures	3	0	0	3	VI
3	CE5463	Environmental Geotechniques	3	0	0	3	VI
4	CE5401	Advanced Soil Mechanics	3	0	0	3	VII
5	CE5416	Geosynthetics Engineering	3	0	0	3	VII
6	CE5453	Soil Dynamics and Machine Foundations	3	0	0	3	VIII
		Total				**18**	

DETAILED SYLLABUS

Honors

Geotechnical Engineering

Course Code: CE5402	GEOTECHNICAL EXPLORATION AND INSTRUMENTATION	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Implement various exploration methods in soil and rock
CO2	Prepare borelog for sub-soil strata
CO3	Apply relevant instrumentation for Geotechnical Engineering works
CO4	Interpret field and laboratory data and prepare soil investigation report

Syllabus:

Introduction: Soil Formation, types of soils, physical and chemical weathering, soil transport, deposition and stratification phenomena and Soil Classification.

Methods of Soil Exploration: Methods of Boring, Auguring and Drilling. Machinery used for drilling, types of augers and their usage for various projects.

Soil Sampling: sampling methods, types of samples, storage of samples and their transport. Sample preparation, sample sizes, types of sampler's specifications for testing.

Borehole Logging: Logging of Boreholes - logging methods - Groundwater observations – Water table fluctuations and effects - Preparation of soil profiles and exploration report.

Field testing of soils: methods and specifications – visual identification tests, standard penetration test (SPT), plate load test (PLT), pressuremeter test (PMT) Dilatometer test (DMT) vane shear test (VST), Cone penetration test (CPT), Becker penetration test (BPT), analysis of test results. Geophysical methods of soil exploration- seismic refraction, electrical resistivity, cross hole test.

Report writing: Soil exploration Reports- identification, calculations and preparation.

Field Instrumentation: Strain gauges, Piezometer, Pressure cells, Inclinometers, proving ring, load cells, displacement gauges.

Learning Resources:

Text Books:

1. Site Investigation, Clayton C. R., Matthews M. C and Simons N. E., Blackwell Science. 2005
2. Geotechnical Instrumentation for Monitoring Field Performance, John Dunn cliff, Wiley-Interscience, 2008
3. Basic and Applied Soil Mechanics- A.S. Rao and Gopal Ranjan, New Age International.

Reference Books:

1. Soil mechanics and Foundation Engineering, Muni Budha, John Wiely and sons, 2010, 3rd Edition.
2. Ground Property Characterization from In-Situ Testing, M. D. Desai, IGS-Surat Chapter, 2005.
3. IS:1892-Code of Practice for subsurface investigation for foundation, 1979.
4. IS:4453-Subsurface Exploration by Pits, Trenches, Drifts and Shafts - Code of Practice, 2009.
5. IS:1888-Method of Load Test on Soils, 1982.
6. IS:2131-Method for Standard Penetration Test for Soils, 1981.

7. IS:10108-Code of practice for sampling of soils by thin wall sampler with stationary piston, 1982.
8. IS:4434-Code of practice for in-situ vane shear test for soils, 1978.
9. IS: SP36 Part 1-Compendium of India Standards on Soil Engineering-Laboratory Testing of Soils for Civil Engineering Purposes, 1987.
10. IS: SP36 Part 2-Compendium of India Standards on Soil Engineering-Field Testing of Soils for Civil Engineering Purposes, 1988.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105039/#

Course Code: CE5461	EARTH RETAINING STRUCTURES	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Calculate earth pressures on various earth retaining structures
CO2	Select suitable retaining structure for different Engineering works
CO3	Design different earth retaining structures
CO4	Appraise state-of-the-art retaining wall structures

Syllabus:

Earth Pressure: Earth pressure at rest, Basic concepts and classical lateral earth pressure theories Rankine's and Coulomb's earth pressure and limitations, graphical methods and their interpretations.

Retaining Walls: types, modes of failure, stability checks, drainage systems, Principles of design, specifications, and pressure distribution variations.

Sheet Pile Walls: use of sheet pile walls, types of sheet piles, design of cantilever sheet pile walls in granular and cohesive soils, design of anchored sheet pile walls by free earth method in granular and cohesive soils, Rowe's moment reduction theory, design of anchored sheet pile wall by fixed earth method, design of anchors-location of anchorage.

Braced Cuts and Coffer Dams: lateral earth pressure on sheeting in sand and clayey soils, types of sheeting and bracing system, design of braced cuts, use of cofferdams, types of coffer dams, merits and demerits, design of coffer dams.

Recent Development in Earth Retaining Structures: Reinforced earth-applications, components, design of reinforced earth wall, Gabian walls- function, application, advantages, crib walls, sail nailed wall.

Learning Resources:

Text Books:

1. Foundation Engineering, B.M. Das, Cengage Learning, 2007.
2. Geotechnical Engineering, Gulhati, Shashi and M. Datta, Mc.Graw Hill Book Company, 2005.
3. Foundation Analysis and Design, J.E. Bowels, McGraw Hill Book Company, 1997.

Reference Books:

1. Earth pressure and Earth–Retaining structure, C.R.I. Clayton, Rick I. Woods and Andrew J. Bond, 2013. Third edition.
2. Basics of Retaining wall design, Hugh books, 2018 11th Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106052/#

Course Code: CE5463	ENVIRONMENTAL GEOTECHNIQUES	Credits 3-0-0: 3

Pre-requisite: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Assess possible reasons for susceptibility of soil properties to Environmental effects
CO2	Identify contaminant transport mechanisms
CO3	Assess chemical interaction effect on Engineering behaviour of soils
CO4	Apply contaminant specific stabilization techniques

Syllabus:

Introduction: Clay water interactions, Causes of soil deterioration, Scope and importance of environmental geotechniques

Ground Contamination: Sources of contamination, chemical diffusion in soils, practical range of flow parameters, simultaneous flow of water, current and salts through a soil, Electrokinetic phenomenon, coupled influences on chemical flow, chemical compatibility and hydraulic conductivity.

Classification of Soil and Susceptibility to Environment: Susceptibility to environment, mineralogy, formation and iso-morphous substitution, Factors affecting surface activity of soils, Ion-exchange and its mechanics, Theories of ion-exchange, clay-organic interactions, Mechanisms controlling the index properties of fine grained soils.

Engineering Properties of Soil due to Changing Environment: Engineering properties and environment, Permeability and its mechanisms, volume change behaviour, Basic mechanisms controlling compressibility, Quasi pre-compression, compression behaviour of saturated Kaolinitic and Montmorillonitic clays with different pore fluids, shear strength Behaviour of Kaolinitic and Montmorillonitic clays with different pore fluids, components of shear strength and their mechanisms

Soil Modification by Environmental Changes: Mitigating acid and alkali contamination in soils by use of additives; effect of lime on sulphate bearing clays; Effect of phosphoric acid, flyash, hydroxy-aluminium and chemicals in clay stabilization.

Learning Resources:

Text Books:

1. Fundamentals of Soil Behavior, James K. Mitchell and Kenichi Soga, John Wiley & Sons, Inc. New York, 3rd Edition, 2014.
2. Environmental Geotechnics, R W Sarsby, Thomas Telford, 2000.

Reference Books:

1. Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Claudio Cameselle, Jeffrey A. Adams, and Krishna R. Reddy. Wiley, 2019.
2. Geo-Environmental Engineering – Principles and Foundations, Laxmi N Reddy, Hilary N Inyang, CRC Press, 1st Edition, 2000.

Online Resources:

1. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-725j-chemicals-in-the-environment-fate-and-transport-fall-2004/

Course Code: CE5401	ADVANCED SOIL MECHANICS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Characterization and stress distribution in soils
CO2	Analyze effective stresses in soils for different field conditions
CO3	Apply three-dimensional consolidation theory for different Geotechnical Applications
CO4	Find state of stresses at different stages of loading through stress paths
CO5	Estimate Pore pressure and Hvorslev shear strength parameters

Syllabus:

Introduction: Mineralogy and soil Water: Origin of soil, Soil mineralogy and structure of clay minerals; classification of soils, Inter-particle forces in soils; Modes of occurrence of water in soils – Absorbed, Adsorbed, Double layer and Capillary water.

Stress distribution: Types of stresses, Estimation of stresses in soils, Isobar and Pressure bulb, Variation of vertical stress under point load along the vertical and horizontal directions, Newmark's Influence Chart

Effective Stress: The principle and nature of effective stress, Inter-granular pressure, Pore pressure, effective stress under different conditions, Effective stress for partially saturated soils, Quick sand phenomenon

Consolidation: Principle of consolidation-compressibility, Difference between compaction and consolidation, pressure-void ratio relationships, Terzaghi's one dimensional consolidation, pre-consolidation pressure, Estimation of total Settlement. Two and three dimensional consolidation, Secondary compression, methods for accelerating the rate of consolidation settlements, Sand and Wick drains.

Shear Strength: Basic concepts, Mohr-Coulomb theory; measurement of shear strength, drainage conditions, stress paths, pore pressure parameters; Shear strength of cohesionless soils – Friction between solid surfaces, Factors affecting strength and deformation, Shear strength of saturated cohesive soils – Effective stress water content relationship, Hvorslev Shear strength parameters; Shear strength of Partially Saturated soils

Learning Resources:

Text Books:

1. Advanced Soil Mechanics, Das, BM, CRC Press, London & New York, 5th Edition, 2020.
2. Soil Mechanics and Foundation Engineering, Murthy V.N.S - CBS publications, New Delhi, 2018
3. Soil Mechanics in Engineering Practice, Karl Terzaghi, Ralph B Peck, and Gholamreza Mesri, 3rd Edition, Wiley, 2009.

Reference Books:

1. Basic and applied soil mechanics, Gopal Ranjan and Rao ASR, New age Publications, Delhi, 3rd Edition, 2016.
2. Foundation Engineering – Geotechnical Principles & Practical applications, Richard L Handy, Mc Graw Hill, New York, 2020.
3. IS 2720 (Part 1 to 41): Methods of tests for Soils.
4. IS 8009: Code of Practice for calculation of Settlement of Foundations, 1976.

Online Resources:

1. https://nptel.ac.in/courses/105/104/105104162/
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-361-advanced-soil-mechanics-fall-2004

Course Code: CE5416	GEOSYNTHETICS ENGINEERING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Select suitable geosynthetic material for the intended purpose
CO2	Evaluate the properties of geosynthetics
CO3	Design the Geosynthetics for Engineering works
CO4	Apply Geocomposite systems to solve contemporary Geotechnical problems

Syllabus:

Introduction: An overview on the development, functions and applications of various geosynthetics - the geotextiles, geogrids, geonets, geomembranes, geocomposites and other products.

Designing with geotextiles: Manufacture of geotextiles, Geotextile properties and test methods – functions - Designing geotextiles for separation, reinforcement, stabilization, filtration and drainage.

Designing with geogrids: Manufacture of geogrids, Types of geogrids, Geogrid properties and test methods – physical properties, mechanical properties, endurance properties and environmental properties – Designing geogrid for reinforcement in pavements, retaining walls and bearing capacity. New generation polymeric strap reinforcing materials.

Designing with geonets: Manufacture of geonets, Geonet properties and test methods – Physical properties, mechanical properties, hydraulic properties, endurance properties and environmental properties -Designing geonet for drainage.

Designing with geomembranes: Geomembrane properties and test methods – physical properties, mechanical properties, chemical properties and biological hazard - Applications of geomembranes and design.

Designing with geocomposites: Geocomposites in seperation, reinforcement – reinforced geotextile composites – reinforced geomembrane composites – reinforced soil composites using discontinuous fibres and meshes, continuous fibres and three –dimensional cells - Designing for bearing capacity, geocomposites in drainage and filtration.

Learning Resources:

Text Books:

1. Fundamentals of Geosynthetics Engineering, Sanjay Kumar Shukla and Jian-Hua Yin, CRC Press, 2017, 1st edition.
2. Designing with geosynthetics, Koerner, R.M., Pearson Education Inc., 2012, 6th edition

Reference Books:

1. Geosynthetics Engineering: in Theory and Practice, Mandal, J.N.,Research Publishing, Singapore, 2018, 1st ed.
2. Reinforced Soil and its Engineering Applications, Swami Saran, I.K. International Publishing House Pvt. Ltd., 2019, 1st edition.
3. Geosynthetic Reinforced Soil (GRS) walls, Jonathan T.H. Wu, Wiley Black Well, 2019, 1st edition.
4. IS:13162-1992; IS:14293 & 94-1995; IS:14324-1995; IS:14714-1999, Geotextiles –

Methods of Tests.
5. IS: 13325-1992: Determination of tensile properties of extruded polymer geogrids using the wide width strip.
6. IS:16352-2020: Testing of HDPE Geomembrane liners.
7. IRC: SP:102-2014: Guidelines for design and construction of reinforced soil walls.

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101143/
2. https://freevideolectures.com › course › 3352 › geosynthetics
3. https://www.swayamprabha.gov.in

Course Code: CE5453	SOIL DYNAMICS AND MACHINE FOUNDATIONS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Apply theory of vibrations to solve dynamic soil problems
CO2	Calculate the dynamic properties of soils using laboratory and field tests
CO3	Analyze and design behavior of a machine foundation resting on the surface, embedded foundation and foundations on piles by elastic half space concept
CO4	Analyze and design vibration isolation systems

Syllabus:

Theory of vibrations: Introduction – Soil behavior under dynamic loads, Vibration of single and two degree freedom system, Vibration of six and multi degree freedom system, Mass spring analogy- Barkan's Theory

Vibration Isolation: Introduction, Active and passive isolation, Methods of vibration isolation

Dynamic Soil Properties: General factors affecting shear modulus, elastic modulus and elastic constants, Field Techniques– Cyclic plate load test, block vibration test, Standard Penetration Test, Seismic bore hole surveys, Laboratory techniques – Resonant column test, Cyclic simple shear and Triaxial compression test Problems

Machine Foundations: General principles of machine foundation design, Types of machines and foundations, General requirements of machine foundation, Permissible amplitudes and stresses

Analysis and Design of Machine foundations: Reciprocating, Impact and Rotary type machines

Learning Resources:

Text Books:

1. Hand Book of Machine Foundation, Sreenivasulu P, and Vidyanathan C V, Tata McGraw Hill, New Delhi, 2017.
2. Soil Dynamics and Earthquake Engineering, Bharath B P, PHI, New Delhi, 2010.
3. Soil Dynamics, Prakash S, McGraw Hill Book Co., New York, 1999.

Reference Books:

1. Principles of Soil Dynamics, Das B M and Ramana G V, Cengage Learning, 2010.
2. Vibrations of Soils and Foundations, Richart F E, Holland J R and Woods R D, 1970.
3. Soil Dynamic and Machine Foundations, Saran S, Galgotia Publications Pvt. Ltd., 2016.
4. IS: 2974 (Part 1)-Code of Practice for Design and Construction of Machine Foundations, Bureau of Indian Standards, New Delhi, 1982.

Resources:

1. https://nptel.ac.in/courses/105/101/105101005/