Course Name:
Unsaturated Soil Mechanics

Course Number:
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Credit:
3

Course Content (outline):

1. **Introduction**
   - 1.1 Categorization of Saturated and Unsaturated Soil Mechanics
   - 1.2 Terminology
   - 1.3 Role of Climatic Conditions
   - 1.4 Examples of Practical Problems
   - 1.5 Typical Profiles of Unsaturated Soils
2. **Basic Physics and Phases in Soils**
   - 2.1 Density and Specific Volume
   - 2.2 Viscosity
   - 2.3 Surface Tension
   - 2.4 Interaction between Air and Water
   - 2.5 Volume-Mass Relationships
3. **Stress State Variables and Stress Analysis**
   - 3.1 Literature Review
   - 3.2 Stress State in Unsaturated Soils
   - 3.3 Limiting Stress State Conditions
   - 3.4 Stress Analysis
   - 3.5 Role of Osmotic Suction
4. **Measurements of Soil Suction**
   - 4.1 Theory of Soil Suction
   - 4.2 Capillary
   - 4.3 Measurements of Total Suction
   - 4.4 Measurements of Matric Suction
   - 4.5 Measurements of Osmotic Suction

5. Flow Laws for Water and Air Phases

5.1 Water Flow in Soils

5.2 Air Flow in Soils

5.3 Diffusion Phenomenon

5.4 Summary of Flow Laws

5.5 Soil-Water Retention Curve and It′s State-Dependency

6. Measurements of Permeability

6.1 Measurements of Water Coefficient of Permeability

6.2 Measurements of Air Coefficient of Permeability

7. Steady-State and Transient Flow

7.1 Steady-State Water Flow

7.2 Steady-State Air Flow

7.3 Two-Dimensional Transient Water Flow

7.4 Examples of Practical Problems

7.5 Distribution of Pore Water Pressure and Slope Stability

8. Theories and Measurements of Shear Strength, Shear Stiffness and Damping Ratio

8.1 Theories of Shear Strength of Unsaturated Soils

8.2 Failure Envelopes

8.3 Triaxial Testing on Unsaturated Soils

8.4 Direct Shear Testing on Unsaturated Soils

8.5 Multi Stage Testing

8.6 Shear Stiffness and Damping Characteristics at Small and Large Strain Levels

9. Plastic and Limit Equilibrium Analysis

9.1 Earth Pressure for Unsaturated Conditions

9.2 Bearing Capacity of Unsaturated Soils

9.3 Slope Stability

10. Constitutive Models for Unsaturated Soils

10.1 Revisit of Critical State Framework for Saturated Soils

10.2 Revisit of the Extended Critical State Framework for Unsaturated Soils

10.3 Advanced Models

11. Recent Advances in Unsaturated Soil Mechanics

11.1 Characterization and Investigation of Microstructural Effects on Unsaturated Soil Behavior

11.2 Temperature Effects on Unsaturated Soil Behavior

11.3 Development of New Devices for Measuring Unsaturated Soil Properties

11.4 Effects of Vegetation on Stability of Slopes Landfill Covers

References:

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- Fredlund, D.G. and Rahardjo, H. (1993), Soil Mechanics for Unsaturated Soils, John Wiley & Sons
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- Lu, N. and Likos, W.J. (2004), Unsaturated Soil Mechanics, John Wiley & Sons
- Ng, C.W.W., Leung, A.K. and Ni, J. (2018), Plant-Soil slope Interaction, Taylor & Francis
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