# CIVIL ENGINEERING DEPT.
# Ph.D. Soil Mechanics
## 2024-2025

**CIVIL ENGINEERING DEPARTMENT**
**Ph.D.-STUDIES-SOIL MECHANIC ENGINEERING**
**First Course**

| Item | Code | Subjects | Units | Hr. |
|---|---|---|---|---|
| 1 | Eng.Civil 619 | FINITE ELEMENTS | 2 | 2 |
| 2 | Eng.Civil 614 | MODELING IN GEOTECHNICS | 3 | 3 |
| 3 | Eng.Civil 615 | PLASTICITY AND APPLICATION IN GEOTECHNICAL ENGINEERING | 2 | 2 |
| 4 | Eng.Civil 616 | UNDER GROUND STRUCTURES | 2 | 2 |
| 5 | Eng.Civil 606 | ENGLISH LANGUAGE | 1 | 1 |
| **TOTAL** | | | **10** | **10** |

**Second Course**

| Item | Code | Subjects | Units | Hr. |
|---|---|---|---|---|
| 1 | Eng.Civil 617 | UNSATURATED SOIL MECHANICS | 3 | 3 |
| 2 | Eng.Civil 618 | DEEP FOUNDATIONS | 3 | 3 |
| 3 | Eng.Civil 613 | ADVANCE ENGINEERING MATHEMATICS (II) | 2 | 2 |
| 4 | Eng.Civil 620 | SOIL DYNAMICS & MACHINE FOUNDATIONS | 3 | 3 |
| 5 | Eng.Civil 612 | ENGLISH LANGUAGE | 1 | 1 |
| **TOTAL** | | | **12** | **12** |

**ADVANCE ENGINEERING MATHEMATICS (II)/Eng.Civil 601**

1- Matrix Differential Equation :

   a- System of Differential Equation.

   b- Linear Differential Equation with constant coefficients.

   c- Differential Equation of Motion.

2- Power Series Solutions of differential Equations :

   a- Infinite Series.

   b- Series Solution of Ordinary D.E.

   c- Introduction to Special functions.

3- Function Spaces and Multiple Integrals :

   a- The algebra of function spaces.

   b- Multiple Integral Theorems.

   c- Material Derivative and Differential forms.

4- Vibrating Strings and Membranes :

   a- The Transversely Vibrating String.

   b- The Transversely Vibrating Membrane.

   c- Steady States String and Membrane.

5- Fluid Dynamic :

   a- Dynamics of compressible fluids.

   b- Irrational , Incompressible and steady Isentropic flow.

6- Prototype second orders problems.

   Wave, Heat and Laplace Equations.

## PHYSICAL MODELING IN GEOTECHNICS\ Eng.Civil

1. Physical modeling in geotechnics
   - Dimensional analysis
   - Scaling laws
   - General conditions of the model in geotechnics
   - Applicability of the geotechnical model to the field conditions for various cases of soil testing and to soil-structure interaction.
   - Model for piles, Anchors, reinforced earth, retaining walls
   - Instrumentation for required model:
   - included the install the load cell and strain gauges
   - Method of connection and measurements for soil deformation
   - Lateral earth pressure (case of plastic condition)
   - Lateral earth pressure on curved surface (concave and convex surfaces)
   - Lateral earth pressure on Diaphragm walls (Applications on different cases of water table in soil, level of slurry, Factor of safety for each case).

2. Constitutive modeling
   - Elastic models
   - Elastic-perfectly plastic models
   - Elastic-hardening plastic models

3. Numerical Models

4. Soil-structure interaction

## PLASTICITY AND APPLICATION IN GEOTECHNICAL ENGINEERING\ Eng.Civil 612

### 1. Limiting Equilibrium of a Granular Medium.

a. Limiting condition.
b. Limiting plane equilibrium of a granular medium.
c. Equation of limiting plane equilibrium.

d. Limiting equilibrium of foundation.

2. **Stability of foundation and slopes.**
    a. Normal restraining pressure on foundation.
    b. Normal failure pressure on foundation.
    c. Inclined restraining and failure pressure.
    d. Stability of slopes.
    e. Shape of curvilinear slopes.
    f. Discontinuous solutions.
3. **Pressure of a fill on retaining walls.**
    a. Active pressure of a fill on retaining walls.
    b. Passive pressure of a fill on retaining walls.
    c. Discontinuous solutions, Broken - Back retaining walls.
    d. Curvilinear retaining walls.
    e. Twin retaining walls.
    f. Limiting plane equilibrium of a Lamellar medium.
4. **Limiting equilibrium of a cohesive medium.**
    a. Limiting plane equilibrium of an ideally cohesive medium.
    b. Stability of foundation.
    c. Shape of curvilinear slopes, Discontinuous solutions.
    d. Pressure of a fill on retaining walls, Discontinuous solutions.
    e. Limiting plane equilibrium of a cohesive medium.
    f. Special form of the limiting condition.

**UNDERGROUND STRUCTURES \ Eng.Civil 613**

- Introduction
- Site investigation.
- Analysis of stress around underground excavation in elastic ground condition.
- Principle governing design of underground structure

- Stresses in underground excavation in stratified rocks.
- Elasto –plastic stress distribution around stratified rocks.
- Theory of rock bolts and rock anchors.

**SOIL MECHANICS \ UNSATURATED SOILS\ Eng.Civil 614**

- Scope and importance of partially saturated soil mechanics.
- Phase properties and relations
- Individual phase
- Interaction of air and water
- Volume- mass relations
- Brief description of Composition and microstructure of soils.
- Soil- water interaction.
- Role of water in the soil forces.
- Microstructure of clay- water system.
- Localization and types of water in soil system.
- Soil- water characteristics curve and their relationships with some soil behaviors [ swelling, shear strength, permeability . . .ext]
- **Suction**
- Theory of soil suction.
- Capillarity
- Measurements of total, matric and osmotic suctions
- properties of unsaturated soils; experimental approach
- [ laboratory techniques for unsaturated soils and some obtained results in this field].
- Introduction for some basic partially saturated soil mechanics subject concerning.
- Volume change & compressibility
- Seepage
- Permeability

**DEEP FOUNDATION\ Eng.Civil 615**

- Load capacity of piles.
- Settlement analysis of single piles.
- Lateral resistance of piles.
- Load deflection for lateral loaded piles.
- Drilled caisson.
- State of the art.
- Selection of drilled pier foundation.
- Design consideration.
- Horizontal force on drilled caisson.
- Caisson.

**FINITE ELEMENTS \ Eng.Civil 616**

1. Introduction : Analysis method and historical development of the F. E.
   a. The mathematical bases of the F. E.
   b. Minimization of energy and Galarkin`s method formulation .

2. Type of element – shape functions, B and K matrices .
   a. According to the physical state of the problem .
   b. According to dimension - line – 2D – 3D .
   c. According to shape , number of nodes and degrees of freedom .

3. Formulation of the steady state problems:
   a. Seepage problems.
   b. Flow of fluid.

4. Formulation of the transient problem :
   a. Consolidation problem
   b. Boit theory of pore pressure formulation in soil mechanics.

5. Introduction to soil dynamics.

6. Computer programming :
    a. Preprocessing and mesh generation.
    b. Solution method.
    c. Post processing and graphics.

7. Introduction on using ANSYS finite element package:
    a. Applications on seepage.
    b. Applications on consolidation.
    c. Applications on soil dynamics.
    d. Applications on Boit coupling of soil with pore water pressure.

8. Examination and evaluation.

**SOIL DYNAMICS & MACHINE FOUNDATIONS/Eng.Civil 617**

- Theory of vibration
- Vibration measuring instruments
- Wave propagation in soil media
- Strength characteristics of soils
- Liquefaction
- Laboratory and field test
- Application of dynamic force in soil mechanics
- Machine foundation