NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

PROPOSED SCHEME OF INSTRUCTION AND SYLLABI

FOR M.TECH. PROGRAM IN

GEOTECNICAL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

DEPARTMENT OF CIVIL ENGINEERING

Vision

To develop into a distinguished department of civil engineering worldwide by providing quality technical education and conducting high-end research that can produce sustainable solutions to the global community

Mission

- To design a curriculum based on the present and future challenges in civil engineering and develop high-quality ethical professionalism among the civil engineers
- To interact with industries with an emphasis on research and development and undertake innovative collaborative projects to solve real-world problems
- To provide effective consultancy services for delivering the output of the research to the society and establish centres of excellence in emerging areas of research

M.TECH. IN GEOTECHNICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

PEO1	Apply the basic principles of sciences and engineering to analyse geotechnical problems
PEO2	Analyse and design geotechnical structures
PEO3	Develop sustainable and cost-effective solutions to the geotechnical problems
PEO4	Communicate effectively, demonstrate leadership qualities and exhibit professional ethics
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	3	3	2	3	3
MS2	3	2	2	2	2
MS3	3	3	3	2	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	Analyse and Design foundations and earth structures
PO4	Identify Engineering solutions to problematic grounds
PO5	Apply modern geotechnics 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

SCHEME OF INSTRUCTION AND EVALUATION

M. Tech. (Geotechnical Engineering) Course Structure

I - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Advanced Soil Mechanics	4	0	0	4	PCC
2		Advanced Foundation Engineering	4	0	0	4	PCC
3		Geotechnical Exploration and Instrumentation	4	0	0	4	PCC
4		Department Elective – I	3	0	0	3	DEC
5		Open Elective – I	3	0	0	3	OEC
6		Experimental Geotechnics	0	0	3	2	PCC
		Total	18	0	6	20	

I - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Finite Element Method in Civil Engineering	4	0	0	4	PCC
2		Ground Improvement Methods	4	0	0	4	PCC
3		Department Elective – II	3	0	0	3	DEC
4		Department Elective - III	3	0	0	3	DEC
5		Open Elective – II	3	0	0	3	OEC
6		Computational Laboratory	0	0	3	2	PCC
7		Geotechnical Engineering Seminar	0	0	3	2	PCC
		Total	18	0	6	21	

II - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Mandatory Elective Course - I (ERA/NPTEL/SWAYAM/MIT)				2	PCC
2		Mandatory Elective Course - II (ERA/NPTEL/SWAYAM/MIT)				2	PCC
3		Comprehensive Viva				2	PCC
4		Dissertation Part A				8	PCC
		Total				14	

II - Year II – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Dissertation Part B				16	PCC
		Total				16	

LIST OF ELECTIVES

For Department Elective I

S. No.	Course Code	Course Title	L	T	P	Credits
1		Environmental Geotechnics	3	0	0	3
2		Computational Geomechanics	3	0	0	3
3		Earth and Rock fill Dams	3	0	0	3
4		Rock Mechanics	3	0	0	3

For Department Elective II & III

S. No.	Course Code	Course Title	L	T	P	Credits
1		Geodynamics	3	0	0	3
2		Application of Geosynthetics	3	0	0	3
3		Offshore Geotechnics	3	0	0	3
4		Soil Structure Interaction	3	0	0	3
5		Tunnelling Technology	3	0	0	3
6		Critical State Soil Mechanics	3	0	0	3
7		Landfill Engineering	3	0	0	3
8		Earth Retaining Structures	3	0	0	3

	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:

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, effective stress principle for partially saturated soils, seepage in soils, stress distribution: Boussinesq's Theory and Westergaard's theory.

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

Shear Strength: Basic concepts, shear strength of soil under plane strain and general stress system. Mohr-Coulomb theory; measurement of shear strength, drainage conditions, pore pressure parameters. Stress paths in p-q space; Direct shear box test, Triaxial test, stress state and analysis of UC, UU, CU, CD, and other special tests, stress paths in triaxial and octahedral plane;

Strength of Cohesion less 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.

Stability of Slopes: Stability analysis of a slope and finding critical slip surface; Sudden Draw down condition, effective stress and total stress analysis, Seismic displacements in marginally stable slopes

Reading:

1. B.M. Das, “Advanced Soil Mechanics”, Taylor & Francis, 2013.
2. S. Helwany, “Applied Soil Mechanics with ABAQUS Applications”, John Wiley & Sons, INC, 2007.
3. W. Powrie, “Soil Mechanics concepts and applications”, Spon Press, Taylor & Francis, 2002.
4. K. Terzaghi, R.B. Peck, and G. Mesri, “Soil Mechanics in Engineering Practice”, 1996
5. B.V.S Viswanadham, “Advanced Geotechnical Engineering”, NPTEL Video Course, MHRD, Govt. India, 2013.

	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, Total and Differential Settlement, control of excessive settlement

Earth Pressure Theory, Retaining Walls: Types (types of flexible and rigid earth retention systems: counter fort, gravity, diaphragm walls, sheet pile walls, soldier piles and lagging). Support systems for flexible retaining walls (struts, anchoring), Braced Excavations and Diaphragm Wall, construction methods, stability calculations, design of flexible and rigid retaining walls – IS Code Procedures.

Shallow Foundations: Foundation classification; Choice of foundations; Deign of Foundations- Isolated, Combined, Raft, foundations –Beams on elastic foundations – Eccentrically loaded footings, Foundation on Slopes – IS Code Procedures

Pile Foundations: Classification and Uses, carrying capacity of Single pile, pull out resistance, laterally loaded Piles; Pile groups - Group efficiency, Settlement of single pile and pile groups, t-z, q-z, p-y Curves. Negative skin friction. Structural design of piles including pile caps; Design of pile groups. Pile load tests- Underreamed Pile- Pile Raft– IS Code Procedures

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 – IS Code Procedures

Reading:

1. J. E. Bowles, “Foundation Analysis & Design”, McGraw Hill Book Co, 2001.
2. N.V. Nayak, “Foundation Design Manual”, Dhanpat Rai Publications, 2018.
3. M. Tomlinson, “Foundation Design and Construction”, ELBS, Longman Group Ltd, 2001.
4. H.G. Poulos, and E.H. Davis, “Pile foundation analysis and design”, John Wiley & Sons Inc, 1980.
5. R. Katzenbach, S. Leppla and D. Choudhury, “Foundation Systems for High-Rise Structures” CRC Press, Taylor & Francis Group, 2016.
6. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors, 2007.
7. D. Choudhury, “Foundation Engineering”, NPTEL Web Course, MHRD, Govt. India, 2006.
8. K. Deb, “Advanced Foundation Engineering”, NPTEL Video Course, MHRD, Govt. India, 2013.

	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 bore logs 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 and Rock Classification.

Soil & Rock Exploration: Soil Exploration Programme for different Civil Engineering Projects- Number and Depth of Boreholes

Exploration Methods: 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- Ground water observations – water table fluctuations and effects - Preparation of soil profiles – calculations

Field testing of soils & Rocks: methods and specifications – visual identification tests, Geo Physical Test- vane shear test, penetration tests (SPT, CPT, DMT, PMT), Plate Load Test, CBR Test, Block Vibration Test, analysis of test results.

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

Field Instrumentation & Monitoring: Pressure meters, Piezometer, Pressure cells, O-Cell, Sensors, Inclinometers, Strain gauges, Accelerometers 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.

4. C.R. Clayton, M.C. Matthews, and N.E. Simons, "Site Investigation", 1995.

5. N.N. Som and S.C. Das, "Theory and Practice of Foundation Design", PHI Learning, 2003.

6. D. Choudhury, "Foundation Engineering", NPTEL Web Course, MHRD, Govt. India, 2006.

7. K. Deb, "Advanced Foundation Engineering", NPTEL Video Course, MHRD, Govt. India, 2013.

	EXPERIMENTAL GEOTECHNICS	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 cohesion less 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. J.E. Bowles, “Physical and Geotechnical Properties of Soils”, McGraw Hill Publishers, 1979.
2. BS 1377 (Part 1 to 8). “Methods of Test for Soils for Civil Engineering Purposes”, British Standard Institute.
3. K. H. Head, Manual of Soil Laboratory Testing, Vol. 1,2, 3 “Soil classification and compaction tests”, Whittles Publishing, Scotland, UK, 1982.
4. IS 2720 (Various parts). “Methods of Test for Soils”, Bureau of Indian Standards.
5. T. W. Lambe, “Soil testing for engineers”, Wiley & Sons, 1951.
6. J.N. Mandal, D.G. Divshikar, “Soil Testing in Civil Engineering”, Oxford & IBH Publishing Company Pvt. Ltd., 1994.

	ENVIRONMENTAL 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	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, Electro kinetic phenomenon, coupled influences on chemical flow, chemical compatibility and hydraulic conductivity

Classification of Soil and Susceptibility to Environment: Susceptibility to environment, mineralogy, formation and isomorphism 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 pre compression, compression behaviour of saturated Kaolinitic and Montmorillonitic clays with different pore fluids, shear strength Behaviour of Kaolinitic and Montmorillonitic clays with different pore fluids, components of shear strength and their mechanisms

Soil Modification by Environmental Changes: 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. J. K. Mitchell, "Fundamentals of Soil Behaviour" John Wiley & Sons, Inc. New York, 1993.
3. T. S. R. 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.

	COMPUTATIONAL GEOMECHANICS	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- Application of Various Commercially Available Geotechnical Software.

Reading:

1. C. S. 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, 2003.
3. D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK, 1981.
4. S. Helwany, "Applied soil mechanics", John Wiley & sons, Inc, USA, 2007.

	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/rock fill dams
CO2	Analyze seepage through a given earth/rock fill 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

Introduction: 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, and drainage- Critical Hydraulic Gradient.

Control of Seepage Through Foundations: Types of foundations, cut-off trenches, Internal Drainage Arrangement, upstream impervious blanket, horizontal drainage blanket, relief wells, drainage trenches, cut-off walls, downstream loading berm- Embankment on pervious soils.

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, Bishop's method, Morgenstern- Price method, Janbu method.

Construction of earth dams: construction equipment, procedures for pervious, semi-pervious, impervious and earth and rock fill sections, Quality Control and 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, and 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. J. L. Sherard, R. J. Woodward, and S. F. Gizienski, "Earth and Earth Rock Dams: Engineering Problems of Design and Construction", John Wiley Inc, 1963.
2. H. D. Sharma, "Embankment dams", Oxford and IBH Publishing Co..1991.
3. B. Singh and R. S. Varshney, "Engineering for embankment dams" A. A. Balekema publications, 1995.

	ROCK 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	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, Uni axial 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, Geo mechanics 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. W. Wittke, “Rock Mechanics” Springer Verlag, New York, 1990.
4. K. Mogi, “Experimental Rock Mechanics” Taylor & Francis Group, UK, 2007.
5. T. Ramamurthy, “Engineering in Rocks for slopes, foundations and tunnels”, PHI Learning Pvt. Limited, 2010.

	FINITE ELEMENT METHOD IN CIVIL 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	Apply numerical methods to solve partial differential equations with application to structural engineering problems.
CO2	Derive constitutive relations and solve structural engineering problems with appropriate mathematical models.
CO3	Apply FE Models to solve trusses, beams, plates, shells and structural dynamics.
CO4	Develop the shape functions for different elements.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	-	-	-	1
CO2	3	2	1	2	-	-	-	-
CO3	2	3	1	2	-	-	-	-
CO4	3	3	1	2	-	-	-	-

Detailed syllabus

Introduction - Background and general description of the method – Applications.
Methods of Structural Analysis - Review of various classical methods of Structural Analysis- Matrix methods- Stiffness and Flexibility methods.
Numerical methods of Structural analysis - Variational method- Weighted residual method- Sub domain and Impulse methods- Galerkins method – Least squares method- Application to bending problems- Strong and Weak formulation.
Basic introduction to constitutive relations.
Theory of Finite Element method - Discretisation concept- Concept of element – various elements shapes – displacement models – Convergence- shape functions – condensation of internal degrees of freedom-Summary of analysis procedure.
Finite Element Analysis - Development of shape functions for different elements-Spring-Truss-Beam-Plane elements- Plane stress and plane strain-Assemblage of elements construction of stiffness matrix and loads – boundary conditions –patch test-solution of overall problem.
Isoparametric Formulation -Concept of Isoparametric element – One- and Two-dimensional Elements-Natural coordinates- Numerical integration-Gaussian Quadrature-Development of Higher order elements- Lagrange –Serendipity –Interpolation-formulation of element stiffness and loads.
Application to Solid Mechanics problems - Analysis of Trusses – Beams – Frames-Plates-Axisymmetric Elements-Shells

Reading

1. O.C. Zeinkiewicz, “Finite Element Method: Its Basic and Fundamentals”, 6th Edition, Butterworth Heinemann, 2007.
2. R. D. Cook, “Concepts and Applications of Finite Element Analysis”, Willey Publication, 1995.
3. Y.M. Desai, T.I. Eldho and A.H.Shah, “Finite Element Method with Application in Engineering’ Pearson, 2011.
4. S.S. Rao, “The Finite Element Method in Engineering”, Elsevier Publication, 2009.
5. C. Belegundu, “Finite Element Method”, McGraw-Hill, 1997.
6. P. Seshu, “Textbook of Finite Element Analysis”, 1st Edition, PHI, 2009.

	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 compaction, preloading and Precompression sand compaction piles, Lab and 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 pre-fabricated vertical drains.

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

Reinforced Earth Technology: Concept of soil reinforcement, reinforcing materials, and 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 and Geotubes, 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. R. M. Koerner, "Construction and Geotechnical methods in Foundation Engineering", McGraw-Hill Pub. Co., New York, 1985.
2. M. 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. P. Raj, "Ground Improvement Techniques" Laxmi Publications (P) Limited, 2006.
5. J. Han, "Principles and Practice of Ground Improvement" John Wiley & Sons, 2015.

	COMPUTATIONAL LABORATORY	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

Plaxis, geo Studio, Rocscience, Flac,Geo5, Shake, L Pile, Pile Group, MIDAS,

Etc.

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.

	GEODYNAMICS	DEC	3 – 0 – 0	3 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 behaviour of a machine foundation resting on the surface, embedded foundation and foundations on piles by elastic half space concept
CO4	Analyze and design of various geotechnical structures under earthquake loads

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

Introduction: Scope and objective; Nature and types of dynamic loading; Importance of soil dynamics

Vibration theory: Vibration of elementary systems; Degrees of freedom (SDOF and MDOF systems); Equation of motion for SDOF system; Types of vibrations; Earthquake excitation; Undamped and damped free vibrations; Torsional vibration; Critical damping; Decay of motion; Undamped and damped forced vibration; Constant force and rotating mass oscillators; Dynamic magnification factor; Transmissibility ratio; Non-harmonic, arbitrary, impact and other types of forced vibrations; Vibration isolation; Equation of motion for MDOF system.

Wave Propagation: Longitudinal and torsional waves in infinitely long rod; Solution for one-dimensional and three-dimensional equations of motion; Waves in semi-infinite body; Waves in layered medium; Earthquake waves – P-wave, S-wave, Rayleigh wave and Love wave; Locating earthquake's epicenter.

Dynamic Soil Properties: Determination of dynamic soil properties; Field tests; Laboratory tests; Model tests; Stress-strain behavior of cyclically loaded soils; Estimation of shear modulus; Modulus reduction curve; Damping ratio; Linear, equivalent-linear and non-linear models; Ranges and applications of dynamic soil tests; Cyclic plate load test; Liquefaction; Screening and estimation of liquefaction; Simplified procedure for liquefaction estimation; Factor of safety; Cyclic stress ratio; Cyclic resistance ratio; CRR correlations with SPT, CPT, SASW test values.

Site Response Analysis: Ground Response Analysis, Transfer Function, Non-linear approach. Site Classification.

Seismic Analysis and Design of Various Geotechnical Structures: Pseudo-static method, Pseudo-dynamic & Modified Pseudo-Dynamic method, other dynamic methods, Seismic analysis of retaining wall, Seismic slope stability analysis, Behaviour of reinforced soil under seismic conditions, Seismic design of retaining structures, seismic design of shallow foundations, seismic design of pile foundations, Codal provisions/guidelines for seismic design of geotechnical structures.

Machine Foundations: Types of machines; Basic design criteria; Methods of analysis; Mass-Spring-Dashpot model; Elastic-Half-Space theory; Tschebotarioff's reduced natural frequency method; Types of foundations; Modes of vibrations; Vertical, sliding, torsional (yawing) and rocking (and pitching) modes of oscillations; Design guidelines as per codes

Reading:

1. S. Prakash, "Soil Dynamics", McGraw-Hill Book Company, 1981.
2. B.M. Das and G.V. Ramana, "Principles of Soil Dynamics", Cengage Learning, 2010.
3. S. L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc, 1996.
4. E. E. Richart, J. R. Hall, and R. D. Woods, "Vibrations of Soils and Foundations", Prentice Hall Inc, 1970.
5. T. H. Wu, "Soil Dynamics", Allyn and Bacon Inc, 1971.
6. R. W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York, 2012.
7. I. Towhata, "Geotechnical Earthquake Engineering", Springer-Verlag Heidelberg, 2008.
8. K. Ishihara, "Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA, 1996.
9. D. Choudhury, "Soil Dynamics", NPTEL Video Course, MHRD, Govt. India, 2013.
10. D. Choudhury, "Geotechnical Earthquake Engineering", NPTEL Video Course, MHRD, Govt. India, 2013.

	APPLICATIONS OF 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 separation, 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. R. M. Koerner, “Designing with geosynthetics”, Pearson Education Inc., 2005.
2. R. A. Jewell, "Soil Reinforcement with Geotextiles", Special Publication No. 123, CIRIA, Thomas Telford. London, UK, 1996.
3. G. L. Sivakumar Babu, “An Introduction to Soil Reinforcement and Geosynthetics”, University Press, 2005.
4. G.V. Rao, “Geosynthetics – an Introduction”, Sai Master Geoenvironmental Services Pvt. Ltd. Hyderabad, 2011.
5. S.K. Shukla, “Fundamentals of Geosynthetic Engg. Imperial College Press, London, 2006.
6. K. Rajagopal, “Geosynthetics and Reinforced Soil Structures” NPTEL Video Course, MHRD, Govt. India, 2013.

	OFFSHORE 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 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	Evaluate the stability of seafloor and pipelines

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

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 near shore foundations, Gravity platforms, Jack-up rigs, pile foundations, caissons, spudcans, anchorage systems

Seafloor Stability: causes of seafloor instability, geological features of submarine slides, mechanisms of instability, slope stability under gravity forces and wave forces, Effects of soil instability on piles, installation and stability of submarine pipelines, Identify key aspects of geotechnical pipeline design

Reading:

1. M. Randolph, and S. Gourvenec, "Offshore Geotechnical Engineering", CRC Press, 2017.
2. B. C. Gerwick, "Construction of Marine and Offshore Structures", CRC Press, 1999.
3. B. Gou, S. Song, J. Chacko and A. Ghalambor, "Offshore Pipelines", GPP Publishers, 2006.
4. H. G. Poulos, "Marine Geotechnics", Unwin Hyman Ltd, London, UK, 1988
5. D. Thomson and D. J. Beasley, "Handbook of Marine Geotechnical Engineering", US Navy, 2012
6. S. K. Hakrabarti, "Handbook of Offshore Engineering", Elsevier, 2005.

	SOIL STRUCTURE INTERACTION	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Interpret the mechanism at the interfaces and joints in structural and foundation systems
CO2	Analyze the problems involving complex behaviour of interfaces between the soil and foundation
CO3	Apply suitable constitutive models to analyze soil structure interaction problems
CO4	Apply the concepts of soil structure interaction for earthquake resist design of buildings

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: Stresses and displacements in soils, solids and structures, Constitutive relations, Fundamentals of soil plasticity, Mathematical modelling, Differential equations in solid mechanics and soil mechanics, Mechanics of soil-structure interaction.

Beams and plates on elastic foundation: Elastic and elasto-plastic analyses of footings and raft foundations, Numerical methods, Finite difference methods, Finite element methods

Analysis of axially and laterally loaded single pile and pile groups, Pile-cap-pile-soil interaction, Behaviour of piled-raft foundations.

Static interaction analysis of structures founded on shallow and deep foundations.

Dynamics of foundations: Foundation input motion, Foundation embedded in a layered half space, Seismic soil-structure interaction analysis in time domain for buildings and bridges. Examples and Case studies.

Reading:

1. C. S. Desai, and M. Zaman, “Advanced Geotechnical engineering –Soil Structure Interaction using Computer and Material Models”, CRC Press, 2013.

2. D. M. Wood, “Geotechnical Modelling”, Spon Press, London, 2004.

3. A. P. S. Selvadurai, “Elastic Analysis of Soil-Foundation Interaction”, Developments in Geotech. Engg., Elsevier, New York, 1979.

4. J. A. Hemsley, “Elastic Analysis of Raft Foundations”, Thomas Telford, London, 1998.

5. D. M. Potts, and L. Zdravkovic “Finite Element Analysis in Geotechnical Engineering: Application”, Thomas Telford, London, 2001.

	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- Building Response to Tunneling.

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- Application of Commercially Available Software

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.

	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 Behaviour: State of stress and strain in soils, Stress and strain paths and invariants, behaviour 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

Behaviour of Over consolidated samples: The Hvorslev surface: Behaviour of over consolidated 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.
4. M. Bolton, "A Guide to Soil Mechanics", Universities Press, 2003.

	LANDFILL ENGINEERING	DEC	0 – 0 – 3	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. M. 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.
4. H.D. Sharama and K.R. Reddy, "Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies", John Wiley & Sons, 2004.

	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 – types - classifications – specifications

Retaining walls and MSE Walls- types – Design specifications and pressure distribution variations-Structural Design & Stability- Water front Retaining Structures

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, Design of Diaphragm Wall, Coffer Dams and Stability of Braced Cuts, Basement Walls

Reading:

1. J. E. Bowels, “Foundation Analysis and Design”, McGraw Hill Company, 1997.
2. B. M. Das, “Foundation engineering”, Cengage Learning, 2007.
3. S. K. Gulhati, and M. Datta, “Geotechnical engineering”, McGraw Hill company, 2017.
4. C. R.I. Clayton, R. I. Woods, A. J. Bond, and J. Milititsky, “Earth Pressure and Earth-Retaining Structures”, 2014.

	GEOTECHNICAL ENGINEERING SEMINAR	PCC	0 – 0 – 3	2 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 Interne

	Dissertation Part – A **&** **Dissertation Part – B**	**PCC**	**0-0-0**	**24 Credits** **(8 + 16)**

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