

## Advanced Soil Mechanics

<b>Code</b> CE-831	<b>Credit Hours</b> 3-0
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### Course Description

This course is designed to allow students to understand and practice the deep knowledge of soil behavior under critical state and unsaturated conditions.

### Course Objectives

1. Understand the behavior of the clay minerals, water-clay relation, and problematic soils
2. To develop skills of constitutive modeling of soils using critical state soils mechanics.
3. To develop understanding of nature and engineering behavior of unsaturated soils.

### References / Textbooks

4. Mitchell, J. K., & Soga, K. (2005). Fundamentals of soil behavior, 3rd. New York: John Wiley & Sons.
5. Das, B. M. (2019). Advanced soil mechanics. Crc Press.
6. Wood, D. M. (1990). Soil behaviour and critical state soil mechanics. Cambridge university press.
7. Atkinson, J. (1993). An introduction to the mechanics of soils and foundations: through critical state soil mechanics. McGraw-Hill Book Company (UK) Ltd.
8. Lu, N. & Likos, W. (2004) Unsaturated Soil Mechanics
9. Fredlund et al. (2012) Unsaturated Soil Mechanics in Engineering Practice;
10. Murray & Sivakumar (2010) Unsaturated Soils A fundamental interpretation of soil behaviour
11. Bishop, A.W.T.; Donald, I.B. (1961) Experimental study of partly saturated soil in the triaxial apparatus.

### Prerequisites

Nil

### Assessment System for Theory

Quizzes	10-15%
Assignments	5-10%
Mid Terms	25-30%
Project	0-10%
ESE	45-50%

### Teaching Plan

Week No	Topics	Learning Outcomes
1	Introduction	Course Outline, objectives, teaching plan, assessment method, concepts review.

2	Clay minerals	Classification of the Soil. Clay Minerals. Sources of the charges Cation Exchange Capacity (CEC). Diffuse double layer. Kaolinite. Illite. Montmorillonite
3-5	Phase Properties and Relations & Water-clay relation	Phase Properties and Relations. Unit weight vs specific gravity vs compaction. Void ratio vs Intergranular Void ratio. Relative density. Soil Plasticity. Liquid Limit (LL). Plastic Limit (PL). Plasticity index (PI). Shrinkage Limit (SL). Activity (A). Plasticity Chart. Soil Structure. Sensitivity of Clay. Thixotropy of Clay
6	Introduction to Problematic soils	Organic soil. Collapsible soil. Conditions & Treatment of Collapsible soil
7-8	Soil Strength & Deformation	Introduction-Definition. Interparticle Forces & the Types of Stress. Strain Behavior. Plasticity and soil strength. Stress-Stress and Stress-Strain
9	<b>MID TERM</b>	
10-12	Soil Strength & Deformation	Theory of Shear strength and Failure criteria. Stress-Stress, Volume Change, and Soil Behavior. Stresses in the triaxial test. Concept of stress Path and $q' - p'$ Diagram. Applications of Stress Path and $q' - p'$ Diagram.
13-15	Introduction to Unsaturated Soil Mechanics.	Introduction. Concept of the unsaturated / partially saturated soil conditions. Effective stress parameter or Bishop's parameter. Unsaturated soil zone. Total Soil Suction. Osmotic action and surface tension. Concept of Water Surface Tension. Calculation of the Surface Tension. Capillary forces in Soil. Hydrostatic Equilibrium in a Capillary Tube. Air-Water Interface (Two phases). Air-Water-Solid interface (Three phases). Soil-water characteristic curve (SWCC). Stress in Unsaturated Soil. Unsaturated Shear Strength. Stress Control by Axis Translation. Air-Water-HAE System. Characteristic Curve for HAE Material. Measuring Soil Suction
16-17	Critical State Soil Mechanics (CSSM).	Review the stress path. Yielding surface. Behavior of the soil in the critical state. TSP, ESP, Overconsolidation, and normal consolidation soil. ESP, TSP, Undrained test
18	<b>End Semester Exams</b>	

