CURRICULUM & SYLLABI

M.Tech. GEOTECHNICAL ENGINEERING

Effective from AY: 2024-25



DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

WARANGAL, TELANGANA

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Vision and Mission of the Institute
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.

Vision and Mission of the Department
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

Program: M.Tech. Geotechnical Engineering

Program Educational Objectives

PEO-1	Apply knowledge of basic sciences and engineering to analyze geotechnical problems.
PEO-2	Analyze and design geotechnical engineering structures
PEO-3	Design techno-economic infrastructure in difficult terrains and problematic soils.
PEO-4	Communicate effectively and demonstrate leadership skills. Identify and use local and environmentally friendly materials in civil engineering projects.
PEO-5	Engage in teamwork and lifelong learning for professional advancement

Program Articulation Matrix

PEO / Mission Statements	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
Generate a specialized cadre of civil engineers by imparting quality education and training	2	3	3	3	2
Attain international standards in teaching, research and consultancy with global linkages	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Program: M.Tech. Geotechnical Engineering

Program Outcomes

PO-1	Engage in critical thinking and pursue research/ investigations and development to solve practical problems.
PO-2	Communicate effectively on complex engineering activities with the engineering community and with society at large, write and present substantial technical reports
PO-3	Demonstrate higher level of professional skills to tackle multidisciplinary and complex problems related to geotechnical engineering.
PO-4	Demonstrate the ability to analyze and design foundations and earth structures.
PO-5	Demonstrate the ability to identify engineering solutions to problematic grounds.
PO-6	Demonstrate the ability in applying modern Geotechniques for building the state-ofthe-art infrastructure.

CURRICULUM
M.Tech. Geotechnical Engineering

1st Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE56001	Advanced Soil Mechanics	3-1-0	4
2	CE56003	Ground Improvement Methods	3-1-0	4
3	CE56005	Geotechnical Exploration and Instrumentation	3-0-0	3
4	CE570XX	Professional Elective-1	3-0-0	3
5	CE570XX	Professional Elective-2	3-0-0	3
6	CE56007	Experimental Geotechnics Lab	0-1-2	2
7	CE56009	Geotechnical Software Lab	0-1-2	2
			Total Credits	**21**

2nd Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE56002	Advanced Foundation Engineering	3-1-0	4
2	CE56004	Soil Dynamics and Machine Foundations	3-0-0	3
3	CE570XX	Professional Elective-3	3-0-0	3
4	CE570XX	Professional Elective-4	3-0-0	3
5	CE570XX	Professional Elective-5	3-0-0	3
6	CE56006	Rock Testing Lab	0-1-2	2
7	CE56008	Foundations and Geosynthetics Lab	0-1-2	2
8	CE56096	Minor Project	0-0-0	2
			Total Credits	**22**

3rd Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE56089	Seminar and Technical Writing	0-0-0	2
2	CE56091	Summer Internship/Research Experience	0-0-0	2
3	CE56093	Comprehensive viva-voce	0-0-0	2
4	CE56097	Dissertation Part-A	0-0-0	8
			Total Credits	**14**

4th Semester

S.No.	Code	Course Title	L-T-P	Credits
1	CE56098	Dissertation Part-B	0-0-0	12
			Total Credits	**12**

The Overall Credit Structure

Course Category	Credits
Basic Science	0
Engineering Science	0
Humanities and Social Sciences	0
Program Core	54
Professional Elective	15
Open Elective	0
Total Graded Credit Requirement	69

Professional Elective Courses:

Professional Elective-I		
S.No.	**Code**	**Course Title**
1	CE57021	Earth & Rockfill Dams
2	CE57023	Marine Geotechniques
3	CE57025	Landfill Engineering
Professional Elective- II		
4	CE57027	Unsaturated soil mechanics
5	CE57029	Computational Methods in Geotechnical Engineering
6	CE57031	Soil Structure Interaction
Professional Elective-III		
S.No.	**Code**	**Course Title**
1	CE57022	Earth Retaining Structures
2	CE57024	Offshore Foundations
3	CE57026	Geo-environmental Engineering
Professional Elective-IV		
4	CE57028	Rock Mechanics
5	CE57030	Critical State Soil Mechanics
6	CE57032	Soil Behaviour
Professional Elective-V		
7	CE57034	Earthquake Geotechnics
8	CE57036	Geosynthetics Engineering
9	CE57038	Tunneling Technology

SYLLABI

M.Tech. Geotechnical Engineering

1st Semester

CE 56001 **3-1-0 (4)**

Advanced Soil Mechanics

Pre-Requisites: **None**

Course Outcomes:

CO-1	Characterization of soils and stress distribution in soils
CO-2	Analyse effective stresses in soils for different field conditions
CO-3	Apply three-dimensional consolidation theory for different geotechnical applications
CO-4	Find state of stresses at different stages of loading through stress paths
CO-5	Estimate pore pressure and Hvorslev shear strength parameters
CO-6	Analyse of critical state conditions of soils

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	-	2	3	2	1
CO-2	-	-	1	3	1	1
CO-3	-	-	3	3	-	3
CO-4	1	-	2	3	-	2
CO-5	3	2	3	1	2	3
CO-6	2	2	3	1	2	2

Syllabus:

Introduction: Introduction to soils, Deposition and Origin of natural soil, Complexity of soil nature, Soil Structure, Mineralogy and soil Water: 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 pleas, Newmark's Influence Chart

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

Permeability: Flow through Soils: Darcy's law, Hydraulic conductivity of soils, Steady and Transient flows, seepage analysis, Flownets, Critical hydraulic gradient.

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

Critical State Soil Mechanics: Critical state concept and its importance, Parameters relevant to critical state, Analysis of critical state, Critical state for NC and OC soils, Yielding and boundary surfaces.

Learning Resources:

Text Books:

1. Das, BM, Advanced Soil Mechanics, CRC Press, London & NewYork, 2020, 5thEdition.
2. Murthy V.N.S, Soil Mechanics and Foundation Engineering, CBS publications, New Delhi, 2018.

Reference Books:

1. Gopal Ranjan and Rao ASR Basic and applied soil mechanics, , New age Publications, Delhi, 2016, 3rd Edition.
2. Richard L Handy, Foundation Engineering – Geotechnical Principles & Practical applications, Mc Graw Hill, New York, 2020.
3. Karl Terzaghi, Ralph B Peck, and Gholamreza Mesri, Soil Mechanics in Engineering Practice, Wiley, 2009, 3rd Edition.
4. William Lamb and Robert V Whitman, Soil Mechanics, Wiley, 2012.
5. Shashi K Gulhati and Majoj Dutta, Geotechnical Engineering, Mc Graw Hill, New Delhi, 2017.
6. D.M. Wood, Soil Behaviour and Critical State Soil Mechanics, Cambridge University Press, 1994.
7. Malcom Bolton, A guide to Soil Mechanics, University Press, 1991
8. IS 2720 (Part 1 to 41): Methods of tests for Soils.
9. IS 8009: Code of Practice for calculation of Settlement of Foundations, 1976.

Other Suggested Readings:

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

CE 56003 **3-1-0 (4)**

Ground Improvement Methods

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify solutions for difficult ground conditions in engineering practice
CO-2	Comprehend different ground improvement techniques
CO-3	Propose site specific method of improvement and its design
CO-4	Promote wider use of techno–economical construction techniques such as soil nailing and confinement methods.
CO-5	Effective alternate techniques for soft soil problems

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	1	2	2	1	2
CO-2	3	2	1	1	3	2
CO-3	2	3	3	3	3	3
CO-4	2	2	3	3	1	3
CO-5	2	1	2	3	2	2

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, pre-compression and compaction piles, Field compaction control and geomaterial replacement concept.

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, vertical drains.

Admixture Stabilization: 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, soil nailing.

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

Geo-materials Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Geo-bags, Sand bags, Fabric form work.

Alternate Techniques: Expansive Soil problems and Foundation Techniques, Construction and application of stone columns in soft clays

Learning Resources:

Text Books:

1. Manfred R. Haussmann, Engineering principles of ground modification, Pearson Education Inc. New Delhi. 2008.
2. Bell, F.G. E and FN Spon, Engineering Treatment of Soils, New York, 2006.

Reference Books:

1. Jie Han, Principles and Practice of Ground Improvement, John Wiley & Sons, Inc.,2007.
2. Anjan Patel, Geotechnical Investigations and Improvement of Ground Conditions, Woodhead Publishing Series in Civil and Structural Engineering, 2006, 1st Edition.
3. Purushothama Raj P, Ground Improvement Techniques, Laxmi Publications (P) Limited, 2006.
4. Klaus Kirsch and Alan Bell, Ground Improvement, 2004, 3rd Edition.

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/108/105108075/

CE 56005 **3-0-0 (3)**

Geotechnical Exploration and Instrumentation

Pre-Requisites: **None**

Course Outcomes:

CO-1	Implement various exploration methods in soil and rock
CO-2	Prepare bore log for sub-soil strata
CO-3	Apply relevant instrumentation for Geotechnical Engineering works
CO-4	Interpret field and laboratory data and prepare soil investigation report

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	1	1	1	-
CO-2	-	-	-	2	-	-
CO-3	2	-	3	1	1	2
CO-4	1	3	3	3	2	3

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. Clayton C. R., Matthews M. C and Simons N. E., Site Investigation, Blackwell Science. 2005
2. John Dunn cliff, Geotechnical Instrumentation for Monitoring Field Performance, Wiley-Interscience, 2008

Reference Books:

1. Muni Budha, Soil mechanics and Foundation Engineering, John Wiley and sons, 2010, 3rd Edition.
2. M. D. Desai, Ground Property Characterization from In-Situ Testing, IGS-Surat Chapter, 2005.
3. A.S. Rao and Gopal Ranjan, Basic and Applied Soil Mechanics, New Age International.
4. IS:1892-Code of Practice for subsurface investigation for foundation, 1979.
5. IS:4453-Subsurface Exploration by Pits, Trenches, Drifts and Shafts - Code of Practice, 2009.
6. IS:1888-Method of Load Test on Soils, 1982.
7. IS:2131-Method for Standard Penetration Test for Soils, 1981.
8. IS:10108-Code of practice for sampling of soils by thin wall sampler with stationary piston, 1982.
9. IS:4434-Code of practice for in-situ vane shear test for soils, 1978.
10. IS: SP36 Part 1-Compendium of India Standards on Soil Engineering-Laboratory Testing of Soils for Civil Engineering Purposes, 1987.
11. IS: SP36 Part 2-Compendium of India Standards on Soil Engineering-Field Testing of Soils for Civil Engineering Purposes, 1988.

Other Suggested Readings:

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

CE 56007 **0-1-2 (2)**

Experimental Geotechniques Lab

Pre-Requisites: **None**

Course Outcomes:

CO-1	Appraise the index and Engineering properties of soils
CO-2	Determine shear strength parameters under different drainage conditions and find out the critical void ratio of sand
CO-3	Assess the swell parameters of expansive clays
CO-4	Comprehend standard penetration test, plate and pile load tests

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	1	2	–	1	–
CO-2	2	3	2	2	–	–
CO-3	1	3	2	3	1	–
CO-4	3	3	2	1	1	–

Syllabus:

Review of Index properties: Grain Size Distribution, Atterberg limits, specific gravity, differential swell tests, determination of density and Relative Density.

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

Consolidation and Swell tests: Compression index, Coefficient of consolidation, Swell Pressure.

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

Field tests: Standard Penetration Test, Plate load Test, Pile Load Test.

Learning Resources:

Text Books:

1. Braja M Das, Soil Mechanics Laboratory Manual, Oxford University Press, 6th Edition, 2002.
2. S. Mittal, and J. P. Shukla, Soil Testing for Engineers, Khanna Publications, 2014.

Reference Books:

1. K. H., Head, Manual of Soil Laboratory Testing, CRC Press,2006, 3rd Edition, Vol 1 & 2, 2006
2. IS 2720 (Part 1 to 41): Methods of tests for Soils

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/104/105104162/
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1 -322-soil-behaviorspring-2005/

CE 56009 **0-1-2 (2)**

GEOTECHNICAL SOFTWARE LAB

Pre-Requisites: **None**

Course Outcomes:

CO-1	Use LATEX for documentation and Origin for plotting graphs
CO-2	Write programs using MATLAB and apply them for engineering applications
CO-3	Work with PLAXIS-3D and finite difference software and other packages.
CO-4	Carryout slope stability analysis using analytical and numerical software packages

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	1	3	-	2	-
CO-2	3	2	3	1	1	-
CO-3	1	3	2	2	1	-
CO-4	3	3	1	1	1	1

Syllabus:

Data processing and graphical presentation of particle size distribution, Consolidation, Direct Shear and Triaxial test, Unconfined compression test, Bearing Capacity, Atterberg limits using ORIGIN

Documentation using LATEX: Keywords, syntaxes, plotting graphs, curves, tables and other features

Mathematical and statistical packages: Basic functions and programs, analysis of Seepage in soils, Laterally loaded piles in MATLAB

Finite Element Analysis: Analysis of Shallow and Deep foundations using PLAXIS; Two-dimensional slope stability analysis under seepage and sudden drawdown conditions using GeoStudio

Learning Resources:

Text Books:

1. Washington S P, Karlaftis M G, Mannering F L, Statistical and Econometric Methods for Transportation Data Analysis, CRC Press, 2010, 2nd edition.
2. Naylor D J and Pande G N, Finite Elements in Geotechnical Engineering, Pineridge Press Ltd., U.K., 1981

Reference Books:

1. C S Desai and J T Christian, Numerical Methods in Geotechnical Engineering, Mc. Graw Hill, 1977
2. Mathews J H and Fink K D., Numerical Methods Using Matlab, Prentice Hall of India, 2005
3. Alexander M Puzrin, Constitutive Modelling in Geomechanics, Springer, 2012
4. David M Potts and Lidija Zdravkovic, Finite element analysis in geotechnical engineering, Thomas Telford, 2001

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/104/105104162/
2. https://communities.bentley.com/products/geotech-analysis/w/plaxis-soilvision-wiki/45573/plaxis-3d-tutorial-01-foundation-in-overconsolidated-clay

2nd Semester

CE56002 **3-1-0 (4)**

Advanced Foundation Engineering

Pre-Requisites: **CE56001**

Course Outcomes:

CO-1	Select different types of foundations based on site conditions.
CO-2	Analyze bearing capacity and settlement of foundations.
CO-3	Design shallow and deep foundations.
CO-4	Analyze and suggest remedial measures against foundation failures.
CO-5	Select special foundations for the problematic soils

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	1	2	2	2	1
CO-2	1	-	2	2	2	2
CO-3	-	-	2	3	2	2
CO-4	2	2	3	2	3	1
CO-5	1	1	2	3	2	1

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, Calculation of settlement and bearing capacity for different ground conditions, control of excessive settlements

Foundations: Foundation classification; Choice of foundations; Shallow Foundations - Isolated (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: Soil pressure for structural design; Bending moment and shear force calculations, Conventional structural design of continuous footings, individual footings – Eccentrically loaded footings; combined footings; Pile foundations - Structural design of pile foundations including pile caps; Design of pile groups.

Foundation Failures – Construction aspects of foundations, Types and causes of failures, Remedial measures, Shoring and Underpinning, Ground water lowering and drainage, Legal aspects of foundation engineering, Field tests in foundation engineering including instrumentation for monitoring of foundations; Case Histories related to settlement of Structures, lateral movement, backfill settlements, causes due to soil types such as collapsible soil, expansive soil, soluble soils, slope Failures and landslides, debris flow, trench collapses, failures in soil reinforcement and geosynthetics.

Special Foundations: Foundations for offshore structures, buried structures, Earthquake prone structures; Foundations on problematic soils like expansive soils, Polluted soils etc.

Learning Resources:

Text Books:

1. Braja M Das, Principles of Foundation Engineering, Cengage Learning, Inc, 9th Edition.
2. Bowles J. E., Foundation Analysis & Design, Mc.Graw Hill Book Co.,2017.

Reference Books:

1. Donald P Coduto, Foundation Design: Principles and Practices, Pearson Education India, 2014.
2. R. Salgado, The engineering of Foundations, Mc Graw Hill, 2006
3. Teng W. C., "Foundation Design", Prentice Hall of India Ltd., 1962
4. Tomlinson, "Foundation Design and Construction", Pearson Publications, 2001
5. Satyendra Mittal, “Pile foundation design and construction”, 2nd Edition, CBS Publishers & Distributors Pvt. Ltd., 2017
6. Winterkorn H. F., and Fang H., "Foundation Engineering Hand Book", Van Nostrand Reinhold Co, New York, 1975
7. An-Bin Huang and Hai-Sui Yu., Foundation Engineering Analysis and Design, CRC Press, Taylor and Francis group,2018, 1st Edition.
8. Gopal Ranjan and Rao ASR, Basic and applied soil mechanics, New Age Publications, Delhi, 2016, 3rd Edition.
9. IS 6403-1981 (Reaffirmed 2002): Code of Practice for determination of Bearing Capacity of Shallow Foundations
10. IS 1080-1985 (Reaffirmed 2002): Code of Practice of Shallow Foundations in Soils

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/104/105104162/
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-364-advancedgeotechnical-engineering-fall-2003

CE 56004 **3-0-0 (3)**

Soil Dynamics and Machine Foundations

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply theory of vibrations to solve dynamic problems
CO-2	Determine the dynamic properties of soils using laboratory and field tests
CO-3	Design the reciprocating and rotating machine foundations
CO-4	Design various vibration isolation systems

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	–	–	1	2	–	1
CO-2	1	1	1	3	1	2
CO-3	–	–	3	2	2	3
CO-4	1	–	3	3	3	3

Syllabus:

Theory of Vibrations: Basics of dynamic system; Types of dynamic loads and solutions; Simple harmonic motion; Free vibration of single degree of freedom systems; Logarithmic decrement; Forced vibration of single degree of freedom under frequency dependent and frequency independent loading; Transmissibility; Bandwidth method; Vibration measuring instruments; Forced vibration of two-degree freedom system.

Dynamic Soil Properties: Elastic constants of soil; Damping of soil; General factors affecting shear modulus and damping; Field tests- cyclic plate load test, block vibration test, standard penetration test, seismic bore hole surveys, Wave propagation tests; Laboratory tests- resonant column test, cyclic simple shear test, cyclic torsional shear test, cyclic triaxial test.

Machine Foundations: General principles of machine foundation design, Types of machines and foundations, General design requirements of machine foundation with codal provisions, Modes of vibration; Design of block foundations under reciprocating and rotating machines- elastic half-space method, linear elastic weightless spring method.

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

Learning Resources:

Text Books:

1. S Prakash and V K Puri, Foundations for Machines: Analysis and Design, Wiley, 1988
2. S Saran, Soil Dynamics and Machine Foundations, Galgotia Publications Pvt Ltd, 1999

Reference Books:

1. B M Das and G V Ramana, Principles of Soil Dynamics, Cengage Engineering, 2014
2. B B Prasad, Fundamentals of Soil Dynamics and Earthquake Engineering, PHI, 2013

Other Suggested Readings:

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

CE 56006 **0-1-2 (2)**

Rock Testing Lab

Pre-Requisites: **None**

Course Outcomes:

CO-1	Determine the physical and engineering properties of rock specimens
CO-2	Find the elastic constants of rock specimens
CO-3	Asses the durability and permeability of rock specimens
CO-4	Determine the shear strength parameters of rock specimens

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	–	–	3	3	3
CO-2	–	–	–	3	3	3
CO-3	–	–	–	3	3	3
CO-4	–	–	–	3	3	3

Syllabus:

Preparation of rock core samples: RQD, Rock core recovery, 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 test,permeability test, Slake Durability Index.

Learning Resources:

Text Books:

1. Mogi, Kiyoo, Experimental Rock Mechanics, Taylor & Francis Group, UK, 2007.
2. Zhang Lianyang, Engineering Properties of Rocks, Elsevier, 2005.

Reference Books:

1. Manual on Rock Mechanics, Central Board of Irrigation and Power,2004.
2. Vutukuri, V.S., Lama, R.D. and Saluja, S.S., Handbook on Mechanical Properties of Rocks, Trans Tech. Publications,1974.
3. Ulusay, R., ISRM suggested methods for testing or measuring properties of rocks and rock masses: 2007-2014.
4. IS 10050: 1981(Reaffirmation 2021), Method for determination of slake durability index of rocks.
5. IS 10082: 1981(Reaffirmation 2021), Method of test for determination of tensile strength by indirect tests on rock specimens.
6. IS 12634: 1989(Reaffirmation 2021), Method of Determination for Direct Shear Strength of Rock Joints.
7. IS 13030: 1991(Reaffirmation 2021), Method of test for laboratory determination of water content, porosity, density and related properties of rock material.
8. IS 13047: 1991(Reaffirmation 2021), Method for determination of strength of rock materials in triaxial compression.
9. IS 13946: Part 1: 1994 (Reaffirmation 2021), Determination of rock stress- Code of practice: Part 1 Using hydraulic fracturing technique.

10. IS 9221: 1979 (Reaffirmation 2021), Method for the determination of modulus of elasticity
11. IS 9143: 1979 (Reaffirmation 2021), Method for the determination of unconfined compressive strength of rock materials.
12. IS 8764: 1998(Reaffirmation 2021), Method for determination of point load strength index of rocks.
13. IS 7317: 2020(Reaffirmation 2021), Uniaxial Jacking Test for Deformation Modulus of Rock Mass-Code of Practice.
14. IS 7746: 1991(Reaffirmation 2021), in-situ shear test on rock mass code of practice

Other Suggested Readings:

1. https://www.youtube.com/watch?v=y_b-35fFCcc

CE 56008 **0-1-2 (2)**

GEOSYNTHETICS AND FOUNDATION ENGINEERING LAB

Pre-Requisites: **None**

Course Outcomes:

CO-1	Understanding and Identification of Geosynthetics
CO-2	Apply various testing methods to assess the tensile strength and interfacial frictional characteristics
CO-3	Evaluating the permeability and mechanical properties
CO-4	Analyze the Dynamic properties of soil

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	1	2	-	1	-
CO-2	2	3	3	2	-	-
CO-3	1	3	2	2	1	-
CO-4	3	3	1	1	1	1

Syllabus:

Categorizing Geosynthetics: Introduction; Types of Geosynthetics; Functions; Mass per unit area, thickness, specific gravity of Geotextiles, Geogrids and Geomembranes

Review of Tensile Properties: Determination of Grab, trapezoidal tear and wide width tensile strengths of geotextiles, Tensile strength of Geogrids and Geomembranes, Determination of Interfacial frictional characteristics of Geotextiles with Fill material.

Insights on Permeability Properties: Determination of in plane and cross plane permeability of geotextiles.

Other Mechanical Properties Evaluation: Determination of Puncture Resistance of geotextiles, A.O.S of geotextiles, Cone Drop Test on geotextiles

Dynamic Behavior of Soils: Dynamic properties of soil by Bi-Axial Shake Table and Cyclic Triaxial Test.

Learning Resources:

Text Books:

1. G. Venkatappa Rao, Goutam Kumar Pothal, Anil Dixit, Geosynthetics Testing and Evaluation - a Laboratory Manual, International Geosynthetics Society, 2019.
2. Sanjay Kumar Shukla, Jian-Hua Yin, Fundamentals of Geosynthetic Engineering by CRC Press.

Reference Books:

1. Robert M. Koerner, Designing with Geosynthetics, Prentice Hall, New Jersey, UAS,1989
2. Relevant ASTM Standards

Other Suggested Readings:

1. https://archive.nptel.ac.in/courses/105/101/105101176/

CE56096 **0-0-0 (2)**

Minor Project

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply engineering principles to real-world projects
CO-2	Plan and monitor project tasks individually or as a team
CO-3	Demonstrate practical experience in project execution
CO-4	Communicate project findings clearly through reports and presentations

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	3	3	-
CO-2	2	2	2	2	2	-
CO-3	2	2	2	2	2	-
CO-4	1	1	1	1	1	-

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Identification of Problem Domain	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Study of Existing Systems and establishing clear objectives	
III	Planning of project and work distribution within the team	
IV	Proper Documentation and Technical Writing	
V	Presentation and Response to questions	

Evaluation Criteria-CO Mapping

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II	X			
III		X	X	
IV				X
V				X

Professional Electives – I, II

CE 57021 **3-0-0 (3)**

Earth & Rockfill Dams

Pre-Requisites: **None**

Course Outcomes:

CO-1	Design of the various earth and rock fill dam components like freeboard, top width etc.
CO-2	Analyses the seepage of the earth dams and design of the filters
CO-3	Analyses and design the slope of the earth and rock fill dams
CO-4	Provide remedies for maintenance of the dams against various types of failures

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	1	-	3	2	2
CO-2	-	-	-	2	-	2
CO-3	-	-	1	2	-	3
CO-4	-	-	1	1	-	3

Syllabus:

Introduction: Classification of dams; Site selection; Preliminary section; Types of earth and rockfill dams.

Failures and Damages of Earth Dams: Nature of failures – hydraulic, seepage and structural failures; piping; settlement; slides; earthquake & miscellaneous damages; case studies.

Design and Construction of Earth Dam Components: Basic design requirements; Free board design; Top width design: Slope erosion protection; Construction of earth dams- soil types, methods, equipment.

Seepage: Fundamentals of seepage flow- Darcy's law and Laplace's equation; Flow nets and its use; Phreatic line determination; Seepage control through dam section- İmpervious core, drains, filters; Design of filters; Seepage control through dam foundation- various impervious cut offs, upstream blanket, relief wells, drainage trenches, downstream loading berm; Sand boiling.

Slope Stability: Fundamentals of slope failures; Types; Critical slip surfaces, Determination of critical slip circle; Factor of Safety; Strength parameters; Pore pressure consideration at slope; Taylor's stability charts; Ordinary method of slices; Bishop's method; Janbu's method; Morgenstern method.

Rock Fill Dams: General characteristics and components; Rockfill materials; Construction; Design.

Learning Resources:

Text Books:

1. B Singh, R S Varshney, Embankment Dam Engineering, Nem Chand & Bros, 2004
2. H D Sharma, Embankment Dams, Oxford & IBH Publishing Company, 1991

Reference Books:

1. S K Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2003
2. C Kutzner, Earth and Rockfill Dams: Principles for Design and Construction, Routledge, 1997
3. https://nptel.ac.in/courses/105105110

CE 57023 **3-0-0 (3)**

Marine Geotechniques

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify the marine soil deposits along the coast lines
CO-2	Comprehend Geotechnical challenges of marine sediments
CO-3	Select suitable marine foundations for offshore structures
CO-4	Analyze behaviour of marine soil deposits under cyclic loading conditions

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	-	-	1	-
CO-2	2	2	2	3	2	2
CO-3	-	-	2	2	-	2
CO-4	1	3	3	3	2	3

Syllabus:

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

Behavior of Soils Subjected to Repeated Loading: Effect of wave loading on offshore foundations, Behavior of sands and clays under cyclic loading, Laboratory experiments including repeated loading, Cyclic behavior of soils based on fundamental theory of mechanics, Approximate engineering methods which can be used for practical cases

Site Investigation of Marine Soil Deposits: Challenges of site investigation in marine environment, Different site investigation techniques, sampling techniques, Recent advancements in site investigation and sampling used for marine soil deposits

Foundations in Marine Soil Deposits: Embankments in soft soils, Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. caissons, 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

Learning Resources:

Text Books:

1. Randolph M. and Susan G., Offshore Geotechnical Engineering, CRC Press, 2017, 1st Edition.
2. Thompson D. and Beasley D. J., Handbook of Marine Geotechnical Engineering, Military Bookshop; 2012, Illustrated edition.

Reference Books:

1. Robert. M. Koerner., Handbook of Marine Geotechnical Engineering, Xlibris, 2012, 6th Edition
2. Military Soils Engineering: The Official U.S. Army / U.S. Marine Corps Technical Manual TM 3-34.6 / McRp 3-17.7g, 2012.

3. Mark R. and Susan G., Offshore Geotechnical Engineering, CRC Press, 2011, 1st Edition.

Other Suggested Readings:

1. https://nptel.ac.in/courses/114/106/114106042/
2. https://nptel.ac.in/courses/114/106/114106011/
3. https://nptel.ac.in/courses/114/106/114106032/
4. https://nptel.ac.in/courses/114/106/114106035/
5. https://nptel.ac.in/courses/114/105/114105002/
6. https://nptel.ac.in/courses/114/106/114106015/
7. https://nptel.ac.in/courses/105/106/105106053/
8. https://nptel.ac.in/courses/105/105/105105170/

CE57025 **3-0-0 (3)**

Landfill Engineering

Pre-Requisites: **None**

Course Outcomes:

CO-1	Characterize the landfill materials and determine landfill properties
CO-2	Select suitable sites for constructing landfills
CO-3	Design of suitable liner and cover systems
CO-4	Adopt developments in landfill Engineering and monitoring

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	–	–	–	–	–
CO-2	3	–	–	2	–	–
CO-3	–	–	–	3	–	–
CO-4	–	–	–	3	1	2

Syllabus:

Geotechnical Characterization of Landfills: Physical Characterization of landfill material (Size distribution, Porosity, Moisture content, Field capacity, Wilting point, Unit weight, Hydraulic conductivity, Shear strength, Compressibility), Dynamic Properties; Landfill regulations (USEPA, RCRA).

Landfill configurations: Landfill siting methodology; liner systems and properties; Recommended Design Procedure; Geomembranes, Geosynthetic Clay Liners (GCL's); Soil Drainage Layer and various materials used for providing drainage, Interface effect among various liner components; Liner system performance, estimation of leakage, Rate of flow through composite liner.

Stability of Landfills Slopes: Sliding Failure of Leachate Collection System and Final Cover System; Rotational Failure of Landfill Waste, Liner, and Subsoil; Translational Failure along the Liner System; Two Part Wedge Failure Mechanism; Vertical expansion of MSW landfills,

Geosynthetics for Reinforcement, Three Part Wedge Failure Mechanism, Stability under seismic conditions.

Analysis and Design of Veneer Cover Soils: Seismic Analysis of Veneer Cover Soil, Geosynthetic Reinforced Veneer Slopes, Seepage Induced Veneer Slope Instability: Horizontal seepage build-up and Parallel-to-slope seepage build-up.

Hydraulic and Structural Design Criteria for Drainage Layer Material, stresses due to liner selfweight, temperature, expansion and contraction. Anchor Trenches; Design of Final Cover Systems; Alternate Cover Systems and Materials. End Uses of Closed Landfills, Typical Landfill failures and mitigation measures.

Learning Resources:

Text Books:

1. Rao, G. V. and Sasidhar, R. S., Solid Waste Management and Engineered Landfills, Sai Master Geo environmental Services Pvt. Ltd., Hyderabad, 2009.
2. Xuede Qian, Robert M. Koerner, Donald H. Gray, Geotechnical Aspects of Landfill Design and Construction, Prentice Hall, 2002.

Reference Books:

1. Claudio Cameselle, Jeffrey A. Adams, and Krishna R. Reddy, Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Wiley, 2019.
2. Hari D Sharma, Krishna R Reddy, Geoenvironmental Engineering, Published by John Wiley, NY, 2004.
3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, New Delhi, 1997

Other Suggested Readings:

1. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1 -34-waste-containmentand-remediation-technology-spring-2004/lecture-notes/
2. https://onlinecourses.nptel.ac.in/noc21_ce57/preview
3. https://www.epa.gov/landfills

CE 57027 **3-0-0 (3)**

UNSATURATED SOIL MECHANICS

Pre-Requisites: **None**

Course Outcomes:

CO-1	Interpret the Soil Water Characteristic Curve
CO-2	Comprehend the unsaturated flow
CO-3	Analyze the stress state variables
CO-4	Apply the unsaturated strength behaviour to Engineering structures

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	1	1	1	1
CO-2	2	2	2	2	1	1
CO-3	2	1	2	1	1	1
CO-4	2	1	2	2	1	1

Syllabus:

Introduction: Unsaturated soil, Gravimetric and Volumetric water content, Pore water pressure, Matric and Osmotic suction, Soil Water Characteristic Curve (SWCC), Hysteresis in SWCC, Methods to determine SWCC

Seepage in unsaturated soil: Permeability and Hydraulic Conductivity, Hydraulic Conductivity Function (HCF), One-dimensional steady state flow, Darcy's and Gardner's Principles, Transient Flow, Infiltration, Numerical Modelling, Capillary Barriers.

Strength characteristics of unsaturated soil: Extended Mohr Coulomb's criterion, Shear strength and pore pressure parameters, Measurements of unsaturated shear strength parameters; Unsaturated shear strength models, Applications in Bearing Capacity, Lateral Earth Pressure, and Slope stability in Unsaturated soils

Volume Change behavior of soils: Stress state variables for unsaturated soils, StressDeformation Behavior, Volumetric continuity, Volume-Mass Constitutive Relations, Swelling and Collapse behavior.

Learning Resources:

Text Books:

1. Murray E. J. and Shivakumar V., Unsaturated Soils: A fundamental interpretation of soil behaviour, Wiley-Blackwell, 2010, 1st edition.
2. Ning Lu and William J. Likos, Unsaturated Soil Mechanics, John Wiley & Sons Inc., 2004

Reference Books:

1. Charles W. W. Ng, and Menzies B., Advanced Unsaturated Soil Mechanics and Engineering, CRC Press, 2007, 1 st edition (Reprint 2019)
2. Fredlund D. G. and Rahardjo H., Soil Mechanics for Unsaturated Soils, John Wiley & Sons Inc., 1993, 1st edition
3. https://nptel.ac.in/courses/105/103/105103139/
4. https://nptel.ac.in/courses/105/101/105101200/

CE 57029 **3-0-0 (3)**

Computational Methods in Geotechnical Engineering

Pre-Requisites: **None**

Course Outcomes:

CO-1	Solve linear and non-linear equations using numerical techniques.
CO-2	Apply the basic concepts of tensor algebra and calculus in continuum mechanics problems.
CO-3	Analyze the behaviour of geotechnical structures using finite difference and finite element methods.
CO-4	Apply the constitutive modeling in Geomechanics.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	-	-	-	3
CO-2	-	-	2	2	-	2
CO-3	2	-	-	-	-	1
CO-4	-	-	2	2	-	1

Syllabus:

Solution of Non-linear and Linear Equations: Bisection, False Position, Newton-Raphson, Jacobi's method, Gauss Seidel method

Solution of ODE using numerical techniques: Initial value problems and boundary value problems; Taylor series method, Picard's method, Euler's method, Runge-Kutta method

Finite Difference Method: Boundary value and Initial value problems - Dirichlet conditions, Neumann conditions; Ordinary and partial differential equations; Non-linear problems

Introduction to Finite Element Method: Formulation of weak form, interpolation functions

Constitutive modelling of soil: Critical state soil mechanics: Elastic-plastic constitutive models; Cam

Learning Resources:

Text Books:

1. Jain M K, Iyengar SRK and Jain R K,Numerical Methods for Scientific and Engineering computations, New Age International (P) Ltd. Publishers, New Delhi, 2012, 3rd edition.
2. Naylor D J and Pande G N, Finite Elements in Geotechnical Engineering, Pineridge Press Ltd., UK, 1981.

Reference Books:

1. C S Desai and JT Christian, Mc Numerical Methods in Geotechnical Engineering. Graw Hill, 1977.
2. Y. M. Cheng, J. H. Wang, Li Liang, W. H. Fung, W. H. Fung Ivan, Numerical Methods and Implementation in Geotechnical Engineering, 2020.

CE 57031 **3-0-0 (3)**

Soil Structure Interaction

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify the suitable method for the analysis of pile foundations.
CO-2	Perform the soil-pile interaction analysis for varying pile configurations
CO-3	Apply elastic analysis principles for design of pile foundations
CO-4	Analyze laterally loaded pile considering the effect of soil-pile interaction.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	-	-	-	3
CO-2	-	-	2	2	-	2
CO-3	2	-	-	-	-	1
CO-4	-	-	2	2	-	1

Syllabus:

Introduction: Soil Foundation interaction problems, Soil behaviour, Foundation behaviour, Interface, behaviour, Scope of soil-foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.

Beam on Elastic Foundation - Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

Plate on Elastic Medium: Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of rectangular and circular plates, Numerical analysis of finite plates, simple solutions.

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, and pile raft system, solutions through influence charts. 6260434649

Learning Resources:

Text Books:

1. Richard L Handy, Foundation Engineering Geotechnical Principles & Practical applications, Mc Graw Hill, New York, 2020.
2. Desai C.S. and Christain J.T., Numerical Methods in Geotechnical Engineering, McGraw Hill Book Co., New York, 2014.

Reference Books:

1. Woodward, J. and Tomlinson, M., Pile Design and Construction Practice, Chapman & Hall, 1994.
2. Poulos, H.G. and Davis, E.H., Pile Foundation Analysis and Design, John Wiley & Sons, 1980.
3. Bowels J.E, Analytical and Computer Methods in Foundation, McGraw Hill Book Co., New York, 1974.
4. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978.

Professional Electives - III, IV, V

CE 57022 **3-0-0 (3)**

Earth Retaining Structures

Pre-Requisites: **None**

Course Outcomes:

CO-1	Calculate earth pressures on various earth retaining structures
CO-2	Select suitable retaining structure for different Engineering works
CO-3	Design different earth retaining structures
CO-4	Appraise state-of-the-art retaining wall structures

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	-	-	1	2	2	1
CO-2	2	2	2	3	2	1
CO-3	1	-	3	3	1	3
CO-4	-	-	1	3	3	2

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: uses and 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. B.M. Das, Foundation Engineering, Cengage Learning, 2007.
2. Gulhati, Shashi and M. Datta, Geotechnical Engineering, Mc.Graw Hill Book Company, 2005.

Reference Books:

1. J.E. Bowels, Foundation Analysis and Design, McGraw Hill Book Company, 1997.
2. C.R.I. Clayton, R. I. Woods and A. J. Bond, Earth pressure and Earth Retaining structure, 2013. 3rd edition
3. Basics of Retaining wall design, Hugh books, 2018 11th Edition.
4. https://nptel.ac.in/courses/105/106/105106052/#

CE 57024 **3-0-0 (3)**

Offshore Foundations

Pre-Requisites: **None**

Course Outcomes:

CO-1	Comprehend the different types of marine foundations
CO-2	Adopt suitable Geotechnical investigations for marine deposits
CO-3	Analyse loads on offshore structures and select appropriate foundation
CO-4	Propose suitable ground improvement techniques for marine deposits

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	–	3	2	–	2
CO-2	3	–	3	1	–	2
CO-3	2	–	3	3	–	3
CO-4	2	–	3	3	–	3

Syllabus:

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

Offshore site-investigation: Describe the main components of an offshore site investigation; Interpret selected geotechnical site investigation data.

Offshore foundation systems: Identify the main types of offshore foundation systems and describe the drivers during foundation design, Perform selected foundation design techniques.

Offshore foundation design: Off-shore ground improvement technics, identify key aspects of geotechnical offshore pipeline design, determine the loads acting on the offshore structures

Learning Resources:

Text Books:

1. Srinivasan Chandrasekaran, Advanced Marine Structures, CRC Press, 2015.
2. Md. El-Reedy, Offshore structures, Design, Construction, and Maintenance, 2012, 1st Edition

Reference Books:

1. Gou B., Song S., Chacko J. and Ghalambor A., Offshore Pipelines, GPP Publishers, 2006.
2. Hakrabarti S.K., Handbook of Offshore Engineering, Elsevier, 2005.
3. Ben C. Gerwick, Construction of Marine and Offshore Structures, CRC Press, 1999, 1st Edition

Other Suggested Readings:

1. https://nptel.ac.in/courses/114/106/114106011/
2. https://nptel.ac.in/courses/114/106/114106035/
3. https://nptel.ac.in/courses/114/106/114106015/
4. https://nptel.ac.in/courses/114/106/114106038/

CE57026 **3-0-0 (3)**

Geo-environmental Engineering

Pre-Requisites: **None**

Course Outcomes:

CO-1	Assess possible reasons for susceptibility of soil properties to Environmental effects
CO-2	Identify contaminant transport mechanisms
CO-3	Assess chemical interaction effect on Engineering behaviour of soils
CO-4	Apply contaminant specific stabilization techniques

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	–	2	1	–	1
CO-2	2	–	2	1	–	–
CO-3	3	–	2	2	–	1
CO-4	2	2	–	2	3	2

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, flow laws and relationships, 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, Deformation behavior, 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, fly ash, hydroxy-aluminium and chemicals in clay stabilization.

Learning Resources:

Text Books:

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

Reference Books:

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

Other Suggested Readings:

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

CE 57028 **3-0-0 (3)**

Rock Mechanics

Pre-Requisites: **None**

Course Outcomes:

CO-1	Determine engineering rock properties and classify the rock mass
CO-2	Assess the stability of rock slopes and suggest slope slide preventive methods
CO-3	Select the suitable rock mass improvement method
CO-4	Estimate foundation capacity of rock mass

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	2	2	1	2
CO-2	2	2	1	2	2	1
CO-3	3	1	2	1	2	3
CO-4	3	1	3	1	3	1

Syllabus:

Introduction: Geological and structural aspects of rock mechanics. Development and Applications of rock mechanics in civil engineering.

Physical and Engineering Properties: 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: Rock Quality Designation (RQD), Core Recovery (CR), 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 rock slides/fall, Modes of failure, Methods of analysis, Prevention and control of rock slope failure, Instrumentation for Monitoring. Stability of hilly slopes.

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

Learning Resources:

Text Books:

1. Ramamurthy T., Engineering in Rocks for slopes, foundations and tunnels, Prentice Hall of India. Learning Pvt. Ltd., (2015).
2. Goodman, Introduction to Rock mechanics, Willey International (2007)

Reference Books:

1. Nagaratnam Sivakugan, Sanjay Kumar Shukla, Braja M. Das, Rock Mechanics an Introduction, CRC Press, 2019.
2. Jaeger J. C., Cook N. G. W., and Zimmerman R. W, Fundamentals of Rock Mechanics, Wiley Blackwell, 2007.
3. R Goel, Bhawani Singh, Engineering Rock Mass Classification, Elsevier, 2011

Other Suggested Readings:

1. https://onlinecourses.nptel.ac.in/noc21 _ce34/preview

CE57030 **3-0-0 (3)**

Critical State Soil Mechanics

Pre-Requisites: **None**

Course Outcomes:

CO-1	Demonstrate basic mechanisms behind index properties and tests on soil
CO-2	Relate behaviour of soils subjected to different loading and drainage conditions within unified framework of critical state soil mechanics
CO-3	Apply theory of elasticity and plasticity to characterize the stress – strain behaviour of soils
CO-4	Formulate constitutive models based on critical state soil mechanics concepts

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	–	2	1	–	3
CO-2	2	–	2	1	–	3
CO-3	1	–	2	2	1	3
CO-4	2	–	3	3	1	3

Syllabus:

General soil tests and the critical state model, interpretation of index test data, Mohr–Coulomb failure criterion, One–dimensional compression, undrained shear strength, general states of stress, pore pressure parameters.

Stress and strain: Stress and Strain paths and invariants, Critical state line, families of Undrained and Drained tests, Undrained and Drained planes, The Roscoe surface, Roscoe surface as a state boundary surface.

Behaviour of Over-consolidated samples: Hvorslev surface, critical state line, complete state boundary surface, volume changes and pore pressure changes, behaviour of sands, effect of dilation.

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

Soil behaviour before failure: Elastic and plastic deformations, Plasticity theory, Development of elastic-plastic model based on critical state soil mechanics, cam-clay, critical states and yielding of cam–clay, compression of cam–clay. Test paths in consolidation and shear testing, soil parameters for design, choice of analysis, Methods – choice of strength parameters**.**

Learning Resources:

Text Books:

1. Azizi F, E & FN Spon, Applied Analysis in Geotechnics, London, 2000.
2. Atkinson J H and Bransby P L, The Mechanics of Soils – An Introduction to Critical State Soil Mechanics, McGraw-Hill Book Company Limited, London, 1982.

Reference Books:

1. Azizi F, Engineering Design in Geotechnics, 2013.
2. Wood D M, Soil Behaviour and Critical state Soil Mechanics, Cambridge University Press, New York, 1990.

3. Schofield A N and Wroth C P, Critical State Soil Mechanics, McGraw-Hill Book Company Ltd., London, 1968
4. Parry R H G, Mohr Circles: Stress Paths and Geotechnics, CRC Press, 2004

Other Suggested Readings:

1. https://onlinecourses.nptel.ac.in/noc21_ce23/preview

CE 57032 **3-0-0 (3)**

Soil Behaviour

Pre-Requisites: **None**

Course Outcomes:

CO-1	Comprehend the formation mechanisms and the importance of soil mineralogy
CO-2	Identify basic mechanisms of soil behaviour under varying Environmental conditions
CO-3	Interpret the soil fabric and structure using XRD and SEM
CO-4	Interpret the mechanisms of volume change and strength characteristics

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	–	–	3	–	–
CO-2	–	2	–	3	–	–
CO-3	2	–	–	2	–	3
CO-4	2	3	–	2	–	1

Syllabus:

Soil formation and mineralogy: Origin of clay minerals, Geological cycle, sediment erosion, transport and deposition; clay mineral types and their importance in geotechnical engineering; gravel, sand and silt particles; Determination of soil composition, Methods for compositional analysis, 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: properties of adsorbed water; clay-water-electrolyte system, diffuse double layer theory; cation exchange, Energy and force of repulsion, Soil-chemical interactions, Volume change, shear strength and deformation behaviour: General volume change behaviour of soils, fabric, structure and volume change; General characteristics of strength and deformation, fabric, structure and strength; friction and physical interactions among soil particles

Learning Resources:

Text Books:

1. Mitchell J.K. and Kenichi Soga, “Fundamentals of Soil Behavior”, John Wiley & Sons Inc., Third Edition, 2014.
2. Karl Terzaghi, Ralph. B Peck, GholamrezaMesri, “Soil Mechanics in Engineering Practice”, Wiley India., Third Edition, 2010.

Reference Books:

1. Malcom D. Bolton, “A Guide to Soil Mechanics”, University Press (India) Pvt. Ltd., 2003.
2. Nyle C. Brady and Ray R. Weil, “The Nature and Properties of Soils”, Pearson Education Inc., 2002

Other Suggested Readings:

1. https://ocw.mit.edu/courses/1-322-soil-behavior-spring-2005/

CE 57034 **3-0-0 (3)**

EARTHQUAKE GEOTECHNIQUES

Pre-Requisites: **None**

Course Outcomes:

CO-1	Estimate the size of earthquake and the strong ground motion parameters.
CO-2	Conduct deterministic and probabilistic seismic hazard analysis
CO-3	Perform site specific ground response analysis.
CO-4	Analyze the liquefaction susceptibility of a site.
CO-5	Design earthquake resistant Geo-structures.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	1	1	2	2	2	1
CO-2	2	-	2	3	2	1
CO-3	3	-	2	3	2	2
CO-4	2	-	3	3	2	2
CO-5	2	1	3	1	-	2

Syllabus:

Seismology and Earthquakes: Seismic 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 propagation from 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, Introduction to earthquake resistant design

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: Analysis for Earthquake Loads: IS:1893-2002 Coefficient method

Learning Resources:

Text Books:

1. S.L., Kramer, Geotechnical Earthquake Engineering, Pearson Education, 2003
2. R.W., Day, Geotechnical Earthquake Engineering Handbook, Mc Graw Hill, 2003
3. Towhata, Geotechnical Earthquake Engineering, Springer, 2008

CE 57036 **3-0-0 (3)**

Geosynthetics Engineering

Pre-Requisites: **None**

Course Outcomes:

CO-1	Select suitable geosynthetic materials for the intended purpose.
CO-2	Evaluate the properties of geosynthetics.
CO-3	Design the geosynthetics for the intended engineering purposes.
CO-4	Apply geocomposite systems to solve contemporary geotechnical problems.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2	2	2	1	-	2
CO-2	1	1	2	2	-	1
CO-3	-	1	3	3	2	3
CO-4	3	2	3	2	1	3

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 applications.

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.

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 purposes.

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

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

Learning Resources:

Text Books:

1. Koerner, R.M., Designing with geosynthetics", Pearson Education Inc., 2012, 6th edition,
2. Mandal, J.N., "Geosynthetics Engineering: in Theory and Practice", Research Publishing, Singapore, 2018, 1st edition.

Reference Books:

1. Swami Saran, I.K., Reinforced Soil and its Engineering Applications" International Publishing House Pvt. Ltd., 2019, 1st edition
2. Mazenn Alshaaer and Han-Yong Jeon "Geopolymers and other Geosynthetics", IntechOpen. 2020.
3. "ICE Handbook of Geosynthetic Engineering: Geosynthetics and their Applications, ICE Publications, 2021

Other Suggested Readings:

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

CE57038 **3-0-0 (3)**

Tunneling Technology

Pre-Requisites: **None**

Course Outcomes:

CO-1	Select specific method of tunnel driving for a given ground condition
CO-2	Design tunnel excavation methods
CO-3	Identify Geotechnical challenges in tunneling
CO-4	Design techniques for tunneling in subsurface

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	3	2	2	1
CO-2	1	–	1	3	1	2
CO-3	2	2	3	2	2	2
CO-4	2	–	2	3	2	2

Syllabus:

Tunnels in Soils and Rocks: Benefits of tunneling, Tunnels for different purposes, Site investigation and geophysical methods adopted for tunneling purposes, Rock rating and classification, Instrumentation on tunnels, planning of tunneling, Tunneling in difficult strata

Tunneling methods: Drill and blast method, Tunnel boring machine, NATM, Shield tunneling, Earth pressure method, Application of compressed air.

Tunnel lining and supports: Different types of support measures adopted in tunneling, Analysis of stresses on the tunnel lining, Design of tunnel lining and support measures. Serviceability and case studies in tunneling.

Tunneling Mechanics: Behavior of soils and rocks, Stress and deformation fields around tunnels, Analytical equations used and derivations, Stability problems in tunnels. Design of Conduits and shafts. tunneling in soft grounds.

Learning Resources:

Text Books:

1. Singh B. and Goel R. K., Tunneling through weak rocks, Elsevier, 2006.
2. Heidelberg V. B., Tunneling and Tunnel Mechanics, Springer, 2005

Reference Books:

1. Hudson, J.A., Rock Mechanics Principles in Engineering Practice, CIRIA, Butterworth & Co, London, 1989.
2. Hoek, E., and Brown, E., Underground excavations in rock, CRC Press, 1980, 1st Edition

Other Suggested Readings:

1. https://nptel.ac.in/courses/105/107/105107208/
2. https://nptel.ac.in/courses/105/103/105103182/
3. https://nptel.ac.in/courses/105/106/105106055/
4. https://nptel.ac.in/courses/105/104/105104147/

3rd Semester

CE56089 **0-0-2 (2)**

Seminar & Technical Writing

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify a domain specific and contemporary topic
CO-2	Review literature to identify gaps and define objectives & scope of the work.
CO-3	Develop a prototype/model, experimental set-up or software systems to meet the objectives
CO-4	Analyze the results to draw valid conclusions

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2			2	1
CO-2	2	2			1	2
CO-3	2	2	3	3	3	2
CO-4	2	2		3	3	

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project

The method of evaluation should be as per the guidelines stipulated for the M.Tech. Project evaluation. The template for preparation of the project report may be downloaded from (https://www.nitw.ac.in/path/?dept=/nitwForms) under PG Forms. The students are required to submit a report showing that plagiarism is within 30%. The M.Tech. Project work will be evaluated for 100 marks, with the following weightages:

Component	**Weightage**
Periodic evaluation by Guide	40 marks
Mid-term review	20 marks
End Semester viva-voce examination	40 marks
Total	100 marks

The midterm review and the end semester viva-voce examination will be conducted by a committee constituted by the Head of the Department. If the performance of a student is not satisfactory, he/ she can be awarded ‘F’ grade. Such a student will be given a maximum time of three months to improve his/her performance. If the performance of such a student is not satisfactory even after the extended time period, he/ she will have to repeat the project work in the next academic year.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Selection of Topic	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Literature Survey	
III	Objectives and Solution Methodology	
IV	Performance of the Task and clarity on the work	
V	Report Preparation	
VI	Presentation and Response to questions	

Evaluation Criteria-CO Mapping

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II		X		
III		X		
IV			X	
V				X
VI				X

CE56091 **0-0-2 (2)**

SHORT TERM INDUSTRIAL / RESEARCH EXPERIENCE

Pre-Requisites: **None**

Course Outcomes:

CO-1	Apply engineering principles to real-world problems, gaining practical experience
CO-2	Plan, manage and execute the work with ethical consideration
CO-3	Review the social and environmental impact of the work
CO-4	Communicate the learnings through report and presentation

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	3	3	-
CO-2	2	2	2	2	2	-
CO-3	-	-	-	-	-	3
CO-4	-	-	-	-	-	-

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

Every student has to undergo either a Summer Internship / Research project. The summer internship may be undergone in an Industry/Research organization or any premier academic Institution, including NIT Warangal for 6-8 weeks. The research project shall be registered under the guidance of any faculty member in the institute. The student is required to submit a report and present the work before an evaluation committee, nominated by the Head of the Department.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Relevance of the area of work	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Performance of the Task	
III	Crucial learnings from the work	
IV	Report Preparation	
V	Presentation and Response to questions	

Evaluation Criteria-CO Mapping

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II		X		
III			X	
IV				X

CE56093 **0-0-0 (2)**

Comprehensive Viva Voce

Pre-Requisites: **None**

Course Outcomes:

CO-1	Comprehend the knowledge gained in the course work
CO-2	Demonstrate the ability in problem solving
CO-3	Communicate effectively using engineering terminology

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	3	3	3	-	2
CO-2	3	3	3	3	-	-
CO-3	2	2	2	2	2	1

1 - Slightly; **2 - Moderately;** **3 - Substantially**

Description:

In Comprehensive viva-voce each student will be evaluated for their overall comprehension of the course work and laboratory training that they have undergone. The students will be expected to answer questions orally, write down simple equations, draw plots, schematics, write simple code etc. as questioned by the panel. Assessment will be done by the panel based on the student response.

CE56097 **0-0-0 (8)**

DISSERTATION: PART-A

Pre-Requisites: **None**

Course Outcomes:

CO-1	Identify a topic in advanced areas of Geotechnical Engineering.
CO-2	Review literature to identify gaps and define objectives and scope of the work.
CO-3	Employ the ideas from literature and develop research methodology.
CO-4	Develop a model, experimental set-up and / or computational techniques necessary to meet the objectives.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	3	1		3
CO-2	3	2	3	1		3
CO-3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project

Dissertation Evaluation:

i. The dissertation shall be submitted as per the schedule given in the academic calendar.
ii. The dissertation supervisor will periodically review the progress of the student and finally give his/her assessment of the work done by the student.
iii. The Dissertation Part – A will be evaluated for 100 marks, with the following weightages:

Sub-component	**Weightage**
a) Periodic evaluation by Guide	40 marks
b) Mid-term review	20 marks
c) End Semester viva-voce examination	40 marks

Evaluation Criteria

The student will be evaluated by the panel based on the below criteria.

Criteria	Description	Weightages
I	Selection of Topic	Weightage for each criterion will be determined by the panel and will be informed to the students.
II	Literature Survey	
III	Defining the Objectives and Solution Methodology	
IV	Performance of the Task	

Evaluation Criteria - CO Mapping:

CO / Criteria	CO1	CO2	CO3	CO4
I	X			
II		X		
III			X	
IV				X

Refer to the M.Tech. – Regulations for any further information regarding mid-term review and end semester evaluation, etc.

4th Semester

CE56098 **0-0-0 (12)**

DISSERTATION: PART-B

Pre-Requisites: **CE56097**

Course Outcomes:

CO-1	Identify the materials and methods for carrying out experiments/develop a code.
CO-2	Execute the research methodology with a concern for society, environment and ethics
CO-3	Analyse, discuss and justify the results/trends and draw valid conclusions.
CO-4	Prepare the report as per recommended format and present the work orally adhering to stipulated time.
CO-5	Explore the possibility to publish/present a paper in peer reviewed journals/conference proceedings without plagiarism.

Course Articulation Matrix:

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	2		3	3	2	3
CO-2	2		3	3	2	3
CO-3	3		3	3	2	3
CO-4	3	3	3	3	3	3
CO-5	3	3	3			3

1 - Slightly; 2 - Moderately; 3 - Substantially

Description:

Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Dissertation Evaluation:

i. The dissertation shall be submitted as per the schedule given in the academic calendar.
ii. The dissertation supervisor will periodically review the progress of the student and finally give his/her assessment of the work done by the student.
iii. The Dissertation Part – B will be evaluated for 100 marks, with the following weightages:

Sub-component	**Weightage**
a) Periodic evaluation by Guide	40 marks
b) Mid-term review	20 marks
c) End Semester viva-voce examination	40 marks

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria as a continuation of Dissertation Part A.

Task	Description	Weightages
IV	Performance of the Task	Weightage for each criterion will be determined by the panel and will be informed to the students.
V	Dissertation Preparation	
VI	Review (Presentation & Understanding)	
VII	Viva-Voce	
VIII	Publications /Possibility of publication	

Evaluation Criteria-CO Mapping:

CO / Criteria	CO1	CO2	CO3	CO4	CO5
IV	X	X			
V				X	
VI			X		
VII				X	
VIII					X