



## National University of Engineering (UNI)

School of Civil Engineering  
Syllabus 2026-II

### 1. COURSE

CE2G2. Soil Mechanics II (Mandatory)

### 2. GENERAL INFORMATION

|                            |                                                  |
|----------------------------|--------------------------------------------------|
| 2.1 Course                 | : CE2G2. Soil Mechanics II                       |
| 2.2 Semester               | : 8 <sup>th</sup> Semester.                      |
| 2.3 Credits                | : 4                                              |
| 2.4 Hours                  | : 3 HT; 2 HP;                                    |
| 2.5 Duration of the period | : 16 weeks                                       |
| 2.6 Type of course         | : Mandatory                                      |
| 2.7 Learning modality      | : Face to face                                   |
| 2.8 Prerequisites          | : CE2G1. Soil Mechanics I. (7 <sup>th</sup> Sem) |

### 3. PROFESSORS

Meetings after coordination with the professor

### 4. INTRODUCTION TO THE COURSE

Soil Mechanics II builds directly on Soil Mechanics I, extending the phase-relationship and hydraulic-behavior framework already developed there into the stress-deformation and strength behavior that governs how soils respond to load. The course first develops shear strength theory and laboratory test interpretation, one-dimensional consolidation and settlement prediction, and stress distribution beneath loaded areas, and then applies this behavioral framework to four major geotechnical design problems: lateral earth pressure and earth-retaining structures, slope stability and landslide mitigation, shallow foundation design, and deep foundation design (piles and drilled shafts). As the second, broad-survey course of the Geotechnical Engineering track, each design topic is introduced at a level appropriate for a first exposure; students who continue into the track's specialization electives will revisit these same topics at a substantially deeper level.

### 5. GOALS

- Determine shear strength parameters of soils from direct shear and triaxial test data, and distinguish drained from undrained behavior.
- Predict consolidation settlement and its time-rate for saturated clays, and compute stress distribution beneath loaded areas.
- Apply lateral earth pressure theory to design retaining walls, anchored walls, and mechanically stabilized earth systems.
- Analyze the stability of natural and engineered slopes and design stabilization measures for identified failure modes.
- Design shallow foundations (isolated, combined, mat) based on bearing capacity and settlement criteria.
- Design deep foundations (piles and drilled shafts) considering axial capacity, lateral capacity, and group effects.

### 6. COMPETENCES

**ABET-1)** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

**ABET-2)** An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (Usage)

### 7. TOPICS

| Unit 1: Shear Strength and Consolidation (30 hours)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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| Competences Expected: ABET-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <ul style="list-style-type: none"> <li>• Shear strength of soils and Mohr-Coulomb failure criterion</li> <li>• Direct shear and triaxial testing methods</li> <li>• Drained and undrained shear strength behavior</li> <li>• Consolidation theory and settlement analysis</li> <li>• Time-rate of consolidation and degree of consolidation</li> <li>• Stress distribution in soil masses using elastic theory</li> <li>• Critical state soil mechanics concepts</li> <li>• Residual shear strength and sensitivity of clays</li> <li>• Secondary compression and creep behavior</li> <li>• Anisotropy and stress path effects on soil behavior</li> </ul> | <ul style="list-style-type: none"> <li>• Apply Mohr-Coulomb criterion to determine shear strength parameters [Familiarity]</li> <li>• Interpret direct shear and triaxial test results [Assessment]</li> <li>• Distinguish between drained and undrained loading conditions [Usage]</li> <li>• Calculate consolidation settlement using one-dimensional theory [Assessment]</li> <li>• Predict time-rate of settlement for consolidating soils [Usage]</li> <li>• Compute stress distribution beneath loaded areas using Boussinesq theory [Assessment]</li> <li>• Explain critical state concepts and their application to soil behavior [Familiarity]</li> <li>• Evaluate residual strength and sensitivity for slope stability problems [Assessment]</li> <li>• Estimate secondary compression for highly plastic soils [Usage]</li> <li>• Analyze the effects of stress paths and anisotropy on soil response [Familiarity]</li> </ul> |
| Readings : [Das19]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Unit 2: Earth Retaining Systems (10 hours)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| Competences Expected: ABET-1,ABET-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <ul style="list-style-type: none"> <li>• Earth pressure theory including active and passive pressures</li> <li>• Retaining wall types and selection criteria</li> <li>• Load testing methods including static and dynamic tests</li> <li>• Anchored walls and tied-back systems</li> <li>• Mechanically stabilized earth walls and reinforced soil systems</li> <li>• Basement and foundation wall design considering top-of-wall restraint conditions</li> <li>• Counterfort and buttressed retaining wall design</li> </ul> | <ul style="list-style-type: none"> <li>• Apply lateral earth pressure theories for retaining wall design [Assessment]</li> <li>• Design gravity and cantilever retaining walls [Usage]</li> <li>• Design anchored wall systems including ground anchor capacity [Assessment]</li> <li>• Proportion mechanically stabilized earth walls and select reinforcement [Usage]</li> <li>• Design basement and foundation walls considering top restraint, surcharge, and hydrostatic loads [Assessment]</li> <li>• Design counterfort retaining walls including stem, heel, toe, and counterfort elements [Usage]</li> </ul> |
| Readings : [Das19], [Cod01]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Unit 3: Slope Stability Analysis and Stabilization (10 hours)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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| Competences Expected: ABET-1,ABET-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Learning Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <ul style="list-style-type: none"> <li>• Infinite slope analysis for simple geometries</li> <li>• Method of slices and limit equilibrium analysis</li> <li>• Circular and non-circular failure surfaces</li> <li>• Factor of safety determination and acceptance criteria</li> <li>• Stability charts and simplified methods</li> <li>• Landslide types and failure mechanisms</li> <li>• Seismic slope stability and pseudo-static analysis</li> <li>• Stabilization methods including drainage and reinforcement</li> <li>• Monitoring systems and early warning for unstable slopes</li> <li>• Probabilistic slope stability analysis</li> </ul> | <ul style="list-style-type: none"> <li>• Perform infinite slope stability analysis for uniform slopes [Assessment]</li> <li>• Apply method of slices to analyze slope stability [Usage]</li> <li>• Analyze slopes with circular and non-circular failure surfaces [Assessment]</li> <li>• Calculate factors of safety and interpret results [Usage]</li> <li>• Use stability charts for rapid slope evaluation [Assessment]</li> <li>• Identify landslide types and their characteristic features [Familiarity]</li> <li>• Evaluate seismic stability using pseudo-static methods [Usage]</li> <li>• Design slope stabilization measures for specific failure modes [Assessment]</li> <li>• Implement monitoring systems for potentially unstable slopes [Usage]</li> <li>• Conduct probabilistic stability analysis considering parameter uncertainty [Assessment]</li> </ul> |
| Readings : [DWB14]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| <b>Unit 4: Bearing Capacity and Design (10 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| <b>Competences Expected: ABET-1,ABET-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Topics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Learning Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <ul style="list-style-type: none"> <li>• Bearing capacity theory and failure mechanisms</li> <li>• Ultimate bearing capacity equations for various conditions</li> <li>• Settlement analysis using elastic and consolidation methods</li> <li>• Isolated spread footing design</li> <li>• Combined footings and strap footings</li> <li>• Allowable bearing pressure and factor of safety selection</li> <li>• Mat foundation analysis and design</li> <li>• Eccentric and inclined loading effects</li> <li>• Soil-structure interaction effects</li> <li>• Differential settlement and tolerable limits</li> <li>• Continuous (strip) footing design for basement and foundation walls</li> </ul> | <ul style="list-style-type: none"> <li>• Explain bearing capacity failure mechanisms in shallow foundations [Familiarity]</li> <li>• Calculate ultimate bearing capacity using Terzaghi and Meyerhof equations [Assessment]</li> <li>• Predict total and differential settlements for shallow foundations [Usage]</li> <li>• Design isolated spread footings for gravity loads [Assessment]</li> <li>• Proportion combined and strap footings for column arrangements [Usage]</li> <li>• Determine allowable bearing pressures based on strength and settlement criteria [Assessment]</li> <li>• Analyze mat foundations using conventional and finite element methods [Assessment]</li> <li>• Evaluate bearing capacity under eccentric and inclined loading [Usage]</li> <li>• Consider soil-structure interaction in foundation design [Familiarity]</li> <li>• Assess differential settlement and apply tolerable settlement criteria [Assessment]</li> <li>• Design continuous strip footings for basement and foundation walls [Usage]</li> </ul> |
| <b>Readings :</b> [Cod01], [Das19]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| <b>Unit 5: Deep Foundations (10 hours)</b>                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| <b>Competences Expected: ABET-1,ABET-2</b>                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Topics</b>                                                                                                                                                                                                                                                                                                                                                                                  | <b>Learning Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <ul style="list-style-type: none"> <li>• Pile types and installation methods</li> <li>• Axial capacity of single piles in cohesive and cohesionless soils</li> <li>• Lateral load capacity and p-y method</li> <li>• Pile group behavior and group efficiency</li> <li>• Drilled shaft design and construction considerations</li> <li>• Negative skin friction and downdrag forces</li> </ul> | <ul style="list-style-type: none"> <li>• Select appropriate pile types based on soil conditions and loading [Familiarity]</li> <li>• Calculate axial capacity of piles using static methods [Assessment]</li> <li>• Analyze laterally loaded piles using p-y curves [Usage]</li> <li>• Evaluate pile group capacity and settlement [Assessment]</li> <li>• Design drilled shaft foundations including shaft diameter and reinforcement [Usage]</li> <li>• Interpret pile load test results and verify design assumptions [Assessment]</li> </ul> |
| <b>Readings :</b> [Cod01], [Das19]                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## 8. WORKPLAN

### 8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

### 8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

### 8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

## 9. EVALUATION SYSTEM

\*\*\*\*\* EVALUATION MISSING \*\*\*\*\*

## 10. BASIC BIBLIOGRAPHY

- [Cod01] Donald P. Coduto. *Foundation Design: Principles and Practices*. 2nd. Prentice Hall, 2001.
- [DWB14] J. Michael Duncan, Stephen G. Wright, and Thomas L. Brandon. *Soil Strength and Slope Stability*. 2nd. John Wiley & Sons, 2014.
- [Das19] Braja M. Das. *Principles of Geotechnical Engineering*. 9th. Cengage Learning, 2019.