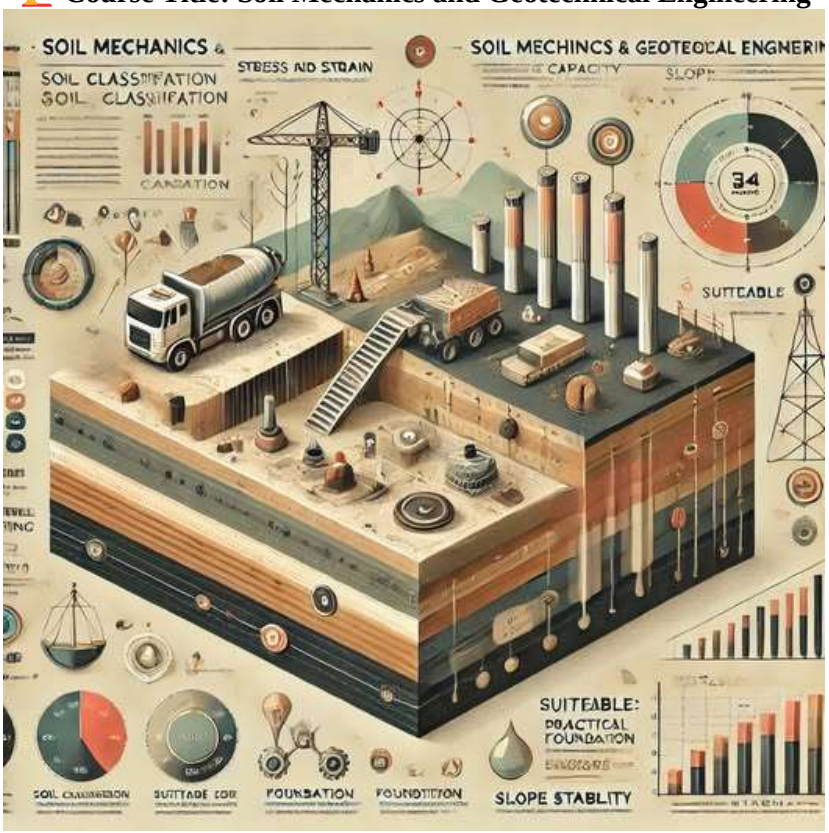
# Course Title: Soil Mechanics and Geotechnical Engineering




**Code: 4032-CIV**

**Duration: 7 Weeks**
**Format: Blended (Theoretical Sessions + Lab & Software Work + Project-Based Learning)**
**Language: Bilingual (English / Arabic)**

## 1. Introduction

Geotechnical engineering forms the foundation of all structural and infrastructural projects. Understanding soil behavior, classification, and foundation design is critical for safe and economical construction. This course provides in-depth knowledge of soil mechanics, geotechnical testing, and foundation engineering—essential for any civil engineer involved in structural design or site preparation.

## 2. Course Description

This 7-week intensive course covers fundamental and advanced topics in soil mechanics and geotechnical design. It integrates theoretical understanding with real-world application through lab work, case studies, and geotechnical software usage. The course is highly practical and aligned with the latest international design standards and site safety practices.

📘 **Course Outline – Detailed Structure**

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🔹 **Week 1: Introduction to Soil Mechanics**

- **Objectives:**
  - Understand the role of soil mechanics in civil engineering.
  - Identify soil as a construction material and its engineering relevance.
- **Topics Covered:**
  - Origin and formation of soils.
  - Phases of soil (solid, liquid, gas).
  - Basic soil properties (void ratio, porosity, unit weight).
  - Stress in soil (total, effective, pore water pressure).
  - Soil-water relationship basics.

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🔹 **Week 2: Soil Classification and Properties**

- **Objectives:**
  - Classify soils using standard systems (USCS, AASHTO).
  - Analyze physical properties of different soil types.
- **Topics Covered:**
  - Particle size distribution (sieve and hydrometer analysis).
  - Consistency limits (liquid limit, plastic limit, shrinkage limit).
  - Soil structure and fabric.
  - Soil compaction and its significance.
  - Field identification and classification.

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🔹 **Week 3: Soil Testing (Lab & Field)**

- **Objectives:**
  - Conduct geotechnical tests to assess soil strength and permeability.
  - Interpret lab and field data for design decisions.
- **Topics Covered:**
  - Standard Proctor and Modified Proctor tests.
  - Direct shear test, triaxial compression test, unconfined compression test.
  - Permeability tests (falling head, constant head).
  - Field tests: SPT, CPT, plate load test.

- Report writing and interpretation of test results.

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- **Week 4: Shallow Foundation Design**
  - **Objectives:**
    - Analyze and design spread footings and mat foundations.
    - Evaluate bearing capacity and settlement.
  - **Topics Covered:**
    - Types of shallow foundations.
    - Terzaghi and Meyerhof bearing capacity equations.
    - Immediate and consolidation settlement.
    - Foundation design under eccentric loads.
    - Structural and geotechnical design coordination.

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- **Week 5: Deep Foundation Design**
  - **Objectives:**
    - Understand principles of pile and pier foundations.
    - Design deep foundations under axial and lateral loads.
  - **Topics Covered:**
    - Classification of piles: driven, bored, CFA, micropiles.
    - Load transfer mechanisms (skin friction & end bearing).
    - Negative skin friction and group effects.
    - Pile load testing methods.
    - Pile design examples (manual + software-assisted).

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- **Week 6: Slope Stability and Earth Retaining Systems**
  - **Objectives:**
    - Assess slope stability for cut/fill slopes.
    - Analyze retaining wall design principles.
  - **Topics Covered:**
    - Types of slope failures and causes.
    - Limit equilibrium methods (Fellenius, Bishop, Janbu).
    - Soil nailing, geogrids, and reinforcement techniques.
    - Earth pressure theories (Rankine, Coulomb).
    - Retaining wall types: gravity, cantilever, anchored.

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- **Week 7: Final Project – Foundation Design**
  - **Objectives:**
    - Apply course knowledge to a real-life project.
    - Present complete geotechnical documentation.
  - **Topics Covered:**

- Site profile interpretation and investigation planning.
- Design of suitable foundation system based on soil data.
- Use of geotechnical software for modeling.
- Technical report and design drawings.
- Group presentation or defense of the proposed design.

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### 📂 Optional Tools/Software Suggested

- **Plaxis 2D/3D**
- **GeoStudio / SLOPE/W**
- **SAFE / Foundation Design Tools**
- **Microsoft Excel for calculations**
- **AutoCAD / Civil 3D (for documentation)**

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### 🎯 Course Objectives

- Build a solid foundation in soil mechanics and geotechnical engineering
- Teach how to conduct and analyze lab/field tests for soil behavior
- Train on design methods for shallow and deep foundations
- Apply geotechnical knowledge to slope stability and soil-structure interaction
- Integrate modern software tools into geotechnical problem-solving

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### ✅ Learning Outcomes

By the end of this course, participants will be able to:

- Classify soils using international systems (USCS, AASHTO)
- Determine essential soil properties and parameters via testing
- Design foundation systems based on soil conditions and loads
- Evaluate safety and stability of slopes and retaining walls
- Use analysis software to simulate real foundation conditions
- Complete a geotechnical design project for a real or hypothetical structure

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### 🗓️ 9. Weekly Breakdown

**Week Topic**

Week 1 Introduction to Soil Mechanics: Basic concepts, soil formation, and role in design

Week 2 Soil Classification & Properties: Grain size, Atterberg limits, compaction

Week 3 Laboratory & Field Testing: Standard Proctor, SPT, CPT, permeability, shear strength

Week 4 Design of Shallow Foundations: Bearing capacity, settlement, design procedures

Week 5 Design of Deep Foundations: Pile types, load transfer, negative skin friction

Week 6 Slope Stability & Retaining Structures: Failure mechanisms, reinforcement techniques

Week 7 Final Project: Complete design and documentation of foundation system for a structure