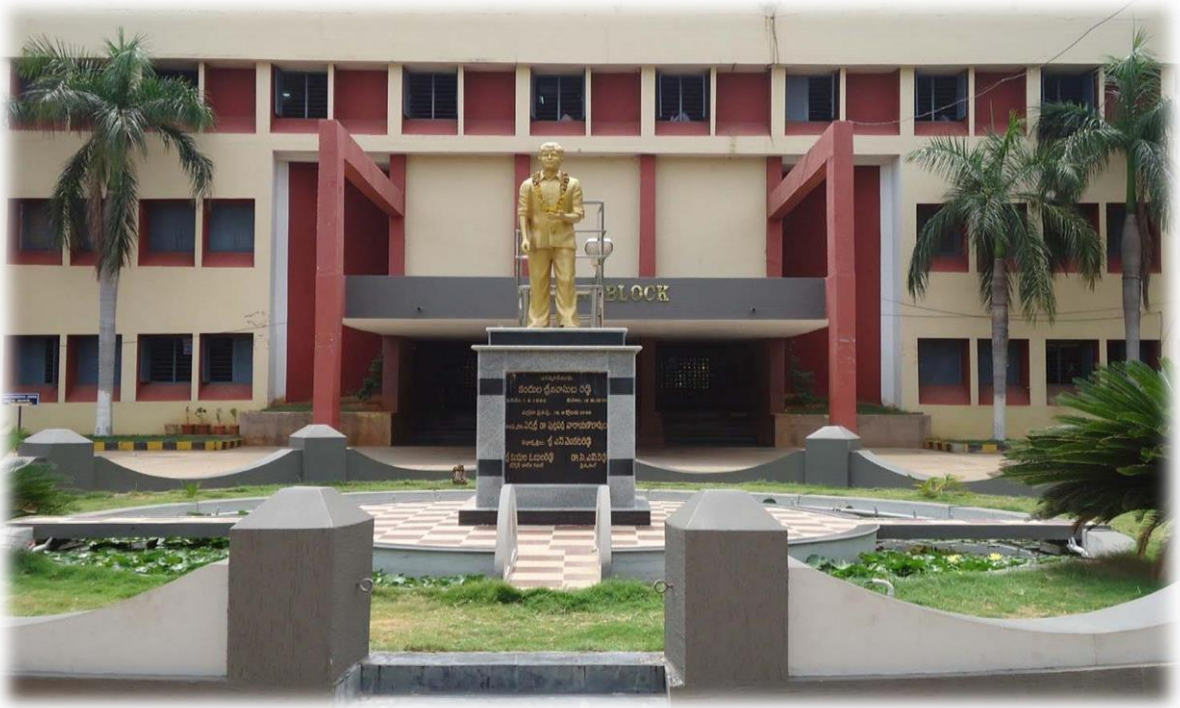
Regulations for PG Programs in Engineering (R22PG)

(Effective from 2022-23)

M. Tech (R22) Syllabus

Geotechnical Engineering



Kandula Srinivasa Reddy Memorial College of Engineering (Autonomous)

Kadapa-516005. AP

(Approved by AICTE, Affiliated to JNTUA, Ananthapuramu, Accredited by NAAC)

(An ISO 9001-2008 Certified Institution)

Annexure – 1 Curriculum

Geotechnical Engineering (Civil Engineering)

1st Semester

S. No.	Course Codes	Course Name	Category	L	T	P	IM	EM	Credits
1	2212101	Advanced Soil Mechanics	PCC	3	0	0	40	60	3
2	2212102	Advanced Foundation Engineering	PCC	3	0	0	40	60	3
3	**Program Elective Course – I**		PEC	3	0	0	40	60	3
	2212103	Soil Structure Interaction							
	2212104	Ground Improvement Techniques							
	2212105	Geoenvironmental Engineering							
4	**Program Elective Course – II**		PEC	3	0	0	40	60	3
	2212106	Critical Soil Mechanics							
	2212107	FEM in Geotechnical Engineering							
	2212108	Pavement Analysis and Design							
5	2212109	Soil Mechanics – 1 Lab	PCC	0	0	4	50	50	2
6	2212110	Soil Mechanics – 2 Lab	PCC	0	0	4	50	50	2
7	2212111	Research Methodology & IPR	-	2	0	0	40	60	2
8	**Audit Course – I**		Audit	2	0	0	40	0	0
				16	**0**	**8**	**340**	**400**	**18**

2nd Semester

S. No.	Course Codes	Course Name	Category	L	T	P	IM	EM	Credits
1	2212201	Experimental Geomechanics	PCC	3	0	0	40	60	3
2	2212202	Earth Retaining Structures	PCC	3	0	0	40	60	3
3	**Program Elective Course – III**		PEC	3	0	0	40	60	3
	2212203	Dynamics of Soil and Foundations							
	2212204	Foundations on Expansive Soils							
	2212205	Offshore Geotechnical Engineering							
4	**Program Elective Course – IV**		PEC	3	0	0	40	60	3
	2212206	Design of Under Ground Excavations							
	2212207	Design with Geosynthetics							
	2212208	Geotechnical Earthquake Engineering							
5	2212209	Subsoil Exploration Lab	PCC	0	0	4	50	50	2
6	2212210	Geotechnical Engineering Modeling Lab	PCC	0	0	4	50	50	2
7	2212211	Technical Seminar	-	0	0	4	100	0	2
8	**Audit Course – II**		Audit	2	0	0	40	0	0
				14	**0**	**12**	**400**	**340**	**18**

3rd Semester

S. No.	Course Codes	Course Name	Category	L	T	P	IM	EM	Credits
1	**Program Elective Course – V**		PEC	3	0	0	40	60	3
	2212301	Stability Analysis of Slopes							
	2212302	Foundations on Weak Rocks							
	2212303	Computational Geomechanics							
2	**Open Elective**		OEC	3	0	0	40	60	3
3	2212307	Dissertation Phase – 1 (to be continued nest semester)	Project	0	0	20	100	0	10
4	2212308	Co-Curricular Activities		0	0	0	0	0	2
				6	**0**	**20**	**180**	**120**	**18**

4th Semester

S. No.	Course Codes	Course Name	Category	L	T	P	IM	EM	Credits
1	2212401	Dissertation Phase – 2	Project	0	0	32	50	50	16
				0	**0**	**32**	**50**	**50**	**16**

List of Audit Courses offered:

Course Codes	Course Name
2270A01	English for Research Paper Writing
2270A02	Disaster Management
2270A03	Sanskrit for Technical Knowledge
2270A04	Value Education
2270A05	Constitution of India
2270A06	Pedagogy Studies
2270A07	Stress Management by Yoga
2270A08	Personality Development through Life Enlightenment Skills

List of Open Elective Courses offered to other branch students:

Course Codes	Course Name
22OE121	Solid Waste Management
22OE122	Waste to Energy
22OE123	Sub soil exploration techniques

I Semester
Syllabus

M. Tech., I Semester

Course Title	Advanced Soil Mechanics				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212101	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To explain about the consolidation theory, strength behaviour of soil under various conditions, analyze the stress paths for different practical situations, study the critical parameters in soils, study the elastic and plastic deformations in soils

On successful completion of this course, the students will be able to

CO 1	Determination of consolidation properties
CO 2	Determine the shear strength properties and interpretation of the triaxial test results
CO 3	Draw the stress paths for drained and undrained conditions of the soil mass
CO 4	Determine the critical state parameters of the soils
CO 5	Understand the elastic and plastic deformations

UNIT-I

Compressibility of Soils

Consolidation theory (one, two, and three dimensional consolidation theories), consolidation in layered soil and consolidation for time dependent loading, determination of coefficient of consolidation (Casagrande method and Taylors method)

UNIT-II

Strength Behavior of Soils

Mohr Circle of Stress; UU, CU, CD tests, drained and undrained behavior of sand and clay, significance of pore pressure parameters; determination of shear strength of soil; Interpretation of triaxial test results.

UNIT-III

Stress Path

Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.

UNIT-IV

Critical State Soil Mechanics

Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane. critical void ratio; effect of dilation in sands; different dilation models.

UNIT-V

Elastic and Plastic Deformations

Elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.

Text books:

1. Das, B.M., Advanced Soil Mechanics, Taylor and Francis, 5th Edition, 2019.
2. Terzaghi, K., and Peck, R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.

Reference Books:

1. Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An Introduction to Critical Soil Mechanics, McGraw Hill, 2013.
2. Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1991.

M. Tech., I Semester

Course Title	Advanced Foundation Engineering				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212102	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To emphasize the importance of soil investigations including destructive and non-destructive methods
- To explain the concept of bearing capacity and how to estimate the safe bearing capacity for various foundation system including settlement consideration
- To explain the need and how do analysis the pile and pile group under various soil conditions
- To explain the concepts of Terzaghi and IRC Methods and individual components
- To analyze the foundations under uplifting loads

On successful completion of this course, the students will be able to

CO 1	Prepare the exploration report and bring the correlations between the soil properties
CO 2	Design the footing and estimating the bearing capacity for various theories
CO 3	Estimate the load capacity, group action and settlement by various methods
CO 4	Design the well foundation and its components
CO 5	Design the foundations for uplifting loads

UNIT-I

Compressibility of Soils

Planning of Soil Exploration

Planning of Soil Exploration for Different Projects, Methods of Subsurface Exploration, Methods of Borings Along with Various Penetration Tests

UNIT-II

Compressibility of Soils

Shallow Foundations

Requirements for Satisfactory Performance of Foundations, Methods of Estimating Bearing Capacity, Settlements of Footings and Rafts, Proportioning of Foundations Using Field Test Data, IS Codes.

UNIT-III

Compressibility of Soils

Pile Foundations

Methods of Estimating Load Transfer of Piles, Settlements of Pile Foundations, Pile Group Capacity and Settlement, Negative Skin Friction of Piles, Laterally Loaded Piles, Pile Load Tests, Analytical Estimation of Load- Settlement Behavior of Piles, Proportioning of Pile Foundations, Lateral and Uplift Capacity of Piles.

UNIT-IV

Compressibility of Soils

Well Foundation

IS and IRC Codal Provisions, Elastic Theory and Ultimate Resistance Methods

UNIT-V

Compressibility of Soils

Coffer Dams

Various Types, Analysis and Design Foundations under Uplifting Loads

Text Books:

1. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edition, 1997.
2. Das B.M., Shallow Foundations: Bearing capacity and settlement, CRC Press, 2017.

Reference Books:

1. Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication, 2008.
2. Poulos, H. G. and Davis, F. H., "Pile Foundation Analysis and Design", Wiley and Sons. 1980.

M. Tech., I Semester

Course Title	Soil Structure Interaction				M. Tech, I Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2212103	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.					End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To study the soil and foundation behaviour
- To analyze the beams on elastic foundations
- To analyze the plates on elastic medium
- To analyze the piles on elastic medium
- To analyze the load prediction on piles

On successful completion of this course, the students will be able to

CO 1	Apply different soil response models for specific problems based on the requirement
CO 2	Analyze the footings on elastic foundations
CO 3	Analyze the plates on elastic foundations
CO 4	Analyze the piles on elastic analysis and their settlement
CO 5	Compute pile response for various loading conditions for design purpose

UNIT-I

Soil-Foundation Interaction

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

UNIT-II

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.

UNIT-III

Plate on Elastic Medium

Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

UNIT-IV

Elastic Analysis of Pile

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

UNIT-V

Laterally Loaded Pile

Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

Textbooks:

1. Selvadurai, A.P.S, Elastic Analysis of Soil-Foundation Interaction, Elsevier, 1979.
2. Poulos, H. G. and Davis, F. H., "Pile Foundation Analysis and Design", Wiley and Sons. 1980

Reference Books:

1. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1978.
2. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.

M. Tech., I Semester

Course Title	Ground Improvement Techniques				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212104	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To study the various modification methods, earth reinforcement techniques and their applications.

On successful completion of this course, the students will be able to

CO 1	Understand the mechanical modification and their importance
CO 2	Understand the chemical modification and their importance
CO 3	Understand the thermal modification and their importance
CO 4	Understand the mechanism of soil reinforcement and types of reinforcement
CO 5	Understand the applications of reinforcement, analysis and design

UNIT-I

Mechanical Modification

Dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, stone columns; Hydraulic modification: dewatering systems, preloading and vertical drains, electro-kinetic dewatering

UNIT-II

Chemical Modification

Modification by admixtures, stabilization using industrial wastes, grouting

UNIT-III

Thermal Modification

Ground freezing and thawing.

UNIT-IV

Soil Reinforcement

Reinforced earth, basic mechanism, type of reinforcements, selection of stabilization / improvement of ground using Geotextiles, Geogrid, geomembranes, geocells, geonets, and soil nails.

UNIT-V

Application of Soil Reinforcement

Shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill, analysis and design of shallow foundations on reinforced earth, road designs with geosynthetics

Textbooks:

1. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill International Editions, 2013.
2. Moseley, M.P., Ground Improvement, Blackie Academic & Professional, 2004.

Reference Books:

1. Xanthakos, P.P., Abramson, L.W. and Bruce, D.A., Ground Control and Improvement, John Wiley & Sons, 1994.
2. Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 2012.

M. Tech., I Semester

Course Title	Geoenvironmental Engineering				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212105	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To learn concepts of geo-environmental engineering, and planning and design of waste in landfills, ash ponds and tailing ponds.
- Explain the effects of pollutants in soil properties
- Awareness about the adverse effects of soil and ground water contaminants
- Analyze and apply the various techniques for remediation of the contaminants

On successful completion of this course, the students will be able to

CO 1	Understand the soil-environment interaction and contaminants
CO 2	Design the landfill and its stability
CO 3	Identify the slurry waste, design the slurry ponds and its operations
CO 4	Identify the contaminated sites and design the barriers
CO 5	Identify the properties of the waste and reuse the material

UNIT-I

Introduction and Contamination

Industrialization and Urbanization, Pollution, Control and remediation. Surface contamination, Contamination transport, Soil-a Geotechnical trap, Effect of subsurface contamination, Detection of polluted zone, Monitoring and Effectiveness of designed facilities.

UNIT-II

Contaminants of Solid Waste in Landfills

Waste contaminants, landfills, types, shape and size of landfills. Liner and liner system, Cover and cover system, Stability of landfills. Landfill construction & operation, sustainable waste management.

UNIT-III

Contaminants of Slurry Wastes

Slurry transported wastes, slurry ponds, operation, Embankment construction and raising, Design aspects, Environmental Impact and control.

UNIT-IV

Vertical Barriers for Contaminant

Contaminated sites, Types of barriers, Soil-Bentonite slurry trench walls, Cement-Bentonite slurry trench walls, construction, material and design aspects.

UNIT-V

Geotechnical Reuse of Waste Materials

Waste reduction, use in geotechnical construction, waste characteristics, transportation consideration, Engineering properties of Wastes, Waste material in Embankment and Fills.

Textbooks:

1. Geo-environmental Engineering by Sharma H.D & Reddy K.R, John Wiley & Sons, Inc, 2004.
2. Geo-environmental Engineering by Reddi L.N & Inyang. H.I, CRC Press, 2000.

Reference Books:

1. Geotechnical Geo – Environmental Engineering hand Book – Kerry Row, Springer Science, New York, 2001.
2. Ground Water Contamination: Bedient, Refai & Newell, Prentice Hall Publishers, 1999.

M. Tech., I Semester

Course Title	Critical Soil Mechanics				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212106	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To demonstrate basic mechanisms behind index properties and tests on soil, relate behaviour of soils subjected to various loading and drainage conditions within unified framework of Critical state soil mechanics.
- To analyze theory of elasticity and plasticity to characterize the stress – strain behaviour of soils and to formulate basic elasto-plastic model based on Critical State Soil Mechanics (CSSM) like Cam-clay

On successful completion of this course, the students will be able to

CO 1	Understand the behaviour soil under various stress strain conditions
CO 2	Determine the critical state line for various drained conditions
CO 3	Understand the behaviour of over consolidated soils
CO 4	Understand the behaviour of sands in critical state
CO 5	Understand the behaviour of sails before failure by constructing elasto-plastic model

UNIT-1

Soil Behavior

State of Stress and Strain in Soils, Stress and Strain Paths and Invariants, Behavior of Soils under Different Laboratory Experiments

UNIT-1I

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

UNIT-1II

Behavior 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

UNIT-1V

Behaviour of Sands

The Critical State Line for Sands, Normalized Plots, The Effect of Dilation, Consequences of Taylor's Model

UNIT-V

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

Textbooks:

1. J. H. Atkinson and P. L. Bransby, "The Mechanics of Soils: An Introduction to Critical State Soil Mechanics", Mcgraw Hill, 1978
2. Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1991

Reference Books:

1. B. M. Das, "Fundamental of Geotechnical Engineering", Cengage Learning, 2013
2. Das, B.M., Advanced Soil Mechanics, Taylor and Francis, 5th Edition, 2019.

M. Tech., I Semester

Course Title	FEM in Geotechnical Engineering				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212107	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To explain the basic concepts of FEM
- To explain the principles and formulation of variational methods
- To analyze the displacements and explain the problems in soils and rocks
- To explain the applications of FEM in geotechnical engineering

On successful completion of this course, the students will be able to

CO 1	Understand the behaviour soil under various stress strain conditions
CO 2	Determine the critical state line for various drained conditions
CO 3	Understand the behaviour of over consolidated soils
CO 4	Understand the behaviour of sands in critical state
CO 5	Understand the behaviour of sails before failure by constructing elasto-plastic model

UNIT-I

Basic Concepts

Basic concepts - Discretization of continuum, typical elements, the element characteristic matrix, Element assembly and solution for unknowns - Applications.

UNIT-II

Variational Principles

Variational principles, variational formulation of boundary value problems, Variational methods approximation such as Ritz and weighted residual (Galerkin) methods, Applications.

UNIT-III

Displacements Based Elements

Displacements based elements, finite elements for axial symmetry. One-dimensional problems of stress, deformation and flow, Assembly, Convergence requirements, Finite elements analysis of two-dimensional problems. The linear and quadratic triangle, Natural coordinates.

UNIT-1V

Iso-Parametric Formulation

Application of FEM to Problems in soils and rocks, Introduction to non-linearity, Finite difference method, Description and application to consolidation, seepage, Winkler foundation etc.,

UNIT-V

Applications in Geotechnical Engineering

Application of FEM to Problems in soils, Introduction to non-linearity, Finite difference method, Description and application to consolidation, seepage, Winkler foundations

Textbooks:

1. Cook, R.D., Malkus, D.S., and Plesha, M.E., Concepts and Applications of Finite Element Analysis, John Wiley, 2007.
2. Smith, I.M., Programming the Finite Element Method with Application to Geomechanics, John Wiley and sons, New Delhi, 2000.

Reference Books:

1. Reddy, J.N., An Introduction to the Finite Element Method, McGraw Hill, 2005.
2. Potts, D.M. and Zdramcovic, L., Finite Element analysis in Geotechnical Engineering - Application, Thomas Telford, 2001.

M. Tech., I Semester

Course Title	Pavement Analysis and Design				M. Tech, I Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2212108	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs.					End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To understand the different types of pavements, conduct analysis of flexible pavements for stresses, strains, and deflections in one-, two-, and three-layered systems, design flexible pavements using the AASHTO design procedure, conduct analysis of rigid pavements for stresses, strains, and deflections, To design rigid pavements using the AASHTO design procedure.

On successful completion of this course, the students will be able to

CO 1	Identify the various types and components of pavements and design factors
CO 2	Understand the stress strain behaviour in flexible pavement
CO 3	Design the flexible pavement for highways and airports
CO 4	Understand the stress components in rigid pavements
CO 5	Design the rigid pavement and their components

UNIT-I

Introduction

Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements

UNIT-II

Stresses and Strains in Flexible Pavements

Stresses and strains in an infinite elastic half space use of Boussinesq's equations - Burmister's two layer and three layer theories; Wheel load stresses, various factors in traffic wheel loads; Equivalent single wheel load of multiple wheels. Repeated loads and EWL factors

UNIT-III

Flexible Pavement Design Methods for Highways and Airports

Empirical, semi-empirical and theoretical approaches; Development, principle, design steps of the different pavement design methods including AASHTO, Asphalt Institute, Shell Methods. IRC method of pavement design

UNIT-IV

Stresses in Rigid Pavements

Types of stresses and causes; Introduction to Westergaard's equations for calculation of stresses in rigid pavement due to the influence of traffic and temperature; Considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.

UNIT-V

Rigid Pavement Design

Design of cement concrete pavement for highways and runways; Design of joints, reinforcements, tie bars, dowel bars. IRC method of design; Design of continuously reinforced concrete pavements

Textbooks:

1. Yoder R.J and Witchakm. W., Principles of Pavement Design, John Wiley, 2000.
2. Yang H Huang - Pavement Analysis and Design, 2nd Edition, Pearson Education, 2010.

Reference Books:

1. Guidelines for the Design of Flexible Pavements, IRC: 37 - 2001, the Indian Roads Congress, New Delhi.
2. Guideline for the Design of Rigid Pavements for Highways, IRC: 58-1998, the Indian Roads Congress, New Delhi.

M. Tech., I Semester

Course Title	Soil Mechanics-1 Lab				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212109	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	4	2	50	50	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- Classify the soil by physical observation
- Carryout interpolation among the estimated soil design parameters

On successful completion of this course, the students will be able to

CO 1	Estimate index and engineering properties of soils (coarse and fine)
CO 2	Identify the soil classification

List of Experiments:

1. Determination of Moisture Content and Specific Gravity
2. Grain Size Analysis
3. Determination of Atterberg's Limits
4. Visual Classification Test for Soils
5. Determination of In-Situ Densities
    a) Core Cutter Method
    b) Sand Replacement Method
6. Proctor Compaction
    a) Standard Proctor Compaction
    b) Modified Proctor Compaction
7. Determination of Coefficient of Permeability
    a) Constant Head Method
    b) Variable Head Method
8. Consolidation Test

Textbooks:

1. S. Mittal and JP Shukla, Soil Testing for Engineers, Khanna Publishers, New Delhi, 2008.
2. KVS Apparao and VCS Rao, Soil Testing – Laboratory Manual & Question Bank, University Science Press, New Delhi, 2013.

Reference Books:

1. Compendium of Indian Standards on Soil Engineering: Part – 1 & 2, Laboratory and Field Testing of Soils for Civil Engineering Purposes.
2. Braja M. Das, Soil Mechanics Laboratory Manual, Oxford University Press, New York, 2016.

M. Tech., I Semester

Course Title	Soil Mechanics-1 Lab				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212110	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	4	2	50	50	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- Conduct the various tests to determine shear strength parameters of the soils
- Study the bearing and swell pressure, chemical components in soils

On successful completion of this course, the students will be able to

CO 1	Estimate shear strength and bearing pressure of the soils
CO 2	Estimate the swell pressure, amount of solids and amount $CaCO_3$ in soils

List of Experiments:

1. Direct Shear Test
2. Unconfined Compression Test
3. Triaxial Shear Test – UU, CU, CD Tests
4. California Bearing Ratio
5. Laboratory Vane Shear Test
6. Swell Pressure Test
7. Total Soluble Solids Content in Soils
8. Calcium Carbonate Content in Soils

Textbooks:

1. S. Mittal and JP Shukla, Soil Testing for Engineers, Khanna Publishers, New Delhi, 2008.
2. KVS Apparao and VCS Rao, Soil Testing – Laboratory Manual & Question Bank, University Science Press, New Delhi, 2013.

Reference Books:

1. Compendium of Indian Standards on Soil Engineering: Part – 1 & 2, Laboratory and Field Testing of Soils for Civil Engineering Purposes.
2. Braja M. Das, Soil Mechanics Laboratory Manual, Oxford University Press, New York, 2016.

M. Tech., I Semester

Course Title	Research Methodology &IPR				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2212111	Mandatory Course (MC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	2	40	60	100
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- About the basics of how research problems are defined, research methods are adopted and/or developed, research is undertaken, and how research results are communicated to the peers.

On successful completion of this course, the students will be able to

CO 1	Understand research problem formulation.
CO 2	Analyze research related information, follow research ethics
CO 3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO 4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO 5	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I

Introduction

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Literature

Effective literature studies approaches, analysis Plagiarism, Research ethics

UNIT-III

Technical Writing

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV

Nature of Intellectual Property

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V

Patent Rights and New Developments in IPR

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks:

1. Stuart Melville and Wayne Goddard, "Research methodology: An Introduction for Science & Engineering Students", Juta Education, 1996.
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners", Sage Publications, 2011.

Reference Books:

1. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", Clause 8 Publishing, 2021.
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

M. Tech., I Semester

Course Title	English for Research Paper Writing				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2270A01	Audit	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	0	40
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- On how to improve your writing skills and level of readability.
- About what to write in each section (Abstract, Introduction, Methodology etc.) and what tenses to use. Of course, not all disciplines use the same section headings, but most papers nevertheless tend to cover similar areas.

On successful completion of this course, the students will be able to

CO 1	Understand that how to improve writing skills and level of readability
CO 2	Learn about what to write in literature
CO 3	Understand the skills needed for writing the title
CO 4	Understand the skills needed for writing the results and conclusions
CO 5	Understand the skills needed for writing a title ensure the good quality of paper at very first time submission

UNIT-I

Planning and Preparation

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-II

Review of Literature

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT-III

Key Skills

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

UNIT-IV

Skills needed to Write Results and Conclusions

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT-V

Paper Submission

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Textbooks:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's Book.

M. Tech., I Semester

Course Title	Disaster Management				M. Tech, I Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2270A02	Audit	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	0	40
Mid Exam Duration: 2 Hrs.					End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To provide a general concept in the dimensions of disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery

On successful completion of this course, the students will be able to

CO 1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response
CO 2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO 3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO 4	Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in
CO 5	Understand the risk assessment and applying the reduction techniques, implementing the disaster mitigation programs to bring awareness

UNIT-I

Introduction

Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Manmade disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III

Disaster Prone Areas in India

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-IV

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data. From Meteorological and Other Agencies, Media Reports:
Governmental and Community Preparedness.

UNIT-V

Risk Assessment and Mitigation

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Textbooks:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, Issues and Strategies", New Royal Book Company, 2007.
2. Sahni, Pardeep Et. Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2007.

M. Tech., I Semester

Course Title	Sanskrit for Technical Knowledge				M. Tech, I Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
2270A03	Audit	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	0	40
Mid Exam Duration: 2 Hrs.						End Exam Duration: 3 Hrs.		

Course Objectives: The course is designed to students,

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

On successful completion of this course, the students will be able to

CO 1	Understand the basic Sanskrit language
CO 2	Ancient Sanskrit literature about science & technology can be understood

UNIT-I
Alphabets in Sanskrit
UNIT-II
Past/Present/Future Tense, Simple Sentences
UNIT-III
Order, Introduction of roots
UNIT-IV
Technical information about Sanskrit Literature
UNIT-V
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Textbooks:

1. "Teach Yourself Sanskrit" Prathama Deeksha - Vempati Kutumba Shastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication, 2012.
2. "Abhyas pustakam" – Dr. HR Vishwas, Samskrita-Bharti Publication, New Delhi, 2020.

Reference Books:

1. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2006.

II Semester
Syllabus

M. Tech., II Semester

Course Title	Experimental Geomechanics					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212201	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To identify the soil type of soil from a job site or in a professional setting, determine that soil's properties based on type and evaluate design decisions from your understanding of that soil's properties.
- To explore the scientific principles used to describe the major engineering properties of soil, and the engineering testing methods used to quantify these properties

On successful completion of this course, the students will be able to

CO 1	Plan subsurface investigation based on the requirement of civil engineering project and site condition. Can finalize depth and number of boreholes
CO 2	Execute different subsurface exploration tests
CO 3	Collect disturbed/undisturbed samples for laboratory tests and can suggest design parameters
CO 4	Expose different methods for estimation of dynamic soil properties required for design purpose.
CO 5	Develop instrumentation scheme for monitoring of critical sites

Unit - I

Introduction

Scopes and objectives of explorations – Planning a subsurface exploration – Stages in sub surface exploration – Explorations for preliminary and detailed design – Spacing and depth of exploration

Unit - II

Open Excavation and Borings of Exploration

Pits and Trenches – Drifts and Shafts – Methods of boring – Auger Borings – Wash Borings –Rotary Drilling –Percussion Drilling – Core Drilling

Unit - III

Soil Samples and Samplers

Types of soil samples – Disturbed samples –Undisturbed samples – Design features affecting the sample disturbance –Split spoon samplers – Scraper Bucket Samplers –Shell by Tubes

and Thin walled Samplers – Piston Samplers – Denis Samplers – Preservation and handling of samples

Unit - IV

In-Situ Testing

Field tests – Standard Penetration Tests – Cone Penetration Tests – In-situ Vane Shear Test– Plate Load Test, monotonic and cyclic –Field Permeability Tests – In-situ Tests using Pressure meter – Observation of Ground Water Table– Instrumentation in soil engineering, strain gauges, resistance and inductance type

Unit - V

Geophysical Methods and Wave Measurements

Geophysical Methods: Types–Electrical Resistivity Methods – Electrical Profiling Method – Electrical Sounding Method – Seismic Methods – Seismic refraction method – Sub-soil Investigation Report.

Wave Measurements: Cross Hole Tests (CHT), Downhole Tests (DHT), Spectral Analysis of Surface Waves, Seismic Refraction, Suspension Logging: Electromagnetic Wave Techniques: Ground Penetrating Radar (GPR), Electromagnetic Conductivity (EM), Surface Resistivity (SR), Magnetometer Surveys (MT)

Textbooks:

1. S.P. Brahma, Foundation Engineering, Tata McGraw-Hill Publishers, New Delhi, 1993.
2. V.N.S. Murthy,Soil Mechanics & Foundation Engineering, CBS Publishers & Distributors Pvt. Ltd., India, 2017.

Reference Books:

1. Hvorslev, MJ, Sub Surface Exploration and Sampling of Soils for Civil Engineering Purpose, Water-ways Station, Vicksburg, Mississippi, 1949.
2. AraArman and NareshSamtani, Sub Surface Investigations, Federal Highway Administration, Arlington, Virginia, 2002.

M. Tech., II Semester

Course Title	Earth Retaining Structures					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212202	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To calculate earth pressure on various earth retaining structures such as gravity retaining walls, sheet pile, bulkheads, bracing/struts and coffer dams, design a relevant earth retaining structure for given soil condition, design of sheet pile with and without anchors, and to design the reinforced wall by using different materials

On successful completion of this course, the students will be able to

CO 1	Determine the earth pressure and point of application for various types of soils and surcharge
CO 2	Analyzing the stability of a retaining structure and drainage conditions
CO 3	Design of sheet pile wall and fixing the embedment length, design and analyze the caissons according to IRC guidelines
CO 4	Designing of lateral supporting system and their stability
CO 5	Design of reinforced earth wall

Unit – I

Earth Pressure

Rankine and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.

Unit – II

Retaining Walls

Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls

Unit – III

Sheet Pile Wall

Free Earth System, Fixed Earth System

Unit – IV

Bulkheads

Bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates

Unit – V

Braced Excavations

Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays

Textbooks:

1. Das, B.M., Principles of Geotechnical Engineering, Cengage Learning India Private Limited, UP,2018.
2. Mandal, J.N., Reinforced Soil and Geo-textiles, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Reference Books:

1. McCarthy, D.F., Essentials of Soil Mechanics and Foundations: Basic Geo-techniques (Sixth Edition), Prentice Hall, 2002.
2. Militisky, J. and Woods, R., Earth and Earth Retaining Structures, Routledge, 1992.

M. Tech., II Semester

Course Title	Dynamics of Soil and Foundations				M. Tech. II Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2212203	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs					End Exam Duration: 3 Hrs		

Course Objectives:

- Study vibration concepts in soils, effect of liquefaction, dynamic elastic constants, cyclic plate load test, machine foundation design and bearing capacity of foundations

On successful completion of this course, the students will be able to

CO 1	Understands theory of vibration and resonance phenomenon, dynamic amplification
CO 2	Understand propagation of body waves and surface waves through soil.
CO 3	Exposed to different methods for estimation of dynamic soil properties required for design purpose
CO 4	Predict dynamic bearing capacity and assess liquefaction potential of any site
CO 5	Apply theory of vibrations to design machine foundation based on dynamic soil properties and bearing capacity

Unit – I

Fundamentals of Vibrations and Wave Propagation

Single, two and multiple degree of freedom systems,vibration isolation, vibration absorbers, vibration measuring instruments. Wave propagation**:** elastic continuum medium, semi-infinite elastic continuummedium,soil behaviour under dynamic loading.

Unit – II

Liquefaction of Soils

liquefaction mechanism, factors affecting liquefaction, studies bydynamic tri-axial testing, oscillatory shear box, shake table and blast tests, assessment ofliquefaction potential.

Unit – III

Dynamic elastic constants of soil

Determination of dynamic elastic constants, variousmethods including block resonance tests, cyclic plate load tests, wave propagation tests,oscillatory shear box test.

Unit – IV

Machine Foundations

Design criteria for machine foundations; Elastic homogeneoushalf space and lumped parameter solutions, analysis and design of foundations for reciprocatingand impact type machines, turbines, effect of machine foundation on adjoining structures.

Unit – V

Bearing Capacity of Foundations

Introduction to bearing capacity of dynamicallyloaded foundations, such as those of water towers, chimneys and high rise buildings, response ofpile foundations.

Textbooks:

1. Das, B.M., "Fundamentals of Soil Dynamics", Elsevier,1983.
2. Prakash, S., Soil Dynamics, McGraw Hill, 1981.

Reference Books:

1. Kameswara Rao, N.S.V., Vibration Analysis and Foundation Dynamics, Wheeler Publication Ltd., 1998.
2. Prakash, S. and Puri, V.K., Foundation for Machines: Analysis and Design, John Wiley & Sons, 1998

M. Tech., II Semester

Course Title	Foundations on Expansive Soils					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212204	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To study the behaviour, treatment and moisture control of the expansive soils and design steps for shallow and deep foundations and estimation of lateral pressure.

On successful completion of this course, the students will be able to

CO 1	Understand the behaviour of expansive soils
CO 2	Understand the treatment methods and moisture control techniques
CO 3	Design the shallow foundations on the expansive soils
CO 4	Design the deep foundations on the expansive soils
CO 5	Determine the lateral pressure and designing the support systems

Unit – I

Nature of Expansive Soils

Microscale Aspects of Expansive Soil Behavior, Macroscale Aspects of Expansive SoilBehavior, Identification of Expansive Soils, Characteristics of Expansive Soil Profiles

Unit – II

Soil Treatment and Moisture Control

Over excavation and Replacement, Pre-wetting Method, Chemical Admixtures, Moisture Control Alternatives

Unit – III

Design Methods for Shallow Foundations

Spread Footing Foundations, Stiffened Slab Foundations, Remedial Measures for Shallow Foundations

Unit – IV

Design Methods for Deep Foundations

Pier and Grade Beam Foundation, Patented Piers, Deep Foundation Design Examples, Remedial Measures for Deep Foundations

Unit – V

Lateral Pressure on Earth Retaining Structures

Computation of Lateral Pressure from Expansive Soils, Testing for Measuring Lateral Swelling Pressure, Reduction of Lateral Swelling Pressure, Design for Lateral Earth Pressure

Textbooks:

1. John D Nelson and Debora J Miller., "Expansive Soils – Problems and Practice in Foundation and Pavement Engineering", John Wiley & Sons, INC., 1997.
2. RamachandraPhani Kumar and Sana Suri., "Expansive Soils – Problems and Remedies", LAP Lambert Academic Publishing, 2013.

Reference Books:

1. D.R. Snethen., "A Review of Engineering Experiences with Expansive Soils in Highway Sub-grades", Federal Highway Administration, Washington DC., 1976.
2. F.H.Chen, Foundations on Expansive Soils, Elsevier Scientific Publishing Company, New York, 1988.

M. Tech., II Semester

Course Title	Offshore Geotechnical Engineering					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212205	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- Execute investigation program for marine soil deposits and select necessary design parameters. Design suitable marine foundation as per project requirement. Can develop numerical model for response of marine foundation for offshore conditions

On successful completion of this course, the students will be able to

CO 1	Understand the marine soil deposits and their properties
CO 2	Understand the behaviour of soils subjected to repeated loading
CO 3	Perform site investigation in marine environment
CO 4	Differentiate the offshore and nearshore foundation structures,
CO 5	Design the marine foundations by using FEM based analysis

Unit – I

Marine Soil Deposits

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

Unit – II

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

Unit – III

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

Unit – IV

Foundations in Marine Soil Deposits

Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. Caissons, Spud Cans

Unit – V

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

Textbooks:

1. H. G. Poulos. "Marine Geotechnics", Unwin Hyman Ltd, London, UK, 1988
2. D. V. Reddy and M. Arockiasamy, "Offshore Structures", Volume: 1, R.E. Kreiger Pub and Co., 1991

Reference Books:

1. D. Thomson and D. J. Beasley, "Handbook of Marine Geotechnical Engineering", USNavy, 2012

M. Tech., II Semester

Course Title	Design of Under Ground Excavations					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212206	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To know the planning and exploration of various underground projects, analyze the stress distribution, analyze the rock quality designation and also evaluate its strength
- To analyze the interaction between the rock mass and tunnel surface

On successful completion of this course, the students will be able to

CO 1	Understand the applications and principles of underground excavations
CO 2	Understand the stress distribution around the tunnel with different shapes
CO 3	Performing the various tests to identify the classification of rock
CO 4	Designing the supporting system for tunnels
CO 5	Performing the tests on rock mass

Unit – I

Introduction

Introduction, planning of exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.

Unit – II

Stress Analysis for Tunnels

Elastic stress distribution around tunnels, stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings,openings in laminated rocks, elasto-plastic analysis of tunnels, Daemen's theory

Unit – III

Rock Mass Classification

Application of rock mass classification systems, ground conditions in tunneling, analysis of underground openings in squeezing and swelling ground, empirical methods, estimation of elastic modulus and modulus of deformation of rocks; uniaxial jacking / plate jacking tests, radial jacking and Goodman jacking tests, long term behaviour of tunnels and caverns, New Austrian Tunneling Method (NATM), Norwegian Tunneling Method (NTM), construction dewatering.

Unit – IV

Design of Support System

Rock mass-tunnel support interaction analysis, ground response and support reaction curves, Ladanyi'selasto-plastic analysis of tunnels, design of various support systems including concrete and shotcrete linings, steel sets, rock bolting and rock anchoring, combined support systems, estimation of load carrying capacity of rock bolts

Unit – V

Test on Rock Mass

In-situ stress, flat jack, hydraulic fracturing and over coring techniques and USBM type drill hole deformation gauge, single and multi-point bore hole extensometers, load cells, pressure cells, etc. Instrumentation and monitoring of underground excavations, during and after construction, various case studies

Textbooks:

1. Hoek, E and Brown, E. T.," Underground Excavations in Rocks", Institute of Mining Engineering, 1980.
2. Singh, B. and Goel, R.K., "Rock Mass Classification- A Practical Engineering Approach", Elsevier, 1999.

Reference Books:

1. Obert, L. and Duvall, W.I., "Rock Mechanics and Design of Structures in Rocks", John Wiley.
2. Singh, B. and Goel, R.K., "Tunneling in Weak Rocks", Elsevier

M. Tech., II Semester

Course Title	Design with Geosynthetics					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212207	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To understand the emerging trends of Geosynthetic in Geotechnical Engineering
- To evaluate the different properties of including different tests
- To analyze the functions of geosynthetic and its suitability
- To design different structures using geosynthetics according to various applications

On successful completion of this course, the students will be able to

CO 1	Understand the applications and principles of underground excavations
CO 2	Understand the stress distribution around the tunnel with different shapes
CO 3	Performing the various tests to identify the classification of rock
CO 4	Designing the supporting system for tunnels
CO 5	Performing the tests on rock mass

Unit – I

Overview of Geosynthetics

Basic description of Geosynthetics, Polymeric Material, Geotextiles, Geogrids, Geonets, Geomembranes, Geosynthetic Clay Liners, Geopipe, Geofoam, Geocomposites.

Unit – II

Designing with Geotextiles

Design Methods, Geotextile Functions, Mechanism, Properties, Test Methods, Separation, Roadway Reinforcement, Soil Reinforcement, Filtration, Drainage, Multiple Functions, Construction Methods and Techniques.

Unit – III

Designing with Geogrids

Properties and Test Methods, Designing for Geogrid Reinforcement, Design Critique, Construction Methods.

Unit – IV

Designing with Geonets

Properties and Test Methods, Designing for Geonet Drainage, Design Critique, Construction Methods.

Unit – V

Designing with Geomembranes

Properties and Test Methods, Survivability Requirements, Liquid Containment Liners, Covers for Reservoirs, Water Conveyance Liners, Solid Material Liners, Landfill Covers and Closures, Under Ground Storage Tanks, Hydraulic and Geotechnical Applications.

Text Books:

1. "Designing with Geosynthetics by Robert M. KoernerPrantice Hall, Eaglewood cliffs, NJ, 2012.
2. "Engineering with Geosynthetics", by G. Venkatappa Rao and GVSSuryanarayana Raju – Tata McGraw Hill Publishing Company Limited – New Delhi, 1990.

Reference Books:

1. Jewell, R.A., Soil Reinforcement with Geotextile, CIRIA, London, 1996.
2. Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Earthworks, London, 1988.

M. Tech., II Semester

<table>
<tr><td>Course Title</td><td colspan="5">Geotechnical Earthquake Engineering</td><td colspan="3">M. Tech. II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours/Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2212208</td><td rowspan="2">Professional Elective
(PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="6">Mid Exam Duration: 02.00 Hrs</td><td colspan="3">End Exam Duration: 3 Hrs</td></tr>
<tr><td colspan="9">Course Objectives:
• To know the causes and quantification of earthquake.
• Exposed to the effect of earthquake and the design criterions to be followed for the design different geotechnical structures</td></tr>
<tr><td colspan="9">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Determine size of earthquake and strong ground motion parameters from a recorded seismogram</td></tr>
<tr><td>CO 2</td><td colspan="8">Analyze deterministic or probabilistic seismic hazard analysis considering the different soil properties and site conditions</td></tr>
<tr><td>CO 3</td><td colspan="8">Study principles of wave propagation through rocks and soil media to derive transfer functions for ground response analysis</td></tr>
<tr><td>CO 4</td><td colspan="8">Analyze liquefaction susceptibility of a site and determine factor of safety against liquefaction</td></tr>
<tr><td>CO 5</td><td colspan="8">Design earthquake resistant geotechnical structures like shallow and deep foundations, retaining walls, slopes</td></tr>
</table>

Unit – I

Earthquake Seismology

Causes of Earthquake, Plate Tectonics, Earthquake Fault Sources, Seismic Waves, Elastic Rebound Theory, Quantification of Earthquake, Intensity and Magnitudes, Earthquake Source Models.

Unit – II

Earthquake Ground Motion

Seismograph, Characteristics of Ground Motion, Effect of Local Site Conditions On Ground Motions, Design Earthquake, Design Spectra, Development of Site Specification and Code-Based Design.

Unit – III

Ground Response Analysis

One-Dimensional Ground Response Analysis: LinearApproaches, Equivalent Linear Approximation of Non-Linear Approaches, Computer Code “SHAKE”.

Unit – IV

Liquefaction and Lateral Spreading

Liquefaction Related Phenomena, LiquefactionSusceptibility: Historical, Geological, Compositional and State Criteria. Evaluationof Liquefaction by Cyclic Stress and Cyclic Strain Approaches, Lateral Deformation and Spreading, Criteria for Mapping Liquefaction Hazard Zones.

Unit – V

Design of Foundations and Stability Analysis of Slopes

Seismic Design of Foundations, Seismic Slope Stability Analysis: Internal Stability and Weakening Instability and Seismic Design of Retaining Walls.

Textbooks:

1. Steven Kramer, "Geotechnical Earthquake Engineering", Pearson, 2008.
2. Ferrito, J.M, Seismic Design Criteria for Soil Liquefaction, Tech. Report of Naval Facilities service center, Port Hueneme, 1997.

Reference Books:

1. Seco e Pinto, P., Seismic Behaviour of Ground and Geotechnical Structure, CRC Press, 1997.
2. Naeim, F., The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.

M. Tech., II Semester

<table>
<tr><td>Course Title</td><td colspan="4">Subsoil Exploration Lab</td><td colspan="3">M. Tech. II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours/Week</td><td>Credits</td><td colspan="2">Maximum Marks</td></tr>
<tr><td rowspan="2">2212209</td><td rowspan="2">Professional Core
(PCC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 02.00 Hrs</td><td colspan="3">End Exam Duration: 3 Hrs</td></tr>
<tr><td colspan="8">Course Objectives:
• To estimate the soil properties, load carrying capacity and soil profile.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Classify the soil based on the collection of soils by borings and SPT</td></tr>
<tr><td>CO 2</td><td colspan="7">Design the suitable foundation based upon the load carrying capacity of the soil</td></tr>
</table>

List of Experiments:

1. Auger Boring
2. Standard Penetration Test
3. Plate Load Test
4. Field CBR Test
5. Pile Load Test
6. Geophysical Exploration Tests

Textbooks:

1. S. Mittal and JP Shukla, Soil Testing for Engineers, Khanna Publishers, New Delhi, 2008.

Reference Books:

1. Compendium of Indian Standards on Soil Engineering: Part – 1 & 2, Laboratory and Field Testing of Soils for Civil Engineering Purposes.

M. Tech., II Semester

Course Title	Geotechnical Engineering Modeling Lab					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212210	Professional Core (PCC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	4	2	50	50	100
Mid Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To estimate the bearing capacity and settlement of footing and pile, safe design of the slope.

On successful completion of this course, the students will be able to

CO 1	Design the bearing capacity and settlement of shallow and deep footings
CO 2	Design the slope and find the factor of safety against shear failure.

List of Experiments:

1. Ultimate, Net and Safe Bearing Capacity Using Terzaghi and IS Code Methods.
2. Net Settlement Pressure
3. Hyperbolic Curve Fitting of Tri-axial Compression Data
4. Terzaghi One dimensional consolidation solution by FDM (perform analysis of substructures by packages)
5. Beam on Elastic Foundation by FDM
6. FDM Solution for Raft Foundation
7. Axial Loaded Piles by Direct FEM
8. Laterally Loaded Piles by FDM & FEM
9. Stability Analysis by Bishop theory
10. Stability Analysis by Method of Slices.

Softwares:

1. GeoWizard
2. GeoStudio
3. Oyasis

M. Tech., II Semester

<table>
<tr><td>Course Title</td><td colspan="5">Technical Seminar</td><td colspan="3">M. Tech. II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours/Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2212211</td><td rowspan="2">Project</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td><td>100</td><td>0</td><td>100</td></tr>
<tr><td colspan="6">Mid Exam Duration: 3 Hrs</td><td colspan="3">End Exam Duration: 0 Hrs</td></tr>
<tr><td colspan="9">Course Objectives:
To explain themselves with the latest developments, the State of art, in a Particular Area. It will be forum for the exchange of ideas with experts and the professional so with a view to acquiring additional knowledge acquainting each other with new research work, new methods and techniques of investigation or production</td></tr>
<tr><td colspan="9">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Students will get an opportunity to work in actual industrial environment if they opt for internship</td></tr>
<tr><td>CO 2</td><td colspan="8">In case of mini project, they will solve a live problem using software/analytical/computational tools</td></tr>
<tr><td>CO 3</td><td colspan="8">Students will learn to write technical reports</td></tr>
<tr><td>CO 4</td><td colspan="8">Students will develop skills to present and defend their work in front of technically qualified audience</td></tr>
</table>

Description:

Students can take up small problems in the field of design engineering as technical seminar. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

M. Tech., II Semester

Course Title	Value Education					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2270A04	Audit	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	0	40
Mid Exam Duration: 2 Hrs						End Exam Duration: 0 Hrs		

Course Objectives:

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

On successful completion of this course, the students will be able to

CO 1	Know the self-development
CO 2	Learn the importance of human values
CO 3	Developing the personality
CO 4	Understanding the true friendship
CO 5	Understanding and improving the character

Unit – I

Values and Self-Development

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements.

Unit – II

Importance of Cultivation of Values

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.

Unit – III

Personality and Behavior 1

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.

Unit – IV

Personality and Behavior 2

True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

Unit – V

Character and Competence

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

Textbooks:

1. Chakroborty, S.K. "Values and Ethics for Organizations Theory and Practice", Oxford University Press, New Delhi, 1999.

M. Tech., II Semester

Course Title	Constitution of India				M. Tech. II Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
2270A05	Audit	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	0	40
Mid Exam Duration: 2 Hrs					End Exam Duration: 0 Hrs		

Course Objectives:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

On successful completion of this course, the students will be able to

CO 1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO 2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO 3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO 4	Discuss the passage of the Hindu Code Bill of 1956.

Unit – I

History and Philosophy of the Indian Constitution

History, Drafting Committee, (Composition & Working), Preamble, Salient Features

Unit – II

Contours of Constitutional Rights & Duties

Fundamental Rights,Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Unit – III

Organs of Governance

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

Unit – IV

Local Administration

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

Unit – V

Election Commission

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Textbooks:

1. The Constitution of India, 1950 (Bare Act), Government Publication., 2021.
2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Reference Books:

1. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1stEdition, 2015.
2. M. P. Jain, Indian Constitution Law, 7thEdn., Lexis Nexis, 2014.

M. Tech., II Semester

Course Title	Pedagogy Studies					M. Tech. II Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2270A06	Audit	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		2	0	0	0	40	0	40
Mid Exam Duration: 2 Hrs						End Exam Duration: 0 Hrs		

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

On successful completion of this course, the students will be able to

CO 1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
CO 2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO 3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Unit – I

Introduction and Methodology

Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

Unit – II

Thematic Overview

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

Unit – III

Pedagogical Practices

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

Unit – IV

Professional Development

Alignment with classroom practices and follow- up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Unit – V

Research Gaps and Future Directions

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact

Textbooks:

1. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell, 2001.
2. Akyeampong K, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID., 2003.

Reference Books:

1. Ackers J, Hardman F, Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261., 2001.
2. Agrawal M, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379., 2004.

III Semester

Syllabus

M. Tech., III Semester

Course Title	Stability Analysis of Slopes					M. Tech. III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212301	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To introduce the concepts of slope stability, introduce the concepts of slope stability analyses using simplified methods, and to describe some of the sophisticated methods of slope stability analyses.

On successful completion of this course, the students will be able to

CO 1	Understand the types of slopes and their failures
CO 2	Design the stability for finite and infinite slopes
CO 3	Check the stability of a slope when there is a seepage
CO 4	Adopt the advanced methods to strengthen the slope
CO 5	Investigate the failures in stability of slopes

Unit – I

Slopes

Types and Causes of Slope Failures, Mechanics of Slope Failure, Failure Modes.

Unit – II

Stability Analysis

Infinite and Finite Slopes with or Without Water Pressures; Concept of Factor of Safety, Pore Pressure Coefficients, Mass Analysis, Wedge Methods, Friction Circle Method; Method of Slices, Bishop's Method, Janbu's Method, Morgenstern and Price, Spencer's Method

Unit – III

Stability Analysis in the Presence of Seepage

Two Dimensional Flow – Laplace Equation and its Solution, Graphical Method, Determination of Phreatic Line, Flow Nets in Homogeneous and Zoned Earth Dams under Steady Seepage and Draw-Down Conditions, Seepage Control in Earth Dams, Influence of Seepage on Slope Stability Analysis of Dam Body During Steady Seepage

Unit – IV

Strengthening Measures

Stabilization of Slopes by Drainage Methods, Surface and Subsurface Drainage, Use of Synthetic Filters, Retaining Walls, Stabilization and Strengthening of Slopes, Shotcreting,

Rock Bolting and Rock Anchoring, Instrumentation and Monitoring of Slopes, Slope Movements, Warning Devices, Maintenance of Slopes

Unit – V

Case studies of urban slope stability

Aims, Regional perspective, Landslide inventory, Stability analyses of three sites, Case study 1 – Site 64 in the suburb of Scarborough, Case study 2 – Site 77, Morrison Avenue – Wombarra, Case study 3 – Site 134, Woonona Heights, concluding remarks on the three case studies, Landslide-triggering rainfall, Landslide susceptibility and hazard, Observational approach and monitoring.

Textbooks:

1. Chowdhary R Phil Flentje and Bhattacharya G, "Geotechnical Slope Analysis", CRC Press., 2009.
2. YM Cheng and CK lau, "Slope Stability Analysis and Stabilization", CRC Press., 2017.

Reference Books:

1. Milton E. Harr., "Groundwater and Seepage", Dover Publications. 2012.

M. Tech., III Semester

Course Title	Foundation on Weak Rocks					M. Tech. III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212302	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 02.00 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To study the properties of weak rock and classification, analyze the effect of structural planes, study the requirements of satisfactory performance of foundation and analyze the pile on weak rock.

On successful completion of this course, the students will be able to

CO 1	Estimate the properties of rock
CO 2	Understand the effect of weak rock on foundations
CO 3	Estimate the satisfactory conditions and bearing capacity
CO 4	Designing the shallow foundation on sloping ground and suggesting the treatment methods of foundations
CO 5	Design of pile foundations on rock and performing the load tests

Unit – I

Properties of Weak Rock

Engineering Properties of Weak Rocks, Different Rock Mass Classification Systems, Relative Merits and Demerits, Failure Criteria for Weak Rocks, Bi-Linear Mohr-Coulomb Failure Criterion, Hoek and Brown Criterion and Modified Hoek and Brown Failure Criterion Etc.

Unit – II

Effect of Weak Rock

Effect of Structural Planes on Rock Foundations, Possible Modes of Failure of Foundations on Rocks/ Rock Masses, Determination of In-Situ Shear Strength of Rocks and Rock Masses

Unit – III

Performance of Foundations

Requirements for Satisfactory Performance of Foundations, Bearing Capacity of Foundations on Rocks and Rock Masses, Allowable Bearing Pressure of Rock Foundations Using a Nonlinear Failure Criterion, Monotonic and Cyclic Plate Load Tests, Pressure-Settlement Characteristics, Effect of Layering, Anisotropy, Heterogeneity and Inelasticity

Unit – IV

Shallow Foundations

Shallow Foundations, Shallow Foundations on Sloping Ground, Raft Foundations, Stilt Foundations, Foundations for Suspension Bridges, Transmission Line Towers, Framed Buildings etc., Treatment of Foundations - Open Joints, Solution Cavities, Weak Seams

Unit – V

Pile Foundations

Piles in Weak Rocks, Bearing Capacity and Settlement of Piles, Piles in Stratified Rock Masses, Field Load Tests on Piles in Weak Rocks, Behaviour of Bored / Driven Piles in Soft / Weathered Rocks

Textbooks:

1. Ramamurthy, T., "Engineering in Rocks", PHI Learning Pvt. Ltd., 2014.
2. Hoek, E., "Practical Rock Engineering", Rock Science., 2006.

Reference Books:

1. Wyllie Duncan C.," Foundations on Rock: Engineering Practice", E &FnSpon, Taylor and Francis., 2005.
2. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: An Introduction to the Principles, 1997. Elsevier, Oxford

M. Tech., III Semester

Course Title	Computational Geomechanics					M. Tech. III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212303	Professional Elective (PEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To understand different numerical and statistical tools for analyzing various geotechnical engineering problems.
- To apply probabilistic approach for selection of design parameters and compute their impact on risk assessment.

On successful completion of this course, the students will be able to

CO 1	Analyze linear and non-linear equations using numerical techniques
CO 2	Apply finite difference and finite element method for analyzing behaviour of geotechnical structures
CO 3	Apply correlation and regression analysis for the geotechnical data.
CO 4	Solve multilayered soil system by FEM and FDM
CO 5	Solve problem of consolidation and flow through porous media using numerical technique

Unit – I

Solution of Non-Linear and Linear Equations

Bisection, False Position, Newton-Raphson, Successive Approximation Method, Iterative Methods, Jacobi's Method, Gauss Seidal Method, Successive over Relaxation Method.

Unit – II

Finite Difference and Finite Element Method

Two Point Boundary Value Problems – Disichlet Conditions, Neumann Conditions; Ordinary and Partial Differential Equations. Fundamentals, Constitutive Finite Element Models for Soils.

Unit – III

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.

Unit – IV

One-Dimensional Consolidation

Theory of Consolidation, Analytical Procedures, Finite Difference Solution Procedure for Multilayered Systems, Finite Element Formulation

Unit – V

Flow through Porous Media and Risk Assessment in Geotechnical Engg.

Geotechnical Aspects, Numerical Methods, Applications and Design Analysis, Flow in Jointed Media. Probabilistic Site Characterization and Design of Foundations

Textbooks:

1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computations", Third Edition, New Age International (P) Ltd. Publishers, New Delhi. 2019.

Reference Books:

1. D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK., 1981.
2. Sam Helwany, "Applied Soil Mechanics", John Wiley & Sons, Inc,, 2007.

M. Tech., III Semester

Course Title	Solid Waste Management				M. Tech. III Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
22OE121	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs					End Exam Duration: 3 Hrs		

Course Objectives:

- To know the necessity of solid waste management
- To study various strategies for the collection of solid waste
- To understand various solid waste disposal methods
- To understand how to categorize the Hazardous Wastes

On successful completion of this course, the students will be able to

CO 1	Understand and identify the physical and chemical composition of solid waste.
CO 2	Understand the optimum route planning for transport of solid waste.
CO 3	Understand the techniques and methods used in transformation, conservation, and recovery of materials from solid wastes.
CO 4	Understand the design of waste disposal systems.

Unit – I

Introduction to Solid Waste

Definition - Types of solid waste - sources of solid waste - Characteristics - properties of solid wastes - Sampling of Solid wastes - Elements of solid waste management

Unit – II

Solid Waste Management

Solid waste generation - onsite handling - storage and processing - collection of solid wastes - Stationary container system and Hauled container systems - Route planning - transfer and transport.

Unit – III

Resource and Energy Recovery

Processing techniques - materials recovery systems - Composting - types of composting - Problems with composing – Pyrolisis – Gasification - RDF - recovery of energy from conversion products - materials and energy recovery systems.

Unit – IV

Landfills

Types and Construction of landfills - Design considerations - Life of landfills - Landfill

Problems - Lining of landfills - Leachate pollution and control - Landfills reclamation.

Unit – V

Hazardous Waste Management

Sources and characteristics - Effects on environment - Risk assessment - Disposal of hazardous wastes - Secured landfills, incineration - Biomedical waste disposal - E-waste management

Textbooks:

1. Tchobanoglous G, Theisen H and Vigil SA 'Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993.
2. Vesilind PA, Worrell W and Reinhart D, 'Solid Waste Engineering' Brooks/Cole Thomson Learning Inc., 2002.

Reference Books:

1. CPHEEO Manual on Municipal Solid Waste Management - 2000
2. Qian X, Koerner RM and Gray DH, 'Geotechnical Aspects of Landfill Design and Construction' Prentice Hall, 2002.
3. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, 'Environmental Engineering', McGraw Hill Inc., New York, 1985.

M. Tech., III Semester

Course Title	Waste to Energy					M. Tech. III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
22OE122	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Objectives:

- To create awareness in students of energy conservation.
- To identify the use of different types of Bio waste energy resources.
- To understand different types of bio waste energy conservations.
- To detect different waste conversion into different forms of energy.

On successful completion of this course, the students will be able to

CO 1	Find different types of energy from waste to produce electrical power
CO 2	Estimate the use of bio waste to produce electrical energy
CO 3	Understanding different types of bio waste and its energy conversions
CO 4	Analyze the bio waste utilization and to avoid the environmental pollution

Unit – I

Introduction to Energy from Waste

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters

Unit – II

Biomass Pyrolysis

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit – III

Biomass Gasification

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit – IV

Biomass Combustion

Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit – V

Biogas

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion -Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Textbooks:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Food, Feed and Fuel from Biomass, Chahal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

Reference Books:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1989.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996

M. Tech., III Semester

Course Title	Sub soil exploration techniques				M. Tech. III Semester		
Course Code	Category	Hours/Week		Credits	Maximum Marks		
22OE123	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	40	60	100
Mid Exam Duration: 2 Hrs					End Exam Duration: 3 Hrs		

Course Objectives:

- To identify the soil type of soil from a job site or in a professional setting, determine that soil's properties based on type and evaluate design decisions from your understanding of that soil's properties.
- To explore the scientific principles used to describe the major engineering properties of soil, and the engineering testing methods used to quantify these properties

On successful completion of this course, the students will be able to

CO 1	Plan subsurface investigation based on the requirement of civil engineering project and site condition. Can finalize depth and number of boreholes
CO 2	Execute different subsurface exploration tests
CO 3	Collect disturbed/undisturbed samples for laboratory tests and can suggest design parameters
CO 4	Expose different methods for estimation of dynamic soil properties required for design purpose.

Unit - I

Introduction

Scopes and objectives of explorations – Planning a subsurface exploration – Stages in sub surface exploration – Explorations for preliminary and detailed design – Spacing and depth of exploration

Unit - II

Open Excavation and Borings of Exploration

Pits and Trenches – Drifts and Shafts – Methods of boring – Auger Borings – Wash Borings –Rotary Drilling –Percussion Drilling – Core Drilling

Unit - III

In-Situ Testing

Field tests – Standard Penetration Tests – Cone Penetration Tests – Plate Load Test, monotonic and cyclic –Field Permeability Tests – Instrumentation in soil engineering, strain gauges, resistance and inductance type

Unit - IV

Geophysical Methods:
Geophysical Methods: Types–Electrical Resistivity Methods – Electrical Profiling Method – Electrical Sounding Method – Seismic Methods – Seismic refraction method – Sub-soil Investigation Report.

Unit - V
Wave Measurements:
Cross Hole Tests (CHT), Downhole Tests (DHT), Spectral Analysis of Surface Waves, Seismic Refraction, Suspension Logging: Electromagnetic Wave Techniques: Ground Penetrating Radar (GPR), Electromagnetic Conductivity (EM), Surface Resistivity (SR), Magnetometer Surveys (MT)

Textbooks:

1. S.P. Brahma, Foundation Engineering, Tata McGraw-Hill Publishers, New Delhi, 1993.
2. V.N.S. Murthy,Soil Mechanics & Foundation Engineering, CBS Publishers & Distributors Pvt. Ltd., India, 2017.

Reference Books:

1. Hvorslev, MJ, Sub Surface Exploration and Sampling of Soils for Civil Engineering Purpose, Water-ways Station, Vicksburg, Mississippi, 1949.
2. AraArman and NareshSamtani, Sub Surface Investigations, Federal Highway Administration, Arlington, Virginia, 2002.

M. Tech., III Semester

Course Title	Dissertation Phase – 1					M. Tech. III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212307	Project	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	20	10	100	----	100
Mid Exam Duration: ----						End Exam Duration: ----		

Course Objectives:

- The purpose of dissertation is to introduce to students, the research methods and to develop competencies for critically examining topics of their interest and present them. This will be a preparatory stage for the terminal or thesis project.

On successful completion of this course, the students will be able to

CO 1	Students will be exposed to self-learning various topics
CO 2	Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research
CO 3	Students will learn to write technical reports
CO 4	Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience

Description:

The Project Work will start in semester 3rd and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

IV Semester

Syllabus

M. Tech., IV Semester

Course Title	Dissertation Phase – 2					M. Tech. IV Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
2212401	Project	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		0	0	32	16	50	50	100
Mid Exam Duration: ----						End Exam Duration: ----		
On successful completion of this course, the students will be able to								
CO 1	Use different experimental techniques, different software / computational / analytical tools							
CO 2	Design and develop an experimental set up/ equipment/test rig							
CO 3	Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them							
CO 4	Able to either work in a research environment or in an industrial environment, conversant with technical report writing							
CO 5	Able to present and convince their topic of study to the engineering community							

Description:

It is a continuation of Project work started in semester 3rd. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.