Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NCED521	Unsaturated Soil Mechanics	3	0	0	3

Course Objective

This course provides fundamental principles, key mechanisms, and an in-depth understanding of the behavior of partially saturated soils. It aims to equip students with the necessary theoretical foundation and practical insights to analyze and address geotechnical challenges involving unsaturated soil conditions.

Learning Outcomes

By the end of this course, students will be able to -

- Understand unsaturated soil behaviour.
- Analyze key mechanisms affecting the unsaturated soil response.
- Utilize soil mechanics concepts to analyze and solve geotechnical problems involving unsaturated soils.
- Enhance practical knowledge of unsaturated soil behavior in geotechnical engineering practice, including its applications in foundations, slope stability, and environmental geotechnics.

Unit No.	Topics to be Covered	Contact Hours	Learning Outcome
1	**Introduction to Unsaturated Soil Mechanics:** Applications associated with unsaturated soil soils, Basic parameters such as state variables and material constants, Phase equilibrium between free water and air.	6 L	Understand the key concepts such as soil parameters (e.g., saturation, water content, soil suction), and material constants.
2	**Soil Hydraulic Response:** Concept of soil water retention, soil water characteristic curve (SWCC), Wetting and drying SWCC or hysteresis, Water retention mechanism in soils, Hydraulic conductivity.	5 L	Learned the water retention behaviour, hysteresis, and the role of capillary forces and adhesion in water movement and retention in soils.
3	**Measurement and Modelling:** Measuring state variables (i.e., soil water characteristic, suction, hydraulic conductivity), prediction of hydraulic conductivity, Capillary barriers. Software demonstration.	10 L	Understand the measurement of state variables, predict hydraulic conductivity, understand capillary barriers, and use software like RET C and HYDRUS for modelling unsaturated soils.
4	**Flow through Unsaturated Soils:** Steady state flow, Absence and influence of gravity, Transient flow, Determination of water	5 L	Learned the steady state and transient flow in unsaturated soils, and the determination

	diffusivity, Analytical methods for transient flow.		of water diffusivity. They will apply analytical methods, like Richards' equation, to model transient flow in soils.
5	**Shear Strength of Unsaturated Soils:** Shear Strength, Stresses in unsaturated soils, Measurement of shear strength, Measurement of Bishop's effective stress parameter, Extended M-C criterion by Fredlund, Estimation of extended M-C parameters, nonlinearity in the extended M-C failure envelope, Empirical relations for prediction shear strength.	12 L	Understand the shear strength in unsaturated soils, apply Bishop's effective stress and the extended Mohr-Coulomb criterion, estimate parameters, and use empirical relations to predict shear strength.
6	**Swell-Collapse Response and Prediction:** Methods of testing swelling pressure, Laboratory techniques to estimate collapse potential, Predictive models for volume change (swelling or collapse), and yielding behaviour of unsaturated soils.	4 L	Learned to test swelling response, estimate collapse potential, use predictive models for volume changes, and analyse the yielding behaviour of unsaturated soils.
	Total Contact Hours	**42 L**	

Text Books

1. Lu, N. and Likos, W.J., Unsaturated soil mechanics, Wiley, 2004.
2. Fredlund, D. J., Rahardjo, R., and Fredlund, M.D. Unsaturated Soil Mechanics in Engineering Practice, Wiley, 2012.

Reference Books

1. Briaud, J. L. (2023). *Geotechnical engineering: unsaturated and saturated soils*. John Wiley & Sons.
2. Murray, E. J., & Sivakumar, V. (2010). *Unsaturated Soils: A fundamental interpretation of soil behaviour*. John Wiley & Sons.
3. Blight, Geoffrey E. *Unsaturated soil mechanics in geotechnical practice*. CRC Press, 2013.
4. Leong, E. C., & Wijaya, M. (2023). *Laboratory tests for unsaturated soils*. CRC Press.
5. Fredlund, D. G., & Rahardjo, H. (1993). *Soil mechanics for unsaturated soils*. John Wiley & Sons.
6. Khalili, N., Russell, A., & Khoshghalb, A. (Eds.). (2014). *Unsaturated soils: research & applications*. Crc Press.
7. Tarantino, A. (2008). *Laboratory and field testing of unsaturated soils*. spring.