GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Civil Engineering
Subject Code: BE05006041
Subject Name: Soil Mechanics

w. e. f. Academic Year:	2026-27
Semester:	5
Category of the Course:	Professional Elective Course-1

Prerequisite:	Knowledge of Basic Geotechnical Engineering, Strength of Materials (MOS), Basic Geology
Rationale:	Soil Mechanics is a fundamental engineering discipline that quantifies the mechanical behavior of soil to ensure the structural integrity of infrastructural projects. This course provides a comprehensive framework for analyzing stress distribution within soil masses and predicting long-term settlement through the study of consolidation theories. By evaluating the shear strength of various soil types, students learn to assess the safety of foundations and the stability of slopes against failure. Furthermore, the curriculum covers the calculation of lateral earth pressure for the design of retaining structures, integrating theoretical analysis with IS codes and modern construction practices to equip engineers with the tools necessary for rigorous, optimum design in multi-disciplinary civil engineering schemes.

Course Outcomes: At the end of the course the students will be able to:

Sr. No.	CO statement	Marks% weightage
CO-1	Analyze geostatic and applied stress distribution in soil masses using analytical methods to determine vertical and horizontal pressure increments.	15
CO-2	Interpret soil behavior and determine shear strength parameters from laboratory results foruse in geotechnical design and stability analysis.	15
CO-3	Assess the stability of infinite and finite slopes by calculating the Factor of Safety using various analytical and graphical methods.	25
CO-4	Evaluate the time-dependent settlement of clay layers and estimate the magnitude of primary consolidation using settlement theories.	25
CO-5	Apply classical earth pressure theories to determine lateral pressures and theresulting stability of various soil-retaining structures.	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

* Problem based learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual

Content:

Sr. No.	Content	Total Hrs.
1.	**Stress Distribution of Soils**: Fundamentals of Soil Stress, Classical Elasticity Theories (Boussinesq and Westargaad), Stress Due to Varied Loading Geometries (point load, line load, strip load, circular, rectangular and triangular loading), New-mark's influence methodology for irregular area loads., Analysis of contact pressure distribution across varying foundation types (rigid, Flexible footing).	8
2.	**Shear Strength**: Fundamentals of Soil Failure (Stress-Strain relationship, Failure criteria, Mohr-Coulomb's failure theory, Modified Mohr-Coulomb's theory), Laboratory and Field Determination of Shear Parameters of cohesive and cohesionless soils under different drainage conditions, Advanced Concepts in Shear Strength (stress-path & its applications, Pore Pressure Measurements), Rheological Models (introduction only), Factors Influencing Shear Strength	10
3.	**Slope stability:** Failure Kinematics (Infinite and finite slopes, types of slope failure, factor of safety, forms of slip surfaces), Limit Equilibrium Analysis (cohesive and cohesionless soil), critical stage instability analysis, Advanced Methods of Slices (Swedish circle, Friction circle, and C-analysis (method of slices)), Effects of tension crack and submergence, Taylor's stability no., and use of Bishop's method , Stability Charts, Modern Stability Concepts (introduction to numerical models)	9
4.	**Consolidation of Soils:** Fundamentals of Compressibility (Compressibility of soils, definitions and mechanism of consolidation), Consolidation Parameters and Indices, Terzaghi's One-Dimensional Consolidation Theory (time factor, and Laboratory tests. Determination of pre-consolidation pressure), Two and Three-Dimensional consolidation related problems, Settlement and Rate Analysis	9
5.	. **Earth Pressure:** Types of lateral earth pressure, earth pressure theories (Rankine and Coulomb), Earth Pressure under Varied Conditions (Stratified Backfills, Surcharge Effects, Submergence and Seepage), Graphical Methods of Determination earth pressure (Rebhann's and Culmann's methods)	9
	Total	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**15**	**20**	**10**	**10**

R: Remembrance; U: Understanding, A: Application, N: Analyze, E: Evaluate, C: Create and above Levels (Revised Bloom's 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.

The syllabus of Soil Mechanics directly contributes to

SDG 9	**Industry, Innovation, and Infrastructure** – Through the design of resilient infrastructure and retaining structures.
SDG 11	**Sustainable Cities and Communities** – By ensuring the structural integrity of slopes in urban development.
SDG 13	**Climate Action -** Accurate soil data reduces structural failure, supports resilient infrastructure, and minimizes environmental damage.
SDG 15	**Life on Land –** Slope stability analysis prevents land degradation through proper planning. Prevents landslides and soil erosion, especially important in hilly regions and during extreme weather events.

Reference Books:

Title	Author/s	Publication
Soil Mechanics and Foundation Engineering (Geotechnical Engineering)	Dr. K. R.Arora	Standard Publishers Distributors, New Delhi
Soil Mechanics and Foundation Engineering	B. C. Punmia	Laxmi Publications, New Delhi
Basic and Applied Soil Mechanics	Gopal Ranjan, Rao A.S.R	New age int.(p) Ltd
Soil Mechanics and Foundation Engineering	Alam singh	CBS Publishers & Distributors, New Delhi
Soil Mechanics & Foundation Engineering	V. N. S. Murthy	CRS Press, Taylor & Francis Group, New York
Principles of Geotechnical Engineering	Das Braja M	Thomson Asia Pvt. Ltd.
Foundation Analysis and Design	Bowles,J.E.	McGraw Hill 5th Edition, NewYork,1995

Relevant IS Codes
IS:1888 – Method of load test on soils
IS:2720 – (Parts 11,12,13,14,15,16,39,41) Methods of tests for soil
*** IS codes are not permitted during examination.**

List of Experiments:

- California Bearing Ratio Test
- Relative density Tests
- Consolidation /Oedometer test
- Direct Box Shear Test
- Unconfined Compression Test
- Triaxial Compression Tests
- Laboratory Vane Shear Test

Suggested Course Practical/Assignment List: Students should follow the DTE laboratory manual for assignments and practical.

Major Equipment: California Bearing Ratio Test Apparatus, , Consolidation Test Apparatus, Box Shear Test Apparatus, Laboratory Vane shear Test Apparatus, Unconfined Compression Test

List of Open-Source Software/learning website: http://nptel.ac.in/
List of suggested activities for Problem based Learning (PBL):

Sr. No	PBL Category	Name of the activity	No. of hours	Evaluation Criteria
1.	Video based learning	Analysis of soil failure mechanisms or construction site case studies via technical videos.	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
2.	Industry/Research Laboratory Visit	Field visit to a geotechnical lab or construction site to observe soil testing and slope stabilization.	Visit = 5h Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
3.	Research paper review/Analysis	Discussion on any reputed / SCOPUS Index research paper out comes	Three research papers = Total 10h	Overview and summary of key research findings
4.	Assignment/ Technical	Assignment writing. Numerical based	6 assignments of 2h each. Total = 12h	Based on the assignment submitted.

	writing/Research writing	assignment related to topics of the soil mechanics course.		
5.	Classification of soil and suggest suitability	Self-learning on-line courses related to soil mechanics field testing for civil engineering projects.	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Problem Solving/Coding	Using software tools(Geo5, Plaxis etc) study case study for analysing slope failure	Software based analyses= 10 h Report prepration=5h. Total = 15 h	Report presentation
7.	Poster/chart/ power point presentation	Poster/chart/power point presentation on topics related to advanced geotechnical techniques and tools	Duration = 6 h	Based on poster/chart preparation and presentation skills
8.	Case study Analysis/ Seminar*	Real world case studies-based learning for state-of-the-art/new technology in soil mechanics	Duration of data collection / study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc
9.	Quiz/Group discussion	Group Discussion on emerging/trending technical topics related to geotechnical techniques and tools	Duration = 02 h each	Based on performance in group discussion, technical depth, knowledge etc.
10.	Complex problem solving/ Mini Project	Modeling a slope stability scenario or calculating settlement for a multi-layered clay deposit.	Duration = 10 h	Depending on the complexity of the Application/Software

In alignment with Out Come Based Education (OBE) and NBA accreditation requirements, the subject of Soil Mechanics Incorporates:

*Compulsory-Seminar-10 marks and other PBL activities of 20 marks.

These activities are incorporated as integral Project Based Learning (PBL) components.

These activities are aim to promote experimental learning, encourage innovation and

Enhance problem solving skills in students through practical engagement. The inclusion of PBL ensures that learner develop higher order cognitive abilities mapped to Bloom Taxonomy, while simultaneously enhancing teamwork, communication and research Competencies essential for professional engineering practice.

1. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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