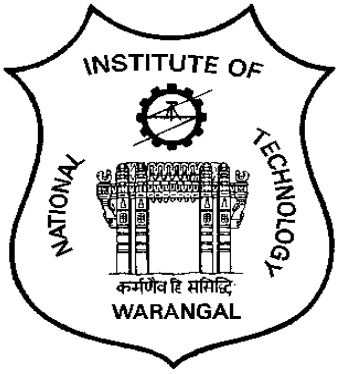
NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL



SCHEME OF INSTRUCTION AND SYLLABI

FOR M.TECH PROGRAM

Effective from 2014-15

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

Department of Civil Engineering

VISION

To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

MISSION

- Generate a specialized cadre of civil engineers by imparting quality education and training
- Attain international standards in teaching, research and consultancy with global linkages.

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Scholarship of Knowledge**: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking**: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving**: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4. **Research Skill**: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools**: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.
8. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

M.TECH IN GEOTECHNICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

PEO1.	Apply knowledge of basic sciences and engineering to analyze geotechnical problems.
PEO2.	Analyze and design geotechnical engineering structures.
PEO3.	Design techno-economic infrastructure in difficult terrains and problematic soils.
PEO4.	Communicate effectively and demonstrate leadership skills. Identify and use local and environmental friendly materials in civil engineering projects.
PEO5.	Engage in team work and lifelong learning for professional advancement

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5
MS1	2	3	3	3	2
MS2	3	2	3	3	3

Mapping of program educational objectives with graduate attributes

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PEO1	3	1	2	1	2	1	-	1	2	-	2
PEO2	3	2	1	1	3	-	-	2	2	1	2
PEO3	3	3	2	3	3	2	1	2	3	1	2
PEO4	3	3	2	3	1	2	-	1	2	1	2
PEO5	3	2	2	1	1	1	1	1	3	-	1

Mapping of program objectives with graduate attributes

PO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PO1	3	1	1	1	3	1	1	3	1	1	-
PO2	3	2	1	1	3	1	-	-	1	2	3
PO3	3	3	3	3	3	2	3	1	3	1	3
PO4	3	2	3	3	2	3	3	3	3	3	3
PO5	3	2	3	3	3	3	2	1	3	1	1
PO6	3	3	3	3	3	3	2	3	3	3	3

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Carry out Geotechnical investigations, testing and analysis for civil infrastructure projects.
PO2	Design and conduct experiments and interpret results
PO3	Analyze and Design foundations and earth structures.
PO4	Identify Engineering solutions to problematic grounds.
PO5	Apply modern geotechniques in building infrastructure facilities.
PO6	Work in inter-disciplinary engineering teams with social responsibility and ethical values and pursue lifelong learning.

Mapping of program outcomes with program educational objectives

PEO	PO1	PO2	PO3	PO4	PO5	PO6
1	3	2	3	3	3	2
2	1	2	3	1	3	3
3	3	2	3	3	3	3
4	2	3	3	3	3	3
5	1	1	2	3	3	3

CURRICULAM COMPONENTS

The total course package M.Tech. Degree program will typically consist of the following components.

a) Core Courses ≥ 30 Credits

b) Elective Courses ≥ 15 Credits

c) Dissertation = 26 Credits

Degree Requirements for M. Tech in Geotechnical Engineering

Category of Courses	Credits Offered	Min. credits to be earned
Program Core Courses (PCC)	34	34
Departmental Elective Courses (DEC)	18	18
Dissertation	26	26
Total	78	78

SCHEME OF INSTRUCTION AND EVALUATION

M.Tech. (Geotechnical Engineering) Course Structure

M. Tech. I - Year I - Semester

Sl. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CE5401	Advanced Soil Mechanics	4	0	0	4	PCC
2	CE5402	Geotechnical Exploration and Instrumentation	4	0	0	4	PCC
3	CE5403	Ground Improvement Methods	4	0	0	4	PCC
4		Elective – I	3	0	0	3	DEC
5		Elective – II	3	0	0	3	DEC
6		Elective – III	3	0	0	3	DEC
7	CE5404	Experimental Geo-techniques Lab	0	0	3	2	PCC
8	CE5405	Computation Laboratory 1	0	0	3	2	PCC
9	CE5441	Seminar – I	0	0	2	1	PCC
		TOTAL	**21**	**0**	**5**	**26**	
			21	**0**	**5**	**26**	

M.Tech. I - Year II - Semester

Sl. No.	Course Code	Course Title	L	T	P	C	Cat. Code
1	CE5451	Rock Mechanics	4	0	0	4	PCC
2	CE5452	Advanced Foundation Engineering	4	0	0	4	PCC
3	CE5453	Soil Dynamics and Machine Foundations	4	0	0	4	PCC
4		Elective – IV	3	0	0	3	DEC
5		Elective – V	3	0	0	3	DEC
6		Elective – VI	3	0	0	3	DEC
7	CE5454	Rock Mechanics Lab	0	0	3	2	PCC
8	CE5455	Computation Laboratory 2	0	0	3	2	PCC
8	CE5491	Seminar – II	0	0	2	1	PCC
		TOTAL	**21**	**0**	**5**	**26**	
			21	**0**	**5**	**26**	

II Year M. Tech. (GTE) I & II – Semesters

Sl. No.	Course Code	Course Title	Credits	Cat. Code
II Year M. Tech. I – Semester				
1		Industrial Training (8-10 weeks) Optional		
2	CE6442	Comprehensive Viva	4	PCC
3	CE6449	Dissertation Part – A	8	PCC
II Year M. Tech. II – Semester				
4	CE6499	Dissertation Part – B	18	PCC

Elective Courses

Sl. No.	Course Code	Course Title	L	T	P	C
	FOR ELECTIVES – I, II, & III					
1	CE5411	Earth & Rock fill Dams	3	0	0	3
2	CE5412	Computational Methods in Geotechnical Engg.	3	0	0	3
3	CE5413	Soil Behavior	3	0	0	3
4	CE5414	Marine Geotechniques	3	0	0	3
5	CE5415	Landfill Engineering	3	0	0	3
6	CE5416	Tunneling Technology	3	0	0	3
7	CE5512	Advanced Surveying and Cartography	3	0	0	3
8	CE5611	Advanced Pavement Materials	3	0	0	3
9	CE5612	Planning and Design of Low Volume Roads	3	0	0	3
10	CE5614	Project Management	3	0	0	3
	FOR ELECTIVES – IV, V & VI					
11	CE5161	Construction Methods and Equipment	3	0	0	3
12	CE5162	Underwater Construction	3	0	0	3
13	CE5364	Climate Change and Sustainable Development	3	0	0	3
14	CE5461	Earth Retaining Structures	3	0	0	3
15	CE5462	Design with Geosynthetics	3	0	0	3
16	CE5463	Earthquake Geotechniques	3	0	0	3
17	CE5464	Environmental Geotechniques	3	0	0	3
18	CE5465	Critical State Soil Mechanics	3	0	0	3
19	CE5466	Offshore Foundations	3	0	0	3

M.Tech (Geotechnical Engineering), I Semester

DETAILED SYLLABUS

CE5401	ADVANCED SOIL MECHANICS	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Analyze effective stress for different field conditions.
CO2	Calculate settlement of soils using one dimensional and three dimensional consolidation theories.
CO3	Estimate shear strength of saturated and partially saturated soils.
CO4	Develop stress path diagrams for different load conditions.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	1	-	-
CO2	3	-	3	3	-	-
CO3	2	-	1	3	-	-
CO4	1	-	2	3	-	-

Detailed syllabus

Effective Stress: The principle of effective stress, Inter-granular pressure, Pore pressure, capillary pressure, problems

Consolidation: Principle of consolidation-compressibility, pressure-void ratio relation ships, Terzaghi's one dimensional consolidation parameters, preconsolidation pressure, Estimation of total Settlement. Two and three dimensional consolidation, radial consolidation, nonlinear consolidation, Secondary compression.

Shear Strength: Basic concepts, Mohr-Coulomb theory; measurement of shear strength, drainage conditions, stress paths, pore pressure parameters.

Strength of Cohesionless Soils: Friction between solid surfaces, Frictional behaviour of minerals, strength of granular soil, Factors affecting strength and deformation, Dilatancy, critical void ratio, Liquefaction.

Strength of Saturated Cohesive Soils: Effective stress-water content relationship, stress history, structure, strain rate, sensitivity, Thixotropy, Hvorslev's strength parameters.

Partially saturated soils: State variables, measurement of pore air and pore water pressure. Strength and deformation characteristics shear strength of soil under plane strain and general stress system. Choice of test conditions and shear parameters.

Reading:

1. K. Terzaghi, "Theoretical Soil Mechanics" - John Wiley & Sons, 1948.
2. R.D. Holtz & W.D. Kovacs, "An Introduction to Geotechnical Engineering" – Prentice – Hall India, 1981.
3. J. K. Mitchel, "Fundamentals of Soil behaviour" - John Wiley & Sons, 1993.
4. T. W. Lambe & R. V. Whitmen, "Soil Mechanics" - Wiley Eastern Ltd.,2000

CE5402	GEOTECHNICAL EXPLORATION AND INSTRUMENTATION	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Prepare borelogs for different soil strata.
CO2	Implement various exploration methods in soil and rock.
CO3	Work with relevant instrumentation required for characterizing the soil and rock with interdisciplinary approach.
CO4	Interpret field and laboratory data and prepare soil investigation report.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	3	2	3	2	-	-
CO3	3	1	1	3	-	3
CO4	3	3	3	3	-	-

Detailed syllabus

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

Soil Exploration: Soil Exploration Programme for different Civil Engineering Projects

Exploration Methods: Methods of Boring, Augering 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 samplers specifications for testing.

Borehole Logging: Logging of Boreholes-logging methods- Ground water observations – water table fluctuations and effects - Preparation of soil profiles - calculations

Field testing of soils: methods and specifications – visual identification tests, vane shear test, penetration tests, analysis of test results.

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

Field Instrumentation: Rollers, Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc.

Reading:

1. J. E. Bowles, “Foundation Analysis and Design”, McGraw Hill Companies, 1997.
2. M. D., Desai, “Ground Property Characterization from In-Situ Testing”, Published by IGS-Surat Chapter,2005.
3. M. J., Hvorslev, “Sub-Surface Exploration and Sampling of Soils for Civil Engineering Purposes”, US Waterways Experiment Station, Vicksburg, 1949.

CE5403	GROUND IMPROVEMENT METHODS	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Identify difficult ground conditions in engineering practice.
CO2	Identify different ground improvement techniques.
CO3	Select Site specific method of improvement and its design.
CO4	Promote wider use of techno – economical construction techniques such as Reinforced soil structures, Gabion walls, Crib walls and fabric form work.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	1	-	-
CO2	1	-	2	3	-	-
CO3	2	-	3	-	2	-
CO4	1	-	2	3	3	2

Detailed syllabus

Introduction to Ground Modification: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement.

Mechanical Modification: Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro-floatation, Blasting, Dynamic consolidation, precompression and compaction piles, Field compaction control.

Hydraulic Modification : Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains, Design of vertical drains.

Physical and chemical modification : Stabilisation with admixtures like cement, lime, calcium chloride, fly ash and bitumen; Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures.

Ground Anchors: Types of ground anchors and their suitability, Uplift capacity of anchors.

Soil Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Sand bags, Evergreen systems and fabric form work.

Miscellaneous Techniques: Expansive Soil Problems and Foundation Techniques, Construction and applications of stone columns in soft clays.

Reading:

1. Robert M. Koerner “Construction and Geotechnical methods in Foundation Engineering”, Mc.Graw-Hill Pub. Co., New York, 1985.
2. Manfred R. Haussmann, “Engineering principles of ground modification”, Pearson Education Inc. New Delhi, 2008.
3. F. G., Bell, “Engineering Treatment of Soils”, E& FN Spon, New York, 2006.
4. P. Purushothama Raj, “ Ground Improvement Techniques” Laxmi Publications (P) Limited, 2006.
5. Jie Han et. al., “Advances in ground Improvement” Allied Pub., 2009.

CE5404	EXPERIMENTAL GEO-TECHNIQUES LAB	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

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

CO1	Determine index and engineering properties.
CO2	Find the critical void ratio of a given sand sample.
CO3	Find the swell properties of expansive clays.
CO4	Conduct standard penetration test, plate load test and pile load test.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	0	1	-
CO2	2	3	2	2	-	-
CO3	1	3	2	3	1	-
CO4	3	3	2	1	1	-

Detailed syllabus

Review of Index properties: Atterberg limits, specific gravity, differential swell tests, determination of density.

Review of Engineering properties: Compaction and California Bearing Ratio (CBR) test; Unconfined compression tests; Permeability test - Constant head and falling head methods

Consolidation and Swell tests : Estimation of settlement, compression index parameter, rate of settlement, coefficient of consolidation, Swell Pressure.

Shear strength tests: Direct Shear Test (Drained for cohesionless and undrained test on Cohesive soil); Triaxial Compression Test - Unconsolidated - Undrained Tests, Consolidated Undrained Tests with Pore pressure measurement, Consolidated Drained Tests.

Field tests: Standard Penetration Test, Plate load Test, Pile Load Test and Large Direct Shear Test

Reading:

1. A. W., Bishop and D. J., Henkel, “Measurement of Soil Properties in Triaxial Test”, Edvard Arnald Ltd., 1962.
2. K. H., Head, “Manual of Soil Laboratory Testing”, CRC Press, 2006.
3. S. Mittal, and J. P. Shukla, “Soil Testing For Engineers”, Khanna Publications, 2003.

CE5405	COMPUTATION LABORATORY 1	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

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

CO1	Process and present the data appropriately using MS EXCEL and ACCESS or open source software's.
CO2	Write programs using MATLAB and apply them for engineering applications.
CO3	Use software SPSS/equivalent open source software for statistical purposes.
CO4	Prepare drawings and detailing for geotechnical structures using AUTOCAD.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	-	-	-
CO2	-	-	2	-	-	-
CO3	1	1	-	-	-	-
CO4	-	-	3	-	-	-

Detailed syllabus

Data processing and graphical presentation using MS EXCEL and ACCESS

Mathematical and statistical packages (MATLAB and SPSS)

Basics of AUTOCAD and CAD

Reading:

1. R. V. Hogg, A. Craig, and J. W., McKean, "Introduction to Mathematical statistics", 6th edition, Pearson Education, 2004.
2. S. P. Washington, M. G. Karlaftis, F. L. Mannering, "Statistical and Econometric Methods for Transportation Data Analysis", 2nd Edition, CRC Press, 2010.

CE5451	ROCK MECHANICS	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Conduct laboratory and field testing for a given project / construction
CO2	Choose appropriate methods to improve stability of rock mass
CO3	Estimate foundation capacity of rock mass.
CO4	Design of tunnel excavation and support systems.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	-
CO2	2	-	1	2	-	-
CO3	3	-	2	1	-	-
CO4	3	1	3	1	-	1

Detailed syllabus

Introduction: Development of rock mechanics, problems of rock mechanics, applications and scope of rock mechanics.

Laboratory Testing : Rock sampling, Determination of density, Porosity and Water absorption, Uniaxial Compressive strength, Determination of elastic parameters, Tensile strength, Shear Strength, Flexural strength, Strength criterion in rocks, Swelling and slake durability, permeability, point load strength, Dynamic methods of testing, Factors affecting strength of rocks.

Rock Mass Classification: Classification by Rock Quality Designation, Rock structure Rating, Geomechanics and NGI classification systems.

In – situ testing : Necessity and Requirements of in – situ tests – Types of in – situ tests – Flat jack Technique – Hydraulic Fracturing Technique, pressure Tunnel Test, Plate Load Test, Shear Strength Test, Radial Jack Test, Goodman Jack Test and Dilatometer Test.

Methods of Improving Rock Mass properties: Rock Reinforcement – Rock bolting – Mechanism of Rock bolting – Principles of design – Types of rock bolts. Pressure grouting – grout curtains and consolidation grouting.

Stability of Rock Slopes: Causes of landslides, Modes of failure, Methods of analysis, Prevention and control of rock slope failure, Instrumentation for Monitoring and Maintenance of Landslides.

Foundations on Rock: Shallow foundations, Pile and well foundations, Basement excavation, Foundation construction, Allowable bearing pressure.

Tunnels: Rock stresses and deformation around tunnels, Rock support interaction, Tunnel driving methods, Design of tunnel lining.

Reading:

1. Central Board of Irrigation and Power - Manual on Rock Mechanics, 1988.
2. R. E. Goodman, “Introduction to Rock Mechanics” John Wiley & Sons, New York, 1989.
3. Wakter Wittke, “Rock Mechanics” Springer Verlag, New York, 1990.
4. Kiyoo Mogi “Experimental Rock Mechanics” Taylor & Francis Group, UK, 2007.
5. T. Ramamurthy, “Engineerng in Rocks for slopes, foundations and tunnels”, PHI Learning Pvt. Limited, 2010.

CE5452	ADVANCED FOUNDATION ENGINEERING	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Select different types of foundations based on site conditions.
CO2	Analyze bearing capacity and settlement of foundations.
CO3	Design shallow and deep foundations.
CO4	Analyze and suggest remedial measures against foundation failures.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	2	-	-
CO2	2	-	3	1	3	-
CO3	-	-	3	1	-	2
CO4	3	-	-	-	-	1

Detailed syllabus

Art of Foundation engineering: Bearing Capacity - Theories of Terzaghi, Meyerhof, Brinch Hansen, Vesic and Skempton, Penetration tests, Plate load tests, Factors; Settlement Analysis - Stresses in soil, Immediate and consolidation settlement, control of excessive settlement

Shallow Foundations: Foundation classification; Choice of foundations; Isolated foundations – individual and combined foundations, Raft foundations - Necessity; Types of rafts; Bearing capacity and settlement of rafts – Beams on elastic foundations

Pile Foundations: Classification and Uses, Carrying capacity of Single pile, Pile load tests, cyclic pile load test, pull out resistance, laterally loaded Piles; Pile groups - Group efficiency, Settlement of single pile and pile groups, Negative skin friction, sharing of loads

Well Foundations: Caissons – Types, advantages and disadvantages, Shapes and component parts, Grip length, Bearing capacity and settlement, Forces acting, Sinking of wells, Rectification of Tilts and Shifts, Lateral stability - Terzaghi's method and IRC method

Design of Shallow and Deep Foundations: Limit state design of reinforced concrete in foundations; Soil pressure for structural design; Conventional structural design of

continuous footings, individual footings – Eccentrically loaded footings; combined footings; Pile foundations - Structural design of piles including pile caps; Design of pile groups.

Foundation Failures - Types and causes of failures, Remedial measures, Shoring and Underpinning.

Reading:

1. J. E. Bowles, “Foundation Analysis & Design”, Mc.Graw Hill Book Co.
2. W. C. Teng, “Foundation Design”, Prentice Hall of India Ltd.
3. Tomlinson, “Foundation Design and Construction”, ELBS, Longman Group Ltd.
4. Winterkorn and Fang, “Foundation Engineering Hand Book”, Van Nostrand Reinhold Co, New York.

CE5453	SOIL DYNAMICS AND MACHINE FOUNDATIONS	PCC	4 – 0 – 0	4 Credits

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

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	-	-	-
CO2	3	2	2	-	-	-
CO3	2	-	3	3	-	-
CO4	3	-	3	1	-	-

Detailed 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 Ttriaxial 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

Foundation of Reciprocating Machines: Dynamic analysis, Design procedure

Foundation of Impact Type Machines: Dynamic analysis, Design procedure

Foundation of Rotary Machines: Dynamic analysis, Design procedure

Reading:

1. Bharath Bhusan Prasad, “Soil Dynamics and Earthquake Engineering”, PHI, New Delhi, 2009.
2. S. Prakash, “Soil Dynamics”, McGraw Hill Book Co., New York, 1999
3. S. Prakash and V. K. Puri, “Analysis and Design of Machine Foundations”, McGraw Hill Book Co., New York, 1993
4. P. Sreenivasulu and C. V. Vidyanathan, “Hand Book of Machine Foundation”, Tata McGraw Hill, New Delhi, 1981

CE5454	ROCK MECHANICS LAB	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

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

CO1	Determine compressive strength of rock specimens
CO2	Find the tensile strength of rock specimens
CO3	Find the durability of rock

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	-	-	-
CO2	3	1	2	-	-	-
CO3	3	1	2	-	-	-

Detailed syllabus

Preparation of rock core samples; Specific Gravity, Porosity and Water Absorption of rock sample.

Fundamental Laboratory tests; Uniaxial, Point load and Brazilian tests - determination of uniaxial compressive strength, Young's Modulus and tensile strength;

Triaxial compression tests

Slake Durability Index

Reading:

1. Central Board of Irrigation and Power, “Manual on Rock Mechanics”, 1988.
2. Mogi, Kiyoo, “Experimental Rock Mechanics”, Taylor & Francis Group, UK, 2007.

CE5455	COMPUTATION LABORATORY 2	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

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

CO1	Work with finite element and finite difference software's PLAXIS-3D, FLAC-3D and other packages.
CO2	Analyse shallow and deep foundations, retaining walls, tunnels under different loading conditions using FEM packages
CO3	Carry out slope stability analysis using analytical and numerical software packages
CO4	Carry out seismic hazard analysis and ground response analysis using CRISIS and EDUSHAKE

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	3	2	-	-
CO2	-	-	3	-	-	-
CO3	2	-	2	-	-	-
CO4	2	-	3	2	2	-

Detailed syllabus

Finite Element Analysis: shallow and deep foundations, slope stability analysis

Retaining walls, reinforced earth structures, tunnelling using geotechnical software packages

Seismic hazard analysis and ground response analysis

Reading:

1. C. S., Desai and J. T., Christian, Numerical Methods in Geotechnical Engineering, Mc. Graw Hill, 1977.
2. D. J., Naylor and G. N., Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., U.K.
3. S. L., Kramer, "Geotechnical Earthquake Engineering", Pearson Education, 2004

CE5411	EARTH AND ROCKFILL DAMS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Select a suitable site, materials and equipment for construction of earth/rockfill dams
CO2	Analyze seepage through a given earth/rockfill dam section and select effective seepage control measures for the prevailing site conditions.
CO3	Analyze stability of slopes and evaluate the failure criteria.
CO4	Design earth and rock fill dams.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	2
CO2	2	-	2	-	-	-
CO3	2	-	3	-	-	-
CO4	1	-	3	-	-	-

Detailed syllabus

INRODUCTION : Classification of dams- Selection of Site-Basic design requirements-Preliminary section.

SEEPAGE THROUGH DAM SECTION AND ITS CONTROL : fundamentals of seepage flow, flow nets, seepage through dam section and foundation, seepage control filters, Impervious core, drainage.

CONTROL OF SEEPAGGE THROUGH FOUNDATIONS: types of foundations trench cutoff, upstream impervious blanket, horizontal drainage blanket , relief wells, drainage trenches, cut-off walls, downstream loading berm.

Foundation treatment: treatment of pervious, impervious and rock foundations, core contact treatment , grouting, foundation excavation.

Stability analysis: critical slip surfaces, test conditions, strength parameters, pore pressures, stability analysis-method of slices, bishops method, Morgenster- price method, jambu method.

Construction of earth dams: construction equipment, procedures for pervious, semi-pervious, impervious and rock fill sections, construction supervision.

Failures and damages of earth dams: nature of failures – piping, settlement cracks, slides, earthquake & miscellaneous damages –case studies.

Rock fill dams: general characteristics, rock fill materials, foundation, construction, deformations, types of dams.

Design of rock fill dams: design of dam section, concrete face and earth core, Nature of failures and damages, case studies.

Reading:

1. Sherard, et.al., “EARTH AND ROCK DAMS”, john wiley inc..1963.
2. H. D. Sharma, “Embankment dams”, Oxford and IBH Publishing Co..1991.
3. Bharath Singh and R. S. Varshney, “engineering for embankment dams” A. A. Balekema publications, 1995.

CE5412	COMPUTATIONAL METHODS IN GEOTECHNICAL ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Solve linear and non-linear equations using numerical techniques.
CO2	Apply finite difference and finite element method for analysing behaviour of geotechnical structures.
CO3	Apply correlation and regression analysis for the geotechnical data.
CO4	Solve problem of consolidation and flow through porous media using numerical technique.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	-	3
CO2	-	-	2	2	-	2
CO3	2	-	-	-	-	1
CO4	-	-	2	2	-	1

Detailed syllabus

Solution of Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods.

Solution of Linear Equations: Jacobi's method, Gauss Seidal method, Successive over relaxation method.

Finite Difference Method: Two point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.

Finite Element Method: Fundamentals, Constitutive finite element models for soils.

Correlation and Regression Analysis: Correlation - Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis.

One-dimensional Consolidation - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation

Flow Through Porous Media - Geotechnical aspects, Numerical methods, Applications and Design analysis, Flow in jointed media.

Risk assessment in Geotechnical Engg. - Probabilistic site characterisation and design of foundations .

Reading:

1. S. Chandrakant., Desai and John T. Christian, “Numerical Methods in Geotechnical Engineering”, Mc. Graw Hill Book Company, 1977.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, “Numerical Methods for Scientific and Engineering computations”, Third edition, New Age International (P) Ltd. Publishers, New Delhi.
3. D.J. Naylor and G.N. Pande, “Finite Elements in Geotechnical Engineering”, Pineridge Press Ltd., UK.
4. Sam Helwany, “Applied soil mechanics”, John Wiley & sons, Inc, USA

CE5413	SOIL BEHAVIOUR	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Recognize the importance of soil mineralogy and mechanisms of formation on engineering behavior of soils
CO2	Identify basic mechanism behind the physical and engineering properties of soils
CO3	Define possible reasons for the observed phenomenon under scientific investigations for solving engineering problems
CO4	Identify soil fabric by direct and indirect measuring methods

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	-	-
CO2	-	2	-	3	-	-
CO3	2	-	-	2	-	3
CO4	2	3	-	2	-	1

Detailed syllabus

Soil formation and mineralogy: Origin of clay minerals, sediment erosion, transport and deposition; clay mineral types and their importance in geotechnical engineering; gravel, sand and silt particles; Determination of soil composition, X-Ray diffraction, Scanning Electron Microscope

Soil fabric and its measurement: Fabrics and fabric elements, contact force characterization, voids and their distribution, pore size distribution analysis, methods of fabric characterization

Clay-water interactions: Mechanisms of soil-water interaction, properties of adsorbed water; clay-water-electrolyte system, diffuse double layer theory; cation exchange, Soil-chemical interactions

Effective, inter-granular and total stress: Principle of effective stress, force distributions in a particulate system, inter-particle forces and inter granular stresses; Water pressures, potentials and water pressure equilibrium in soil; Measurement of pore pressure, inter-granular stress, effective stress for saturated and unsaturated soils

Volume change, shear strength and deformation behaviour: General volume change behaviour of soils, physical interactions, fabric, structure and volume change; General characteristics of strength and deformation, fabric, structure and strength; friction and physical interactions among soil particles

Reading:

1. L. D., Baver, “Soil Physics”, Asia Publishing House, 1960.
2. Malcom D. Bolton, “A Guide to Soil Mechanics”, University Press (India) Pvt. Ltd., 2003.
3. J. K., Mitchell, “Fundamentals of Soil Behavior”, John Wiley & Sons Inc., 1993.
4. Nyle C. Brady and Ray R. Weil, “The Nature and Properties of Soils”, Pearson Education Inc., 2002

CE5414	MARINE GEOTECHNICS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze distribution of marine sediments along the Indian coasts.
CO2	Analyze geotechnical challenges in case of marine sediments.
CO3	Implement in-situ testing procedures for determining the properties of marine clays.
CO4	Analyze behavior of marine soil deposits under repetitive loading conditions.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-
CO2	3	-	2	3	1	-
CO3	3	2	2	1	-	-
CO4	2	-	2	-	-	-

Detailed syllabus

Marine soil deposits: Offshore environment, Offshore structures and foundations, Specific problems related to marine soil deposits, Physical and engineering properties of marine soils

Behaviour of soils subjected to repeated loading: Effect of wave loading on offshore foundations, Behaviour of sands and clays under cyclic loading, Laboratory experiments including repeated loading, Cyclic behaviour of soils based on fundamental theory of mechanics, Approximate engineering methods which can be used for practical cases

Site Investigation in the case of marine soil deposits: Challenges of site investigation in marine environment, Different site investigation techniques, sampling techniques, Geophysical methods, Recent advancements in site investigation and sampling used for marine soil deposits

Foundations in marine soil deposits: Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. cassions, spudcans

Numerical modeling of marine foundations subjected to wave loading: Numerical modeling of cyclic behavior of soils, empirical models, elastic-plastic models, FEM analysis of marine foundations subjected to wave loading

Reading:

1. H. G. Poulos. “Marine Geotechnics”, Unwin Hyman Ltd, London, UK, 1988
2. D. V. Reddy and M. Arockiasamy, “Offshore Structures”, *Volume: 1*, R.E. Kreiger Pub and Co., 1991
3. D. Thomson and D. J. Beasley, “Handbook of Marine Geotechnical Engineering”, US Navy, 2012

CE5415	LANDFILL ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Characterize landfill materials and determine their engineering properties.
CO2	Select suitable sites for constructing landfills.
CO3	Design of suitable liner for landfills.
CO4	Adapt to developments in landfill engineering and monitoring.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	-	-	-
CO2	3	-	-	2	-	-
CO3	-	-	-	3	-	-
CO4	-	-	-	3	1	2

Detailed syllabus

Waste Generation and Disposal: Municipal solid waste (management and handling) rules, hazardous waste (management and handling) rules, biomedical waste handling rules, flyash rules, recycled plastics usage rules, batteries (management and handling) rules.

Waste management: The definition of waste and its classification, Waste treatment technologies including waste incineration and energy from waste, advanced conversion technologies of pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes

Advances in waste recycling and recovery: Technologies to deliver added-value products

Landfill engineering: Management of landfill leachate and the mining of old landfills, Specific waste streams including healthcare wastes, food wastes, mineral and mining wastes, hazardous wastes and producer responsibility wastes

Sustainability and resource efficiency: Consideration for materials flow through the economy, steps towards designing out waste and maximising the value of outputs from waste treatment processes

Interface of waste and resource management: Civil engineering in the context of sustainable waste management in global cities and developing countries.

Reading:

1. D. E. David and R. M. Koerner, “Waste Containment Facilities”, ASCE Press, Allied Pub. Pvt. Ltd., 2007.
2. Manoj Datta, “Waste Disposal in Engineered Landfills”, Narosa Publishing House, New Delhi, 1997.
3. G. V. Rao and R. S. Sasidhar, “Solid Waste Management and Engineered Landfills”, Sai Master Geoenvironmental Services Pvt. Ltd., Hyderabad, 2009.

CE5416	TUNNELLING TECHNOLOGY	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Select specific method of tunnel driving for a given ground condition
CO2	Design tunnel excavation methods.
CO3	Identify possible difficulties in different ground conditions.
CO4	Select suitable tunnel support systems and its design.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	1	-	-
CO2	3	-	3	2	2	2
CO3	3	-	-	3	-	-
CO4	3	-	2	3	2	3

Detailed syllabus

Tunnels in Soils and Rocks: Benefits of tunnelling, Tunnels for different purposes, Site investigation and geophysical methods adopted for tunnelling purposes, Rock rating and classification, Instrumentation on tunnels

Tunnelling methods: Drill and blast method, Tunnel boring machine, NATM, Shield tunnelling, Earth pressure method, Application of compressed air

Tunnel lining and supports: Different types of support measures adopted in tunnelling, Analysis of stresses on the tunnel lining, Design of tunnel lining and support measures

Tunnelling Mechanics: Behaviour of soils and rocks, Stress and deformation fields around tunnels, Analytical equations used and derivations, Stability problems in tunnels

Numerical Analysis of Tunnelling: Finite element analysis of tunnelling process, Constitutive models used, Development of longitudinal displacement curves and ground reaction curves, Ground surface settlement due to tunnelling in soft grounds

Reading:

1. D. Kolymbas, “Tunnelling and Tunnel Mechanics”, A rational approach to tunnelling, Springer, 2005
2. B. Singh and R. K. Goel, “Tunelling through weak rocks”, Elsevier, 2006

CE 5461	EARTH RETAINING STRUCTURES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Calculate earth pressure on various earth retaining structures such as gravity retaining walls, sheet pile, bulkheads, bracing/struts and coffer dams
CO2	Design a relevant earth retaining structure for given soil condition
CO3	Design of sheet pile with and without anchors.
CO4	Analyze earth pressures on shafts, conduits and tunnels

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	2	-	-
CO2	2	-	3	-	-	-
CO3	2	-	3	2	1	-
CO4	3	-	-	3	2	2

Detailed syllabus

Introduction to earth pressure – basic concepts – active, passive and at rest earth pressures

Rankine's and Coulomb's earth pressure theories – concepts and drawbacks – earth pressure models – graphical methods and their interpretations

Types of earth retaining structures – classifications – specifications

Retaining walls – types – Design specifications and pressure distribution variations

Sheet Piles and Bulkheads in Granular and Cohesive Soils - Materials Used for Sheet Piles – Free Earth and Fixed earth Support Methods

Braced Excavations: Arching in Soils - Soil Pressures on Braced Walls and their Design

Coffer Dams, types and their design

Reading:

1. J. E. Bowels, “Foundation Analysis and Design”, Mc Graw Hill Companies, 1997
2. B. M. Das, “Foundation engineering”, Cengage Learning, 2007
3. Gulhati, K. Shashi and M. Datta, “Geotechnical engineering”, Mc.Graw Hill book company, 2005

CE 5462	DESIGN WITH GEOSYNTHETICS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Select different geosynthetics for intended purpose.
CO2	Evaluate properties of geosynthetics.
CO3	Design geosynthetics for intended purpose.
CO4	Apply geocomposite systems to solve contemporary geotechnical problems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	2	3	2
CO2	3	2	1	-	-	-
CO3	-	2	3	2	3	3
CO4	-	-	-	2	2	3

Detailed syllabus

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

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

Designing with geogrids: Geogrid properties and test methods – physical properties, mechanical properties, endurance properties and environmental properties – Designing for grid reinforcement and bearing capacity

Designing with 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 for geomembranes.

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, geocomposites in drainage and filtration

Reading:

1. G. L. Sivakumar Babu, “An Introduction to Soil Reinforcement and Geosynthetics”, University Press, 2005.
2. R. M. Koerner, “Designing with geosynthetics”, Pearson Education Inc., 2005.
3. G. V. Rao, “Geosynthetics – an Introduction”, Sai Master Geoenvironmental Services Pvt. Ltd. Hyderabad, 2011.
4. Shukla, “Fundamentals of Geosynthetic Engg. Imperial College Press, London, 2006

CE 5463	EARTHQUAKE GEOTECHNIQUES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Determine size of earthquake and strong ground motion parameters from a recorded seismogram or accelerogram.
CO2	Carry out deterministic or probabilistic seismic hazard analysis considering the different soil properties and site conditions.
CO3	Apply principles of wave propagation through rocks and soil media to derive transfer functions for ground response analysis.
CO4	Analyze liquefaction susceptibility of a site and determine factor of safety against liquefaction.
CO5	Design earthquake resistant geotechnical structures like shallow and deep foundations, retaining walls, slopes

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	1	2	1
CO2	2	-	2	2	2	1
CO3	-	-	2	1	-	2
CO4	3	-	3	2	2	2
CO5	2	-	3	3	2	2

Detailed syllabus

Seismology and Earthquakes: Siesmic waves and their properties, Interior of earth, Theory of plate tectonics, Plate boundaries, Faults and their properties, Elastic Rebound Theory, Determination of epicenter, Intensity and Magnitude, Magnitude scales

Earthquake Hazards and Evaluation: Strong ground motion parameters, Amplitude, Frequency content, duration, Estimation of ground motion parameters, Deterministic Seismic Hazard Analysis, Probabilistic Seismic Hazard Analysis

Ground Response Analysis: Kinematics of earthquake wave propagationfrom source to site, Dynamic soil properties, One-dimensional ground response analysis, Two and

three-dimensional ground response analysis. Local site effects, Design earthquakes and design spectra

Liquefaction: Concepts of liquefaction, critical state line, steady state line, Factors affecting liquefaction potential, Cyclic shear stress, cyclic stress ratio, laboratory determination of liquefaction potential, cyclic resistance ratio and its determination using field and laboratory experiments, Factor of safety against liquefaction

Earthquake Resistant Design: Shallow and deep foundations, Seismic slope stability, seismic design of retaining walls, Ground improvement for remediation of seismic hazards

Reading:

1. S. L. Kramer, “Geotechnical Earthquake Engineering”, Pearson Education, 2003
2. R. W. Day, “Geotechnical Earthquake Engineering Handbook”, Mc Graw Hill, 2003
3. Kamalesh Kumar, Basic Geotechnical Earthquake Engineering, New age, 2008

CE 5464	ENVIRONMENTAL GEOTECHNIQUES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Consider possible susceptibility of soil properties to environmental effects.
CO2	Identify contaminant transport mechanisms in soils
CO3	Estimate environmental influences on engineering properties of soil to be used in design.
CO4	Apply environmental changes to soil stabilization and landfill engineering

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	-	1
CO2	2	-	-	-	-	-
CO3	3	-	2	2	-	2
CO4	2	-	-	2	-	2

Detailed syllabus

Introduction: Soil-the three-phase system, Clay - the most active soil fraction, 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 isomorphous substitution, Factors affecting surface activity of soils, Ion-exchange and its mechanics, Theories of ion-exchange, clay-organic interactions, Atomic absorption spectroscopy analysis, 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 precompression, 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: Stabilisation of soil by environmental changes, use of additives and their basic mechanisms, effect of lime on sulphate bearing clays, effect of phosphoric acid, use of flyash in soil modification, use of hydroxy-aluminium in clay stabilization, stabilization by chemical transport

Waste Containment: Overview on landfill liners, Siting considerations and geometry, typical cross-sections, grading and leachate removal, case studies

Reading:

1. A. Sridharan, " Engineering Behaviour of Fine Grained Soils" A Fundamental Approach, IGS Annual Lecture – 1991
2. James K. Mitchell, "Fundamentals of Soil Behaviour" John Wiley & Sons, Inc. New York,1993
3. T. S. Ramanatha Ayyar, " Soil Engineering in Relation to Environment " Published by LBS Centre for Science and Technology, Thiruvananthapuram, 2000.
4. R. M. Koerner, "Designing with geosynthetics", Pearson Education Inc., 2005
5. D. E. David, and R. M. Koerner, "Waste Containment Facilities" ASCE Press, Allied Pub. Pvt. Ltd., 2007

CE 5465	CRITICAL STATE SOIL MECHANICS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Demonstrate basic mechanisms behind index properties and tests on soil.
CO2	Relate behaviour of soils subjected to various loading and drainage conditions within unified framework of Critical state soil mechanics.
CO3	Apply theory of elasticity and plasticity to characterize the stress – strain behaviour of soils.
CO4	Formulate basic elasto-plastic model based on Critical State Soil Mechanics (CSSM) like Cam-clay

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	-	3
CO2	-	-	-	-	-	3
CO3	-	-	2	2	2	3
CO4	-	-	-	2	2	3

Detailed syllabus

Soil Behavior: State of stress and strain in soils, Stress and strain paths and invariants, behavior of soils under different laboratory experiments

The Critical state line and the Roscoe surface: Families of undrained tests, Families of drained tests, the critical state line, drained and undrained surfaces, The Roscoe surface

Behavior of Overconsolidated samples: The Hvorslev surface: Behaviour of overconsolidated samples, drained and undrained tests, The Hvorslev surface, complete State Boundary Surface, Volume changes and pore water pressure changes

Behaviour of Sands: The critical state line for sands, Normalized plots, the effect of dilation, Consequences of Taylor's model

Behaviour of Soils before Failure: Elastic and plastic deformations, Plasticity theory, Development of elastic-plastic model based on critical state soil mechanics, The Cam-clay model, The modified Cam-clay model

Reading:

1. J. H. Atkinson and P. L. Bransby, “The mechanics of soils: An introduction to critical state soil mechanics”, McGraw Hill, 1978
2. D. M. Wood, “Soil behaviour and critical state soil mechanics”, Cambridge University Press, 1990
3. B. M. Das, “Fundamental of geotechnical engineering”, Cengage Learning, 2013

CE 5466	OFFSHORE FOUNDATIONS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze index and engineering properties of marine clays.
CO2	Adopt suitable investigation method and sampling techniques for these marine deposits
CO3	Analyze loads on offshore structures and select appropriate foundation for these structures.
CO4	Implement required ground improvement technique for these structures

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	3	2	-	-
CO2	3	-	-	-	-	-
CO3	2	-	3	2	-	-
CO4	2	-	2	3	-	2

Detailed syllabus

Identify and describe key challenges of offshore engineering design; describe the aspects of the marine environment that feed into offshore engineering design

Describe the main components of an offshore site investigation; Interpret selected geotechnical site investigation data

Identify the main types of offshore foundation systems and describe the drivers during foundation design, Perform selected foundation design calculations to illustrate the interplaying mechanisms

Identify key aspects of geotechnical pipeline design and perform selected design calculations to illustrate the interplaying mechanisms, determine the loads acting on the offshore structures

Reading:

1. Ben C. Gerwick, “Construction of Marine and Offshore Structures”, CRC Press, 1999.
2. B. Gou, S. Song, J. Chacko and A. Ghalambor, “Offshore Pipelines”, GPP Publishers, 2006.
3. S. K. Hakrabarti, “Handook of Offshore Engineering”, Elsevier, 2005.
4. M. J. Tomlinson, “Pile Design and Construction”, E and F Spon, 1994

CE5441 & CE5491	Seminar – I & Seminar – II	PCC	0-0-2	1 Credits

Prerequisites: None.

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

CO1	Undertake a critical review of literature on a chosen topic.
CO2	Present topics of relevance to a group of professionals.
CO3	Prepare a technical report.

Mapping of course outcomes with program outcomes

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	2	3
CO2	2	-	-	-	1	1
CO3	2	-	-	-	-	-

Detailed Syllabus:

The student can choose any topic, pertaining to Geotechnical Engineering. Topic should be a relevant and currently researched one. Students are advised to refer articles published in current journals for choosing their seminar topics. Student should review minimum of 5 to 6 research papers relevant to the topic chosen, in addition to standard textbooks, handbooks, etc. Students are required to prepare a seminar report, in the standard format and give presentation to the Seminar Assessment Committee (SAC) in the presence of their classmates.

Reading:

1. Geotechnical Engineering Journals, Conference Proceedings
2. Research Articles / Reports available on Internet

CE6449 & CE6499	**Dissertation Part – A & Dissertation Part – B**	**PCC**	**0-0-0**	**26 Credits (8 + 18)**

Prerequisites: None.

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

CO1	Identify topics in thrust areas of Geotechnical engineering.
CO2	Take up critical review of literature on the chosen topic.
CO3	Carry out independent research work on the topic by experimental / analytical approaches.
CO4	Document and present the results of research work

Mapping of course outcomes with program outcomes

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	2	1	3
CO2	-	-	-	1	3	3
CO3	-	3	2	2	3	3
CO4	2		-	-	-	-

Detailed Syllabus:

Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a topic for his dissertation, based on his/her interest. A student shall be required to submit a dissertation report on the research work carried out by him/her.

Reading:

1. Journal Publications
2. Conference / Seminar Proceedings
3. Handbooks / Research Digests
4. Research articles on internet

CE6442	Comprehensive Viva Voce	PCC	0-0-0	1 Credits

Prerequisites: None.

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

CO1	Assimilate knowledge of different courses studied
CO2	Develop overall comprehension about Geotechnical Engineering
CO3	Analyze real life geotechnical problems with theoretical knowledge learned
CO4	Interpret and articulate solutions to real life geotechnical problems

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2		
CO2	2	2	2	2		
CO3	3	2			2	2
CO4	2	2	2	2	2	2

Detailed Syllabus:

All the subjects studied in I year I semester and II semesters.

Reading:

1. Reading Material of all the courses
2. Case Studies