Guru Nanak Dev Engineering College, Ludhiana

Civil Engineering Department

M.Tech. (Geotechnical Engineering)

Program Outcomes (PO)

After completion of the program graduates will be able to

1. Learn the behavior of soil and rock.
2. Perform various laboratory and in-situ tests on soil/rock to find out design parameters.
3. Design shallow/deep foundations, earth retaining structures, embankment and earthen dams, tunnel support systems for given site conditions.
4. Compute factor of safety to assess stability of slopes and apply preventive measures for stability.
5. Develop numerical models to estimate response of various geotechnical structures under different loadings.

First Semester									
Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Core Theory	MGT-101	Advanced Soil Mechanics	3	0	0	50	100	150	3
Core Theory	MGT-102	Subsurface Investigations & Instrumentation	3	0	0	50	100	150	3
Elective	MGT- AAA	Program Elective I	3	0	0	50	100	150	3
Elective	MGT-BBB	Program Elective II	3	0	0	50	100	150	3
Core Lab I	LMGT-101	Soil Mechanics lab - I	0	0	2	50	50	100	1
Core Lab II	LMGT-102	Soil Mechanics lab - II	0	0	4	50	50	100	2
MLC	MRM-101	Research Methodology and IPR	3	0	0	50	100	150	3
Audit 1	MAC-102	Disaster Management	2	0	0	50	-	50	0
		Total	**17**	**0**	**6**	**400**	**600**	**1000**	**18**
Second Semester									
Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Core Theory	MGT-103	Advanced Foundation Engineering	3	0	0	50	100	150	3
Core Theory	MGT-104	Soil Dynamics	3	0	0	50	100	150	3
Elective	MGT- CCC	Program Elective III	3	0	0	50	100	150	3
Elective	MGT- DDD	Program Elective IV	3	0	0	50	100	150	3

Core Lab III	LMGT-103	Model Testing Lab	0	0	2	50	50	100	1
Core Lab IV	LMGT-104	Numerical Analysis Lab	0	0	4	50	50	100	2
Core	LMPGT-101	Project	0	0	4	50	50	100	2
Audit 2	MAC-101	English for research report / paper writing	2	0	0	50	100	150	0
		Total	**14**	**0**	**10**	**400**	**650**	**1050**	**17**

Third Semester									
Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Elective	MGT- EEE	Program Elective V	3	0	0	50	100	150	3
Open Elective	MOGT- XXX	Open Elective	3	0	0	50	100	150	3
Pre-thesis	MPTGT-101	Formulation of Research Problem	0	0	2*+ 18**	100	100	200	10
		Total	**6**	**0**	**20**	**200**	**300**	**500**	**16**
Fourth Semester									
Course Type	**Course Code**	**Course Name**	**Load Allocations**			**Marks Distribution**			**Credits**
			L	**T**	**P**	**Int**	**Ext**	**Total Marks**	
Thesis	MTGT-101	Thesis	0	0	4*+ 28**	100	200	300	16
		Total	**0**	**0**	**32**	**100**	**200**	**300**	**16**

* Max hours for teacher
** Independent study hours

List of Electives

S No	**Course Name**	**Course Code**
1	Soil Structure Interaction	MGT – 111
2	Ground Improvement Techniques	MGT – 112
3	Pavement Analysis and Design	MGT – 113
4	FEM in Geomechanics	MGT – 114
5	Environmental Geotechnology	MGT – 115
6	Critical Soil Mechanics	MGT – 116
7	Rock mechanics	MGT – 117
8	Computational Geomechanics	MGT – 118
9	Geosynthetics Engineering	MGT – 119
10	Earth retaining structures	MGT – 120
11	Design of underground excavations	MGT – 121

Third Semester		
12	Clay Mineralogy	MGT – 122
13	Stability Analysis of Slopes	MGT – 123
14	Geotechnical Earthquake Engineering	MGT – 124
15	Design of Foundations on Weak Soils & Rocks	MGT – 125

M.Tech. (Soil Mechanics and Foundation Engineering) - Part Time Scheme Structure					
Semester	**Course Type**	**Number of course**	**Credit per course**	**Total Credits**	**Total Contact Hours**
First	Core Theory	2	3	06	06
	Elective	1	3	03	03
	Core Lab	1	1	01	02
Second	Core Theory	2	3	06	06
	Elective	1	3	03	03
	Core Lab	1	2	02	04
Third	Elective	1	3	03	03
	Audit	1	0	00	02
	Project	1	2	02	04
	Core Lab	1	2	02	04
Fourth	Elective	1	3	03	03
	Audit	1	0	00	02
	Mandatory	1	3	03	03
	Core Lab	1	1	01	02
Fifth	Elective	1	3	03	03
	Open	1	3	03	03
	Pre-thesis	1	10	10	2*+18**
Sixth	Thesis	1	16	16	4*+28**
* Max hours for teacher ** Independent study hours				**67**	

MGT-101 ADVANCED SOIL MECHANICS

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the behavior of different types of soils under drained and undrained conditions.
2. Compute consolidation settlements.
3. Evaluate shear strength of different soils.
4. Understand the concept of critical state soil mechanics.
5. Trace the stress path under drained and undrained conditions.
6. Compute the elastic and plastic deformations.

Syllabus Content:

- **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)
- **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.
- **Stress path:** Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.
- **Introduction to 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.
- **Elastic and plastic deformations:** elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.

Reference Books:

1. Atkinson J.H. and Bransby P.L, The Mechanics of Soils: An introduction to Critical soil mechanics, McGraw Hill
2. Atkinson J.H, An introduction to the Mechanics of soils and Foundation, McGraw- Hill
3. Das B.M., Advanced Soil Mechanics, Taylor and Francis
4. Wood D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press
5. Craig R.F., Soil Mechanics, Van Nostrand Reinhold Co. Ltd.
6. Terzaghi K. and Peck R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons
7. Lambe T.W. and Whitman R.V., Soil Mechanics, John Wiley & Sons

MGT- 102 SUBSURFACE INVESTIGATIONS AND INSTRUMENTATION

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the importance of sub surface soil investigation and learn the various techniques of soil investigation.
2. Suggest stabilization method for bore hole stability.
3. Apply appropriate sampling techniques as per site conditions.
4. Identify the various soil parameters required for the preparation of geotechnical report using in-situ and laboratory tests.
5. Update their skills with regard to the new technology available in the field of geotechnical engineering.
6. Have sufficient exposure about the soil investigation for off-shore structure using instruments.

Syllabus Contents:

- **Soil formation** -Processes – Characteristics of major soil deposits of India. Necessity and Importance of soil exploration Method of sub surface exploration Test pits , Trenches, Caissons, Tunnels and drifts, Wash boring , Percussion drilling , Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth for various Civil engineering structures.
- **Indirect method of exploration,** Seismic method, Electrical resistivity, Resistivity sounding and profiling, Qualitative and quantitative interpretation of test results, Comparison of resistivity and seismic surveys, Shortcomings.
- **Stabilization of bore holes:** Different method of stabilization of the bore holes, their relative merits and demerits.
- **Ground water Observation:** Different method of ground water observation: Time lag in observation, Sampling of ground water.
- **Sampling:** Source of disturbance and their influence, Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils, Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample preparation of bore log.
- **In situ Permeability:** Pumping in test in a cased hole with open end, Falling head packer test constant head packer test, Pump in out tests in a single test wall and open pit or unlined hole, Piezometer methods .
- **Water content at site:** Speedy moisture tester, Their relative merits and demerits.
- **Fields Tests:** Standard penetration test, Dynamic cone penetration tests with and without bentonite mud slurry. Static cone penetration test, Surface sampling. Cyclic plate load test, Large shear box test, Vane shear test, Pile load, , Block resonance test, wave propagation test. Small size penetrometers, Pressuremeter test and Diltometer test. Various corrections in the test results and interpretation of test results for design of foundations. Correlation among various test results. Precautions to be exercised during the execution of these tests. Preparation of bore hole log.
- **Investigation below sea/river bed:** methods and equipment – interpretation of offshore exploration, Instrumentation in soil engineering - strain gauges - resistance and inductance type - load cells, earth pressure cells - settlement and heave gauges - Piezometers and slope indicators -inclinometer, Field visit, data and report preparation.

Reference Books:

1. Bowles J.E., Foundation Analysis and Design, McGraw Hill International Edition
2. Schnaid F., In Situ Testing in Geomechanics, Taylor and Francis
3. Hvorsler M., Subsurface exploration and sampling of soil for civil engineering purposes.
4. Simon and Cayton, Site investigation

MGT-103 ADVANCED FOUNDATION ENGINEERING

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Plan soil exploration program for different projects.
2. Select different types of foundations based on site conditions
3. Analyze the bearing capacity and settlement characteristics of foundations.
4. Design the shallow and deep foundations for various site conditions as per codal provisions.
5. Suggest foundations for problaematic soils.
6. Analyze and design of foundation for coffer dams.

Syllabus Content:

- **Planning of soil exploration:** for different projects, methods of subsurface exploration, methods of borings along with various penetration tests
- **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.
- **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.
- **Well foundation:** IS and IRC codal provisions, elastic theory and ultimate resistance methods
- **Foundations on problematic soils:** Foundations for collapsible and expansive soil
- **Coffer dams**: various types, analysis and design Foundations under uplifting loads

Reference Books:

1. Bowles J.E., Foundation Analysis and Design, Tata McGraw Hill
2. Das B.M., Shallow Foundations: Bearing capacity and settlement, CRC Press
3. Tomlinson M.J., Pile design and construction Practice, Chapman and Hall Publication
4. Poulos H. G. and Davis F. H., Pile Foundation Analysis and Design, Wiley and Sons

MGT-111 SOIL STRUCTURE INTERACTIONS

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the interaction of soil and structure and factors affecting the interaction.
2. Understand the concept of various model developed to simulate the soil structure interaction.
3. apply different soil response models for specific problem based on the requirement.
4. analyze footings/rafts resting on soil as beams/plates on elastic foundation and work out design bending moments/shear and displacements.
5. compute pile and pile cap response under vertical loading for design purpose.
6. Compute the settlement and load carrying capacity of pile and pile group under lateral loading condition.

Syllabus Content:

- **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.
- **Beam on Elastic Foundation**- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.
- **Plate on Elastic Medium**: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.
- **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.
- **Laterally Loaded Pile:** Load deflection prediction for laterally loaded piles, Sub grade reaction and elastic analysis, Interaction analysis.

Reference Books:

1. Selvadurai A.P.S, Elastic Analysis of Soil-Foundation Interaction, Elsevier
2. Poulos H.G., and Davis E.H., Pile Foundation Analysis and Design, John Wiley
3. Scott R.F., Foundation Analysis, Prentice Hall
4. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers
5. ACI 336 (1988), Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute.

MGT-112 GROUND IMPROVEMENT TECHNIQUES

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the mechanism of ground improvement.
2. Identify the necessity of ground improvement.
3. Identify the ground conditions and suggest suitable methods of improvement.
4. Design and assess the degree of improvement required.
5. Understand the functions of geosynthetics and soil nailing in engineering constructions.
6. Design reinforced soil structures.

Syllabus Content:

- **Introduction:** situations where ground improvement becomes necessary
- **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
- **Chemical modification;** modification by admixtures, stabilization using industrial wastes, grouting
- **Thermal modification:** ground freezing and thawing.
- **Soil reinforcement:** Reinforced earth, basic mechanism, type of reinforcements, selection of stabilisation/improvement of ground using Geotextiles, Goegrid, Geomembranes, Geocells, Geonets, and Soil Nails.
- **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

Reference Books:

1. Hausmann M.R., Engineering Principles of Ground Modification, McGraw Hill International Editions
2. Yonekura R., Terashi M. and Shibazaki M. (Eds.), Grouting and Deep Mixing, A.A. Balkema
3. Moseley M.P., Ground Improvement, Blackie Academic & Professional
4. Xanthakos P.P., Abramson L.W. and Bruce D.A., Ground Control and Improvement, John Wiley & Sons
5. Koerner R. M., Designing with Geosynthetics, Prentice Hall Inc.
6. Shukla S.K., Yin Jian-Hua, Fundamentals of Geosynthetic Engineering, Taylor & Francis

MGT-113 PAVEMENT ANALYSIS AND DESIGN

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. appreciate the functions of various components of a pavement.
2. identify the factors affecting design of pavements
3. design flexible pavements
4. design of rigid pavements.
5. evaluate performance of pavement and .
6. design the overlay on flexible and rigid pavement.

Syllabus Content:

- **Introduction:** Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components
- **Pavement Design Factors:** Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, Axles configuration and tyre pressure. Drainage – Estimation of flow, surface drainage, sub-surface drainage systems, design of sub-surface drainage structures.
- **Flexible Pavement Design:** Empirical, semi-empirical and theoretical approaches as Methods for design of flexible pavements; Group Index method, California Bearing Ratio (CBR) method, California Resistance Value method, Triaxial Test method, Burmister method, McLeod's method. Design of highway by IRC as per latest IRC code, AASHTO Methods, applications of pavement design software.
- **Rigid Pavements Design:** Westergaard’s Theory and Assumptions, Stresses due to Curling, Stresses and Deflections due to Loading, Frictional Stresses. Wheel load & its repetition, sub grade strength & proportion, strength of concrete- modulus of elasticity. Reinforcement in slab. Design of joints. Design of Dowel bars. Design of Tie bars. IRC methods of Rigid Pavement design.
- **Pavement Evaluation and Rehabilitation:** Pavement evaluation and rehabilitation, condition and evaluation surveys – PSI models, Need for Overlays, Overlays design methods for Flexible and Rigid pavements.

Reference Books:

1. Yang and H. Huang, Pavement Analysis and Design, Pearson Prentice Hall
2. Yoder and Witzech, Pavement Design, McGraw Hill
3. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House
4. Teng, Functional Designing of Pavements, McGraw Hill

MGT-114 FEM IN GEOMECHANICS

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the fundamentals of Finite element method.
2. impart the knowledge and skill of analyzing physical problems with FE software.
3. understand the basic functions of FE based software and its applications in geotechical engineering.
4. select the appropriate element and mesh for FE analysis for given problem.
5. evaluate the type of problem and develop the FE-model.
6. estimate the stresses and strain in soil through FE analysis for given physical problem

Syllabus Content:

- **Stress-deformation analysis:** One dimensional, two dimensional and three-dimensional formulations.
- **Discretization of a Continuum**, Elements, Strains, Stresses, Constitutive, Relations, Hooke's Law, Formulation of Stiffness Matrix, Boundary Conditions, Solution Algorithms
- **Principles of discretization**, element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence.
- **Displacement formulation** for rectangular, triangular and iso-parametric elements for two dimensional and axisymmetric stress analysis.
- **Settlement Analysis:** 2-D elastic solutions for homogeneous, isotropic medium, Steady Seepage Analysis: Finite element solutions of Laplace's equation, Consolidation Analysis: Terzaghi consolidation problem, Choice of Soil Properties for Finite Element Analysis

Reference Books:

1. Zienkiewicz O.C. and Taylor R.L., Finite element methods (Vol I & Vol II), McGraw Hill
2. Bathe K.J., Finite element procedures, PHI Ltd.
3. Potts D.M. and Zdravkovic L., Finite Element Analysis in Geotechnical Engineering, Thomas Telford

MGT-115 ENVIRONMENTAL GEOTECHNOLOGY

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand soil environment interaction, composition, soil structure and its behaviour.
2. Specify site investigation techniques for characteristics of contaminated site.
3. Identify contaminant transport mechanisms in soils.
4. Specify site investigation techniques for characterization of contaminated site
5. Understand the principles of soil treatment techniques
6. Identify contaminants transport mechanism in soil.

Syllabus Content:

- **Soil as a multiphase system:** Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.
- **Soil mineralogy:** significance of mineralogy in determining soil behaviour; Mineralogical characterization.
- **Mechanisms of soil-water interaction:** Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction.
- **Concepts of waste containment:** Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport, desirable properties of soil; contaminant transport and retention; contaminated site remediation.
- **Soil characterization techniques:** volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis. contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, end uses of landfill sites, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

Reference Books:

1. Mitchell J.K and Soga K., Fundamentals of Soil Behavior, John Wiley and Sons Inc.
2. Fang H-Y., Introduction to Environmental Geotechnology, CRC Press
3. Daniel D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall
4. Rowe R.K., Quigley R.M. and Booker J.R., Clayey Barrier Systems for Waste Disposal Facilities, CRC Press
5. Rowe R.K, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers
6. Reddi L.N. and Inyang H.F, Geoenvironmental Engineering - Principles and Applications, Marcel Dekker Inc.
7. Sharma H.D. and Lewis S.P, Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley & Sons Inc.

MGT-116 CRITICAL SOIL MECHANICS

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Characterize stress-strain behaviour of soils, the failure criteria and to evaluate the shear strength and compressibility parameters of soils.
2. Use the concepts of stress path for different conditions.
3. Acquire knowledge for computing stress and changes in boundary surface, volume and pore water pressure.
4. Understand failure criteria of soils and apply models to study the time-deformation behaviour of soils.
5. Understand both the applications and limits of engineering methods commonly used to solve soil mechanics problems.
6. Understand the development of various elastic-plastic model.

Syllabus Content:

- **Soil Behavior:** State of stress and strain in soils, Stress and strain paths and invariants, behavior of soils under different laboratory experiments
- **The Critical state line** and the Roscoe surface: Families of undrained tests, Families of drained tests, the critical state line, drained and undrained surfaces, The Roscoe surface
- **Behavior of Over-consolidated samples:** The Hvorslev surface: Behaviour of over-consolidated samples, drained and undrained tests, The Hvorslev surface, complete State Boundary Surface, Volume changes and pore water pressure changes
- **Behaviour of Sands:** The critical state line for sands, Normalized plots, the effect of dilation, Consequences of Taylor's model
- **Behaviour of Soils before Failure:** Elastic and plastic deformations, Plasticity theory, Development of elastic-plastic model based on critical state soil mechanics, The Cam-clay model, The modified Cam-clay model

Reference Books:

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

MGT-120 Earth Retaining Structures

(Credits - 3:0:0 = 3)

Teaching Scheme

Lectures: 3 hrs/ week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Analyze the earth retaining structures for their stability against earth pressure.
2. Apply engineering knowledge for the designing of earth retaining structures in various site conditions and evaluation of retaining structures using appropriate design methods, factors of safety, earth pressure diagrams and check their stability.
3. Determine the required depth of penetration and embedment of free and fixed sheet pile walls in cohesion and cohesionless soils.
4. Evaluate anchored sheet pile walls in free and fixed earth support conditions, spacing between bulkheads and anchors, resistance of anchor plates.
5. Explain the stress distribution around tunnels, types of conduits, arching and open cuts in soils.
6. Evaluate earth pressure against bracings in cuts and heave of the bottom of clay.

Syllabus Content:

- **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.
- **Retaining walls:** Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls
- **Sheet Pile wall:** Free earth system, Fixed earth system
- **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
- **Tunnel and Conduit:** Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils,
- **Braced excavations:** Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clay

Reference Books:

1. Das, Braja M., Principles of Foundation Engineering, PWS Publishing
2. Bowles. J.E., Foundation Analysis and Design, Tata McGraw Hill

LMGT-101 (Soil Mechanics Lab-I)

(Credits - 0:0:2 = 1)

Lab: 2 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understand the procedure for classifying coarse grained and fine grained soils.
2. Evaluate the index properties of soil.
3. Determine the engineering properties of soil.
4. Interpret the results of compaction test for relative compaction in the field
5. Conduct experiments analyze and interpret results for geotechnical engineering design.
6. Compute and analyze the consolidation settlements.

List of Practicals:

1. Determination of Moisture Content and Specific gravity of soil
2. Grain Size Distribution Analysis and Hydrometer Analysis
3. Atterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit)
4. Visual Classification Tests
5. Vibration test for relative density of sand
6. Standard and modified proctor compaction test
7. Falling head permeability test and Constant head permeability test
8. Consolidation test

LMGT-102 (Soil Mechanics Lab-II)

(Credits - 0:0:4 = 2)

Lab: 4 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. To develop an appreciation the use of field tests in the engineering of civil infrastructure.
2. To develop an understanding of the relationships between physical characteristics and mechanical properties of soils.
3. To understand and experience experimental measurement of the mechanical soil properties commonly used in engineering practice.
4. To determine thickness of outlay required for existing pavements
5. To determine bearing capacity of site for providing shallow foundation.
6. To determine load carrying capacity of pile foundation through soil testing.

List of Practicals:

1. Field CBR Test
2. Lab CBR Test Soaked and unsoaked
3. Dynamic cone penetration test
4. Plate load Test.
5. Deflection by Benkelman beam
6. Standard Penetration Test
7. Design of a shallow foundation
8. Design of a pile foundation

MRM-101 Research Methodology and IPR

(Credits - 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Understanding and formulation of research problem.
2. Analyze research related information.
3. Understand plagiarism and follow research ethics.
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. 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.
6. 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.

Syllabus Content:

Unit 1: 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 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit 3: 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 4: 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 5: Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases. Geographical Indications

Unit 6: New Developments in IPR: Administration of Patent System, New developments in IPR; IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies, IPR and IITs

Reference Books:

1. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students
2. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction (Volume –II)
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd.
5. Mayall, Industrial Design, McGraw Hill.
6. Niebel, Product Design, McGraw Hill.
7. Asimov, Introduction to Design, Prentice Hall.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age
9. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand

MAC-102 DISASTER MANAGEMENT

(Credits - 2:0:0 = 0)

Teaching Scheme

Lectures: 2 hrs/week

Course Outcomes:

On completion of the course, the student will have the ability to:

1. Know about the various types of disaster and their components.
2. Know about the measures and precautions at the time of a disaster.
3. Know about various disaster-prone areas and various concepts about disaster preparedness, GIS and remote sensing.
4. Assess risk caused by a disaster and learn about various mitigation measures.

Syllabus Content:

- **Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.
- **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, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.
- **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
- **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.
- **Risk Assessment:** 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
- **Disaster Mitigation:** Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India

Reference Books:

1. R. Nishith, Singh A.K, Disaster Management in India: Perspectives, issues and strategies, New Royal book Company.
2. Sahni P. et al., Disaster Mitigation Experiences and Reflections, Prentice Hall of India
3. Goel S.L., Disaster Administration and Management Text and Case Studies, Deep & Deep Publication Pvt. Ltd.

M. Tech. (Geotechnical Engineering)

MGT-104 Soil Dynamics

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

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

Course Content:

Unit I
Fundamentals of vibrations: single degree of freedom systems, vibration isolation, vibration absorbers, vibration measuring instruments.

Unit II
Liquefaction of soils: liquefaction mechanism, factors affecting liquefaction, studies by dynamic tri-axial testing, oscillatory shear box, shake table and blast tests, assessment of liquefaction potential.

Dynamic elastic constants of soil: determination of dynamic elastic constants, various methods including block resonance tests, cyclic plate load tests, wave propagation tests, oscillatory shear box test.

Unit III
Machine foundations: Design criteria for machine foundations, Linear elastic weightless spring method, Elastic homogeneous half space method, Lumped parameter solution (Vertical vibration & Pure sliding vibration) for reciprocating machines, effect of machine foundation on adjoining structures.

Unit IV
Bearing capacity of foundations: Introduction to bearing capacity of dynamically loaded foundations, such as those of water towers, chimneys and high-rise buildings, response of pile foundations.

Reference/Text Book:

- Das B.M., “Fundamentals of Soil Dynamics”, Elsevier (1983).

- Steven Kramer, “Geotechnical Earthquake Engineering”, Pearson (2008).
- Prakash S., “Soil Dynamics”, McGraw Hill (1981).
- Kameswara Rao, N.S.V., “Vibration Analysis and Foundation Dynamics”, Wheeler Publication Ltd. (1998).
- Richart, F.E., Hall J.R and Woods R.D., “Vibrations of Soils and Foundations”, Prentice Hall Inc. (1970).
- Prakash S. and Puri V.K., “Foundation for Machines: Analysis and Design”, John Wiley & Sons (1998).

LMGT-103 Model Testing Lab

(Credits – 0:0:2 = 1)

Teaching Scheme
Lectures: 2 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. setup confined fill under control conditions,
2. setup sloping fill under control conditions,
3. analyse behaviour of footings of various shapes on confined fill conditions,
4. analyse behaviour of footings of various shapes on sloping fill conditions, and
5. interpreting results of model testing.

Course Content/Experiments:

Experiment 1: To determine load settlement characteristics of Strip footing on confined fill.

Experiment 2: To determine load settlement characteristics of Square footing on confined fill.

Experiment 3: To determine load settlement characteristics of Circular footing on confined fill.

Experiment 4: To determine load settlement characteristics of Strip footing on sloping fill.

Experiment 5: To determine load settlement characteristics of Square footing on sloping fill.

Experiment 6: To determine load settlement characteristics of Circular footing on sloping fill.

Reference/Text Books:

- Bowles, J.E., "Physical and Geotechnical Properties of Soils", McGraw Hill Publishers (1979).
- Head K.H., "Manual of Soil Laboratory Testing", Vol. 1,2, 3 (1982).
- Lambe, "Soil Testing in Engineering", Wiley & Sons (1951).
- Head K.H., "Soil Classification and Compaction Tests", Whittles Publishing, Scotland, UK. (2006).
- Mandal, J.N. and Divshikar, D.G., "Soil Testing in Civil Engineering", Oxford & IBH Publishing Company Pvt. Ltd., New Delhi (1994).
- IS 2720 (1983), "Methods of Test for Soils, Bureau Of Indian Standards".

LMGT-104 Numerical Analysis Lab

(Credits – 0:0:4 = 2)

Teaching Scheme
Lectures: 4 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. formulate the algorithm to analyze a geotechnical problem and find the optimized solution of the problem,
2. evaluate the slope stability using limit equilibrium and FEM software,
3. calculate bearing capacity and settlement of shallow and deep foundation using software,
4. simulate the geotechnical problem and observe the effect of soil structure interaction, and
5. decide the most appropriate and optimized techniques to strengthen the ground up to a desirable limit.

Course Content/Experiments:

Experiment 1: To write/ draw algorithm/flow chart for various geotechnical engineering problems using spread sheet.

Experiment 2: To perform Stability analysis of earth slope using various software such as GEO5, PLAXIS etc.

Experiment 3: To find out the Bearing Capacity of shallow and deep foundations using software such as GEO5, PLAXIS etc.

Experiment 4: To estimate the Settlement of shallow and deep foundations using software such as GEO5, PLAXIS etc.

Experiment 5: To observe the effect of soil-structure interaction for piled-raft, laterally loaded piles, sheet piles etc.

Experiment 6: To find out the effect of various ground improvement techniques such as soil nailing, use of geogrids/ geosynthesis/nailing etc.

LMPGT-101 Project

(Credits – 0:0:4 = 2)

Teaching Scheme
Lectures: 4 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify geotechnical engineering problems reviewing available literature,
2. decide the methodology to solve the problems related to geotechnical engineering,
3. find multiple possible solutions and decide the best suited solution under the given conditions,
4. analyse the effects of various parameters as applicable to the given solution, and
5. present a report that completely defines the problem and its solution.

Course Content:

The purpose of this subject (Project) is to introduce, familiarise and prepare the student for research work to be carried out during thesis. Thus, there is no fixed syllabus as such (although general guidelines are given below), and the student can choose any topic considering that the work to be carried out must result in certain deliverables (conclusions). Since the report outline of this subject is similar to 'Thesis Work', it would provide an opportunity to learn and present the work in a systematic fashion.

Following broad areas (or part thereof) can be considered to be taken up as 'Project':

1. Classify and characterization of soil.
2. Evaluation of index, physical and engineering properties of soil using established procedures and techniques.
3. To investigates the effect of use of various wastes material in different doses on the engineering properties of soil.
4. To asses the present condition of geotechnical problems and find out the appropriate solution for the construction purpose.
5. To identify and suggest a suitable and most optimised foundation for a project.
6. To test the models and observe the effects of various parameters (Geometrical) to economise the constriction.
7. To identify problematic soil and suggest various techniques/solution to construct structure on problematic soil.

MGT-116 Critical Soil Mechanics

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. define the behavior of soils under different stress conditions,
2. plot the CSL under drained and undrained loadings for lightly and heavily consolidated soils,
3. evaluate the volume changes and pore pressure changes in soils,
4. express the effect of dilation in sands, and
5. develop the elastic-plastic model based on critical state soil mechanics.

Course Content:

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

Unit II
The Critical state line and the Roscoe surface: Families of undrained tests, Families of drained tests, the critical state line, drained and undrained surfaces, The Roscoe surface, Behavior of Over consolidated samples - Hvorslev surface: Behaviour of over consolidated samples, drained and undrained tests, complete State Boundary Surface, Volume changes and pore water pressure changes.

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

Unit IV
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.

Reference/Text Books:

- Atkinson J. H. and Bransby P. L., “The mechanics of soils: An introduction to critical state soil mechanics”, McGraw Hill (1978).
- Wood D. M., “Soil behaviour and critical state soil mechanics”, Cambridge University Press (1990).
- Das B. M., “Fundamental of geotechnical engineering”, Cengage Learning (2013).
- Whitlow R., “Basic Soil Mechanics”, Pearson (2001).

MGT-117 Rock Mechanics

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. develop the co-relation between rock mechanics, engineering geology and soil mechanics,
2. define the formation and classification of rocks,
3. evaluate lab and in-situ properties of rock mass,
4. analyse the stress distribution in situ and around opening in rock, and
5. summarize the applications of rock mechanics in various Civil Engineering projects.

Course Content:

Unit I
Rock: Introduction to the rock mechanics its relation with engineering geology and soil mechanics, Formation of rocks, Physical properties, Classification of rocks and rock masses, Elastic constants of rocks, In-situ stresses in rocks.

Unit II
Rock Testing & Discontinuities in Rock Masses: Laboratory and Field tests, Discontinuity orientation, Effect of discontinuities on strength of rocks.

Unit III
Strength Behavior/ Failure criterion: Mohr-Coulomb, Griffith theory, Stresses in rock near underground openings, Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior.

Unit IV
Application of rock mechanics in Civil Engineering: Rock tunneling, Rock slope stability, Bolting, Blasting, Grouting, Rock foundation design, Modern modeling techniques & analysis in rocks.

Reference/Text Books:

- Jaeger, J.C. et al., "Fundamentals of Rock Mechanics", Wiley India Pvt Ltd. (2012).
- Goodman, R.E. "Introduction to Rock Mechanics", Wiley India Pvt Ltd. (2010).
- Hudson J.A. and Harrison J.P., "Engineering Rock Mechanics: An Introduction to the Principles", Pergamon (1997).
- Verma B. P. "Engineering Geology and Rock Mechanics", Khanna publishers (2017).
- Ramamurthy T., "Engineering in Rocks for slopes, foundation and tunnels", PHI Learning Pvt. Ltd. (2014).

MGT-118 Computational Geomechanics

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. understand different numerical and statistical tools for analyzing various geotechnical engineering problems,
2. solve linear and non-linear equations using numerical techniques,
3. apply finite difference and finite element method for analyzing behavior of geotechnical structures,
4. apply correlation and regression analysis for the geotechnical data, and
5. solve problem of consolidation and flow through porous media using numerical technique.

Course Content:

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

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

Unit II
Finite Difference Method: Two-point Boundary value problems, Disichlet conditions, Neumann conditions, ordinary and partial differential equations.

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

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.

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

Reference/Text Books:

- Sam Helwany, "Applied soil mechanics", John Wiley & sons, Inc. (2007).
- Naylor D.J. and Pande G.N., "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK (1981).
- Chandrakant S., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company (1977).

- Jain M.K., Iyengar S.R.K. and Jain R.K., "Numerical Methods for Scientific and Engineering computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi (1984).

MGT-119 Geosynthetics Engineering

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. classify the Geosynthetics, it's functions and assessment of their properties,
2. describe the mechanism of improvement of bearing capacity and Geosynthetics's application in different Geotechnical problems,
3. design with geosynthetics for the various functions in different Geotechnical problems,
4. depict the mechanism of the drainage and filtration for different Geotechnical problems, and
5. evaluate the quality and monitor the performance of Geo-synthetics used in field.

Course Content:

Unit I
An overview of Geosynthetics: Classification of Geosynthetics, Functions, Properties of Geotextiles, Geogrids and Geomembranes.

Unit II
Soil Reinforcement: Mechanism, improvement of bearing capacity, Embankments on soft ground, Reinforced Embankments and Reinforced soil walls-Internal and External Stability, Applications of Geosynthetics: Applications: Retaining walls, Embankments, Shallow foundations, Roads, Unpaved roads, Paved roads, Railway tracks, Filters and drains, Slopes, Erosion control, Stabilization, Containment facilities, Landfills, Ponds, reservoirs, canals, Earth dams, Tunnels, Installation survivability requirements.

Unit III
Designing with Geosynthectics: Designing methodologies, construction with Geotextiles, Geogrids and Geomembranes for Retaining/Earth walls, Embankments, Shallow foundations, Unpaved roads, Paved roads, Slopes, Erosion control, Mechanism of filtration and drainage functions & their applications.

Unit IV
Quality: Concepts of quality and its evaluation, Field performance monitoring, Case Study.

Reference/Text Books:

- Koerner, R. M., "Designing with Geosynthetics", 6th edition, Prentice Hall (2012).
- Hausmann, M. R., "Engineering Principles of Ground Modifications", McGraw Hill Pub Co. (1989).
- Xianthakos, Abreimson and Bruce, "Ground Control and Improvement", John Wiley & Sons (1994).
- Shukla, "An introduction to Geosynthetic Engineering", CRC Press/Taylor & Francis Group (2016).
- Rao G. V. & Raju G. V. S. S., "Engineering with Geosynthetics", Tata-McGraw Hill. Publication, New Delhi (2004).

- Shukla, “Fundamentals of Geosynthetic Engineering”, Taylor & Francis (2006).
- Babu Sivakumar, “Introduction to Soil Reinforcement and Geosynthetics”, Univ. Press, Hyderabad (2013).
- Jones C. J. F. P., “Earth Reinforcement and Soil Structures”, Butterworths, London (1985).

MGT-121 Tunneling Techniques in Soil

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the need, planning and exploration of various underground construction projects,
2. understand elastic and plastic analysis in the design of underground support system,
3. develop understanding of the application of rock mass classification systems, ground conditions in tunneling and rock mass-tunnel support interaction analysis,
4. elaborate the field tests generally conducted during and after construction of under structures, and
5. understand the system of instrumentation and monitoring of underground excavations during and after construction.

Course Content:

UNIT I

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

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 II

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 III

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 IV

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.

Reference/Text Books:

- Hoek, E and and Brown, E. T., "Underground Excavations in Rocks", Institute of Mining and Metallurgy, UK (1981).
- Obert, L. and Duvall W., "Rock Mechanics and Design of Structures in Rocks", John Wiley (1967).
- Lohanson, John and Mathiesen, C.F., "Modern trends in Tunnelling and Blast Design", AA Balkima (2000).
- Bickel J.O., Kuesel T.R. and King E.H., "Tunnel Engineering Hand Book", CBS Publishers and distributors (2018).

MGT-122 Clay Minerology

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. identify the importance of soil mineralogy and mechanisms of formation on engineering behavior of soils,
2. analyze basic mechanism behind the physical and engineering properties of soils,
3. evaluate possible reasons for the observed phenomenon under scientific investigations for solving engineering problems,
4. identify soil fabric by direct and indirect measuring methods, and
5. determining the properties of clayey soil.

Course Content:

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

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

Unit III
Behavior of clayey soil subjected to repeated loading, Effect of wave loading on offshore foundations, Behavior of clays under cyclic loading, Cyclic behavior of soils based on fundamental theory of mechanics, Approximate engineering methods which can be used for practical cases; The Cam-clay model, The modified Cam-clay model.

Unit IV
Environmental Geotechniques, Stabilization of soil by environmental changes, use of additives and their basic mechanisms, effect of lime on sulphate bearing clays, effect of phosphoric acid, use of fly ash in soil modification, use of hydroxy aluminum in clay stabilization, Mitigating acid and alkali contamination in soils by use of additives; effect of lime on sulphate bearing clays.

Reference/Text Books:

- L. D., Baver, “Soil Physics”, Asia Publishing House (1960).
- Mitchell J. K., “Fundamentals of Soil Behavior”, John Wiley & Sons Inc. (1993).
- Nyle C. Brady and Ray R. Weil, “The Nature and Properties of Soils”, Pearson Education Inc. (2002).
- Sarsby R. W., “Environmental Geotechnics”, Thomas Telford (2000).
- D. M., Wood, “Soil behavior and critical state soil mechanics”, Cambridge University Press (1990).

- Malcom D. Bolton, “A Guide to Soil Mechanics”, University Press (India) Pvt. Ltd. (2003).

MGT-123 Stability Analysis of Slopes

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. understand the types and causes of slope failures,
2. explain the method for checking the stability of an infinite and finite slope with and without water pressure,
3. understand the stability of slopes with different methods and concept of factor of safety,
4. determination of phreatic line, flow net in homogeneous and zoned earth dams under steady seepage and draw-down conditions, seepage control in earth dams, and
5. suggest the stabilization and strengthening of slopes with different method, rock bolting, anchoring, instrumentation, monitoring and maintenance of slopes.

Course Content:

Unit I
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 it's 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.

Reference/Text Books:

- Harr M. E.," Ground Water and Seepage", McGraw Hill (1962).
- Hvorsler M., "Subsurface exploration and sampling of soil for civil engineering purposes", Engineering Foundation (1962).
- Duncan C. Wyllie, "Rock Slope Engineering", 5th Edition, Civil Applications (2017).
- Chowdhary R and Chowdhary I., "Geotechnical Slope Analysis", CRC Press (2009).
- Wood D.M., "Soil behaviour and critical state soil mechanics", Cambridge University Press (2014).
- Arora K.R., "Soil mechanics and foundation engineering", Standard Publisher dist. (2009).

MGT-124 Geotechnical Earthquake Engineering

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. summarize the source and causes of the earthquake,
2. describe the concept of earthquake ground motion and its response,
3. evaluate the liquefaction potential for a given site,
4. design the different types of foundations and retaining walls considering the seismic safety, and
5. analyze the stability of a slope under seismic conditions.

Course Content:

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. 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 II
Ground response analysis – One-dimensional ground response analysis: Linear approaches, Equivalent linear approximation of non-linear approaches.

Unit III
Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.

Unit IV
Seismic design of foundations, Seismic slope stability analysis and Seismic design of retaining walls.

Reference/Text Books:

- Steven Kramer, "Geotechnical Earthquake Engineering", Pearson (2008).
- Seco e Pinto, P., "Seismic behaviour of ground and Geotechnical structure", 1st edition, CRC Press (1997).
- Ferrito, J.M, "Seismic design criteria for soil liquefaction", Tech. Report of Naval Facilities service centre, Port Hueneme (1997).
- Robert W Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York (2007)

- Bharat Bhusan Prasad, “Fundamental of Soil Dynamics and Earth quake Engineering”, PHI (2005).
- Ishihara K., “Soil Behaviour in Earthquake Geotechnics”, Oxford Science, NY (1996).

MGT-125 Design of Foundations on Weak Soils & Rocks

(Credits – 3:0:0 = 3)

Teaching Scheme
Lectures: 3 hours/week

Course Outcomes:

After completing this course, the students will demonstrate the knowledge and ability to:

1. calculate swelling potential and design foundation on swelling/expensive soil,
2. compute the Collapse settlement and design foundation on collapsible soil with or treatment,
3. determine the bearing capacity/ bearing pressure of foundation under uniform or layered rocks,
4. design the foundation or suggest the techniques to repair foundation in different condition as per requirement in the field, and
5. access the bearing capacity of piles in the field on week rock or rock mass.

Course Content:

Unit I
General consideration, General characteristics of swelling soils, clay mineralogy and mechanism of swelling, Evaluation of swelling potential of expensive soil by single index method, classification of swelling soils by indirect measurement, swelling pressure by direct measurement, Effect of initial moisture content and initial dry density on swelling pressure, Estimation the magnitude of swelling, Design of foundation in swelling soils, Drilled pier foundation in expensive soil.

Unit II
General Observation, Collapse potential and settlement, Computation of Collapse settlement, Foundation design, Treatment method for collapsible soil**.**

Unit III
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.

Unit IV
Shallow foundations, shallow foundations on sloping ground, raft foundations, treatment of foundations - open joints, solution cavities, weak seams, Piles in weak rocks, bearing capacity and settlement of piles, field load tests on piles in weak rocks.

Reference/Text Books:

- Wyllie Duncan C.," Foundations on Rock: Engineering Practice", E & F N Spon, Taylor and Francis (1992).
- Hudson J.A. and Harrison J.P., "Engineering Rock Mechanics: an Introduction to the Principles", Elsevier, Oxford (1997).
- Hoek E., "Practical Rock Engineering", Rock science (2007).

- Singh, B. and Goel R.K., “Rock Mass Classification- A Practical Engineering Approach”, Elsevier (1999).
- Ramamurthy, T., “Engineering in Rocks”, PHI Learning Pvt. Ltd. (2014).
- Murthy, V.N.S., “Advance Foundation Engineering”, CBS Publisher and Distributors (2017).