

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: SOIL MECHANICS
(Code: 3340605)**

Diploma Programme in which this course is offered	Semester in which offered
Civil Engineering, Transportation Engineering	4 th Semester

1. RATIONALE

Knowledge and understanding of soil and its engineering properties are very important for engineers working at site in order to make Civil Engineering Structures safe and serviceable. In INDIA, from region to region soil varies in properties and characteristics. Under different loading conditions soil is subjected to various stresses and problems like water logging, liquefaction of soil, seepage through soil and settlement. At diploma level students are expected to study about these aspects of soil so as to develop their understanding in order to apply their knowledge in construction industry

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- Conducting different laboratory tests for determining engineering properties / parameters of a soil, evaluate engineering properties / characteristics of soil for their suitability to construction of engineering structures

3. COURSE OUTCOMES:

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Explain various engineering properties / characteristics of soil with respect to construction and engineering applications
- Conduct different laboratory tests for determining engineering properties /parameters of a soil.
- Evaluate engineering properties / characteristics of soil for their suitability to construction of engineering structures.
- Explain essential features and requirements of site investigation with respect to soil.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
03	00	02	05	70	30	20	30	150

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction	1a. Discuss soil formation cycle & general characteristics of soil. 1b. List structures where soil is used as Construction material. 1c. Describe soil-formation in Geological cycle 1d. State the types of failures due to soil in Civil Engineering structure	1.1 History 1.2 List structures where soil is used as construction material 1.3 Soil-formation in Geological cycle 1.4 State the types of failures due to soil in Civil Engineering structure 1.5 General characteristics of different types of soils 1.6 Overview of different types of soils in Gujarat / India.
Unit – II Index Properties & Interrelationship	2a. Explain phase diagram of Soil 2b. Discuss various index properties of soil for the purpose of their classification & Use 2c. Describe interrelationship between different index properties	2.1 Three phase diagram 2.1.1 State three constituents of soil 2.1.2 Sketch showing three i. phases of soil 2.1.3 Assumptions in drawing a ii. phase diagram 2.2 Properties of soil like Density, Field density, Dry density, Saturated density, Void ratio, Porosity, Specific Gravit, Degree of saturation, Moisture conten, Density Index 2.3 Derive the following relations for a soil sample from fundamentals 2.3.1 $e = n/n-1, n = e/1+e$ 2.3.2 $w \times G = e \times s_r$ 2.3.3 $\gamma_d = \gamma_b / 1 + w$ 2.3.4 $\gamma_b = (G + e \cdot s_r) \gamma_w / (1 + e)$ 2.3.5 $\gamma_{sat} = (G + e) \gamma_w / (1 + e)$ 2.3.6 $\gamma_d = G \gamma_w / 1 + e$ 2.4 Numerical on 2.3

<p>Unit – III</p> <p>Soil Classification</p>	<p>3a. Discuss methods of Classification</p> <p>3b. Describe method of I.S. Classification of Soil</p> <p>3c. Classify Soil based on Consistency Limits</p>	<p>3.1 Classification of soil (Grain size) as per Indian Standard</p> <p>3.1.1 Basis /criteria of classification</p> <ol style="list-style-type: none"> i. of soils ii. Three main categories of soils iii. Scale for classifying soil iv. on the basis of grain size <p>3.2 Mechanical Analysis of soil</p> <p>3.2.1 Difference between course grained and fine grained Soil on the basis of range of grain size and engineering properties</p> <p>3.2.2 Sieves designation as per</p> <ol style="list-style-type: none"> i. I.S. code ii. Coarse & Fine Sieve analysis, sedimentation analysis <p>3.3 Grading Curves and different coefficients i.e. CU and CC</p> <ol style="list-style-type: none"> a. Clay, silt, sand and gravel as per particle size b. Consistency Limits like Liquid limit, Plastic limit, Shrinkage <p>3.4 Limit and Plasticity Index`</p>
<p>Unit – IV</p> <p>Compaction</p>	<p>4a. Comprehend the principle and methods of compaction of soil</p> <p>4b. Differentiate between compaction and consolidation with examples</p> <p>4c. Determine MDD & OMC of soil by conducting appropriate test</p>	<p>4.1. Compaction and its Application</p> <p>4.1.1 Effects of compaction on different soil properties like permeability, shear strength, soil settlements-stability of embankments.</p> <p>4.2. Maximum dry density and O.M.C.</p> <p>4.2.1 Typical compaction curve</p> <p>4.2.2 Optimum moisture content (OMC), Maximum dry density (MDD)</p> <p>4.3. Proctor test</p> <ol style="list-style-type: none"> 4.3.1 Light compaction 4.3.2 Heavy compaction test 4.3.3 Light compaction test on a given soil sample <p>4.4. Factors affecting compaction like water content, nature of soil (fine or course grained), Grading of soil, compaction energy, thickness of layer</p> <p>4.5. Compaction and Consolidation</p> <p>4.6. Role of O.M.C in the field</p> <p>4.7. Methods of Field Compaction & various Equipment for compaction</p>

<p>Unit – V</p> <p>Permeability & Seepage</p>	<p>5.a Explain concept of permeability & its implications with respect to use of soil.</p> <p>5.b Determine 'permeability' of given soil.</p> <p>5.c Comprehend the concept of Seepage Analysis in relation to 'quick sand condition' with examples.</p>	<p>5.1 5.1 Permeable and Impermeable soils</p> <p>5.1.1 Permeability and Impermeability</p> <p>5.1.2 Flow of water through pipe and Through soil</p> <p>5.2 Factors affecting the permeability</p> <p>5.2.1 The factors affecting permeability of soil</p> <p>5.2.2 Factors used to control the permeability of soil to desired extent in various Civil engineering structures</p> <p>5.3 Methods to find Coefficient of Permeability</p> <p>5.3.1 Constant Head Method</p> <p>5.3.2 Falling Head Method</p> <p>5.4 Coefficient of permeability</p> <p>5.4.1 Numerical based on</p> $K = (Q \times L) / (t \times h \times A)$ $K = (2.3 \times a \times L) / (A \times t) \log_{10} h_1 / h_2$ <p>5.5 Seepage pressure</p> <p>5.1 Seepage pressure.</p> <p>5.2 Quick sand condition.</p> <p>5.3 Flow net, its characteristics and application.</p>
<p>Unit-VI</p> <p>Shear Strength</p>	<p>6a. Explain different terms used in the context of 'shear strength' of soil.</p> <p>6b. Evaluate shear parameters of various types of soil, with their practical significance</p>	<p>6.1. Definition</p> <p>6.1.1 Define: (a) Cohesion (b) internal friction (c) Shear strength</p> <p>6.1.2 Coulomb's law for shear strength $S = C + \sigma_n \tan \phi$</p> <p>6.2. Shear strength of soil</p> <p>6.2.1 Different shear tests used to determine shear strength of soil in laboratory</p> <p>6.2.2 Procedure of direct shear test (Box shear test)</p> <p>6.3. Types of soil C-soil, ϕ-soil, C-ϕ soil.</p> <p>6.3.1 Draw failure envelope by drawing Mohr's circle from the data obtained during direct shear test</p> <p>6.3.2 Calculate the values C and ϕ</p> <p>i. from the failure envelope of</p> <p>ii. direct shear test on soil</p>

VII Bearing Capacity of soil	7a. Explain concept of bearing capacity of soil. 7b. Describe various methods to determine bearing capacity of soil. 7c. Explain the concept & occurrence mechanism & effect of 'Liquefaction' of soil.	7.1 Bearing capacity of soil 7.1.1 Net Bearing capacity 7.1.2 Safe Bearing Capacity 7.1.3 Ultimate Bearing Capacity 7.1.4 Bearing Capacity of various soil 7.2 Methods – Plate Load Test, Penetration Test & using $C - \Phi$ parameters for determining bearing capacity of soil and to improve bearing capacity of soil 7.2.1 Foundation on soils of various bearing Capacity 7.3 Liquefaction 7.4 Definition 7.5 Occurrence & effect Effects of Liquefaction Remedial for Liquefaction
VIII Soil Investigation & Exploration	8a. Discuss various methods & appropriate use for investigation & exploration of soil.	8.1 Purposes of exploration of soil. 8.2 Planning of exploration program 8.3 Soil samples and collection. 8.4 Field penetration Test:SPT 8.5 Introduction to geophysical methods

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	02	02	00	00	02
II	Index Properties & Interrelationships	07	02	04	08	14
III	Classification of Soil	07	04	02	08	14
IV	Compaction of Soil	06	03	03	04	10
V	Permeability & Seepage	06	03	03	04	10
VI	Shear Strength	05	02	02	03	07
VII	Bearing Capacity of soil	05	02	02	03	07
VIII	Soil Investigation & Exploration	04	02	01	03	06
Total		42	20	17	33	70

Legends: R = Remember, U = Understand, A= Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx Hrs Required.
1	I	Determine field moisture content of soil	02
2	I	Determine bulk density and dry density of soil by core cutter method	02
3	I	Determine specific gravity of sand by pycnometer	02
4	I	Determine bulk density and dry density of soil by sand replacement method	04
5	I	Conduct Sieve analysis of given soil for its classification	04
6	I	Determine consistency Limits i.e. Liquid limit, Plastic limit, Shrinkage limit	04
7	V	Determine permeability of soil by constant head method	02
8	V	Determine permeability of soil by falling head method	02
9	V	Determine shear parameters of soil by box shear test	02
10	I	Determine OMC and MDD by Proctor Test	04
Total Hours			28

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Collect few samples & find out different characteristics/properties of Soil from nearby site
- ii. Undertake site visit related to road compaction& consolidation and prepare report
- iii. Undertake site visit related to SPT on field & prepare report
- iv. Visit to Soil Testing Laboratory for awareness related to other Soil Testing Equipment, Soil Testing Report.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

- i. Show Video Clips of Soil Testing and interact with students by asking questions
- ii. Show Picture Clips through Power Point regarding Testing of soil and its commercial report
- iii. Video programs on soil engineering tests – by NITTTR – Bhopal
- iv. Video/animation films on soil behavior during earthquake

10. SUGGESTED LEARNINRESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1.	Soil Mechanics & Foundation	Dr. B C Punamia	Standard Book House
2.	Modern Geo Technical Engineering	Dr. Alam singh	Jodhpur University
3.	Textbook of Soil Mechanics & Foundation Engineering	V N S Murthy	UBS Publisher
4.	Soil Sampling & Testing Manual	Dr A K Duggal	NITTTR , Chandigardh
5.	IS 2720 , IS 1892 , IS 2132 & IS 2809	----	BIS , New Delhi

B. List of Major Equipment/Materials

- i. Core Cutter
- ii. Hot Air Oven
- iii. Sand Pouring Cylinder
- iv. Pyconometer Bottle
- v. Permeability Apparatus
- vi. Set of IS Sieves
- vii. Casgrande Apparatus
- viii. Direct Shear Apparatus
- ix. Electronic Weighing Balance
- x. Heavy & Light Proctor Test Apparatus

C List of Software/Learning Websites

- i. www.issnge.org
- ii. www.springer.com
- iii. www.britannica.com
- iv. www.trb.org

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- Prof. B. G. Rajgor, H.O.D, App. Mech. , BBIT , V. V. Nagar
- Prof. K. Venkateshwarlu , H.O.D , T F G Polytechnic, Adipur
- Prof. C. H. Bhatt, Lecturer Dr. S. & S.S. Ghandhy College, Surat
- Prof. K. K. Patel, H.O.D, G. P Rajkot

SCoordinator and Faculty Members from NITTTR Bhopal

- Dr. V H Radhakrishnan , Professor, Department of Civil and Environmental Engineering