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.