Program : **Diploma in Civil Engineering**	
Course Code : **4011**	Course Title: **Geotechnical Engineering**
Semester : **4**	Credits: **4**
Course Category: **Program Core**	
Periods per week: **4 (L:3, T:1, P:0)**	Periods per semester: **60**

Course Objectives:

- To impart knowledge about the index and engineering properties of soil and soil classification
- To impart knowledge about the various methods of determination of soil properties.

Course Prerequisites:

Topic	Course code	Course name	Semester
Basics of mathematics		Engineering Mathematics	1
Basic knowledge about building components and construction techniques		Building Construction and Construction materials	3
Basics of mechanics		Engineering Mechanics	2

Course Outcomes:

COn	Description	Duration (Hours)	Cognitive Level
CO1	Determine the physical and index properties of soil	15	Applying
CO2	Determine the engineering properties such as permeability and shear strength of soil.	13	Applying
CO3	Determine the compressibility of soil.	12	Understanding
CO4	Illustrate the process of field investigation and determine the bearing capacity of soil.	18	Applying
	Series tests	2	

CO – PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3					
CO2	3						
CO3							
CO4	3						

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

Course Outline:

On completion of the course, the student will be able to:

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Determine the physical and index properties of soil**		
M1.01	Summarize the physical and index properties of soil.	3	Remembering
M1.02	Solve the Functional relationships.	3	Understanding
M1.03	Discuss the procedures for determination of index properties of soil.	3	Understanding
M1.04	Discuss the consistency limits of soil.	3	Understanding
M1.05	Determine the gradation and classification of soils	3	Applying

Contents:

Introduction to Soil Mechanics: Use of soil as construction material in Civil engineering. Soil formation and transportation of soil - water transported soil, wind transported soil, glacier deposited soil and gravity deposited soil. Field applications of geotechnical engineering.

Physical and Index Properties of Soil:

Soil as a three-phase system: definethe terms - water content, void ratio, porosity, degree of saturation, density index, Unit weight of soil (bulk unit weight, dry unit weight, unit weight of solids, saturated unit weight, submerged unit weight).

Functional relationships: between void ratio and porosity; water content and void ratio; bulk unit weight and void ratio; dry unit weight and water content. Simple problems based on the above functional relationships.

Procedures for determination of: water content by oven drying method (BIS); field density of soil by core cutter and sand replacement method; specific gravity using pycnometer.

Consistency limits of soil: Procedure for determination of liquid limit, plastic limit and shrinkage limit. Define the terms - Plasticity index, consistency index, flow index and liquidity index. Simple problems relating consistency limits and indices.

Gradation of soil: Define coarse grained and fine-grained soils. Procedure for determination of particle size distribution by sieve analysis. Define effective diameter of soil, well graded soils, uniformly graded soils, Uniformity co-efficient and coefficient of curvature. BIS classification of soil based on particle size.

CO2	**Determine the engineering properties such as permeability and shear strength of soil.**		
M2.01	Determine the permeability coefficient of soil	3	Understanding
M2.02	Apply Darcy's law to find the co-efficient of permeability	3	Applying
M2.03	Outline the concept of shear strength of soil	3	Understanding
M2.04	Discuss the procedures of direct shear test and vane shear test	4	Understanding
	Series Test – I	1	

Contents:

Permeability of Soil: Define permeability. State Darcy's law of permeability. List the factors affecting permeability. Procedure for determination of coefficient of permeability by constant head and variable head tests. Simple problems to find permeability of soil.

Shear Strength of Soil: Define cohesion and internal friction. Define purely cohesive soils and cohesionless soils. Define shear strength of soil. Describe Mohr-Coulomb failure theory - Strength envelope, strength equation for purely cohesive and cohesion less soils. Procedure for determination of shear strength by direct shear test and vane shear test (simple problems on vane shear test only).

CO3	**Determine the compressibility of soil.**		
M3.01	Explain the procedure for Standard and Modified Proctor Test for the determination of compaction characteristics of soil.	4	Understanding
M3.02	List the factors affecting compaction	1	Remembering
M3.03	Discuss the different field methods of compaction	2	Understanding
M3.04	Outline the concept of consolidation of soil	3	Understanding
M3.05	Compare compaction and consolidation of soil	2	Understanding

Contents:

Compaction of Soil: Define compaction of soil. Procedure for Standard and Modified Proctor Test. Compaction curve - general discussion, differences of curves for sand and clay, Optimum moisture content (OMC), maximum dry density (MDD) and Zero air voids line. List the factors affecting compaction. Field methods of compaction - rolling, ramming and vibration. Suitability of different types of rollers - smooth wheel roller, sheep foot roller, pneumatic tyred roller.

Consolidation of soil: Define consolidation of soil and differentiate between compaction and consolidation. Describe Terzaghi's soil-spring analogy model to explain the process of consolidation and different stages of consolidation (Initial, primary and secondary consolidation).

CO4	**Illustrate the process of field investigation and determine the bearing capacity of soil.**		
M4.01	Enumerate the objectives and the different stages involved in site investigation	1	Understanding
M4.02	Discuss the criteria for deciding depth, location and number of pits or boreholes.	1	Understanding
M4.03	Outline the methods of soil exploration	4	Understanding
M4.04	Define the various terminology connected with bearing capacity of soil.	1	Understanding
M4.05	Discuss the types of bearing capacity failures and Therzaghi's theory of bearing capacity.	2	Applying
M4.06	Identify the field tests for determination of bearing capacity	3	Applying
M4.07	Determine area and depth of foundation	3	Applying
M4.08	Classify types of foundation	3	Understanding
	Series Test – II	1	

Contents:

Site investigation and soil exploration:

List the objectives of site investigation. Discuss the different stages of site investigation. Criteria for deciding the depth, location and number of test pits or bore holes.

Discuss the different methods of soil exploration - Open excavation methods, different types of boring (Auger boring, wash boring, rotary drilling, percussion drillin, core drilling) and geo-physical methods.

Define undisturbed samples.

Bearing Capacity of Soil:

Define terms- bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure.

Discuss the types of bearing capacity failures. Terzaghi's theory of bearing capacity - introduction, assumptions, equation (derivation not required) and simple problems to find area and depth of foundation - Isolated and trip footing only (effect of water table not to be considered).

Procedure for determination of bearing capacity of soil - Plate load test (as per IS:1888) and Standard Penetration Test (IS:2131).

Different types of foundation - Shallow and Deep - isolated, strip, raft, Pile, well (Types and suitability).

Text / Reference:

T/R	Book Title/Author
T1	Gopal Ranjan & A.S.R Rao, '*Basic and Applied Soil Mechanics'*, New Age International
R1	Punmia, B.C., '*Soil Mechanics and Foundation Engineering*', Laxmi Publication, Delhi.
R2	Arora K.R, '*Soil Mechanics and Foundation Engineering'*, Standard Publisher.
R3	Murthy, V.N.S., '*A Text book of Soil Mechanics and Foundation Engineering'*, CBS Publishers & Distributors Pvt. Ltd., New Delhi.
R4	Ramamurthy, T.N. &Sitharam, T.G., '*Geotechnical Engineering (Soil Mechanics)*', S Chand and Company LTD., New Delhi.
R5	Raj, P. Purushothama, '*Soil Mechanics and Foundation Engineering'*, Pearson India, New Delhi.
R6	Kasamalkar, B. J., '*Geotechnical Engineering'*, Pune Vidyarthi GrihaPrakashan, Pune.

Online Resources:

Sl.No	Website Link
1	https://nptel.ac.in/courses/105/103/105103097/
2	https://nptel.ac.in/courses/105/101/105101084/
3	https://law.resource.org/pub/in/bis/S03
4	https://www.astm.org/Standards/geotechnical-engineering-standards.html