



IIT Mandi

Proposal for a New Course

Course number	: CE613
Course Name	: Mechanics of Unsaturated Soils
Credit Distribution	: 3-0-0-3
Intended for	: UG and PG students
Prerequisite	: Geotechnical Engineering I (CE302), Geotechnical Engineering II (CE 402) or equivalent course.
Mutual Exclusion	: None

1. Preamble:

The conventional course on Geotechnical Engineering introduces students to the traditional analysis and design procedures which considers the soil as either completely dry or completely saturated. But the significant portion of the conditions encountered in the routine geotechnical engineering practice involves unsaturated soils. Therefore, the major aim of this course is to introduce the students to the fundamental behaviour of unsaturated soils. The course starts with concepts of phases relationships in unsaturated soils, contractile skin, and stress state variables. Then the course discusses in detail about the concepts of soil suction and measurement of soil suction, soil water characteristic curve, permeability in unsaturated soil through laboratory testing. Through this course, the students will also learn about the shear strength properties of unsaturated soils, determination of its shear strength through triaxial and direct shear tests, and estimation of swelling pressure and heave.

2. Course Modules with quantitative lecture hours:

- 1. Introduction to Unsaturated Soil Mechanics:** Role of climatic conditions, Need and application areas of unsaturated soil mechanics, Typical profile of unsaturated soils (**2 Hours**)
- 2. Phase Properties and Stress state variables:** Properties of individual phases, Interaction of air and water, Volume-mass relations, Effective stress for unsaturated soils, Stress state variables, Limiting stress state conditions and experimental testing of stress state variables (**8 Hours**)
- 3. Measurement of soil suction:** Theory of soil suction, Capillarity, Measurement of Total suction, Matric suction, and Osmotic suction (**8 Hours**)
- 4. Flow behaviour in unsaturated soils:** Flow of water, Driving potential for water phase, Darcy's law, coefficient of permeability with respect to water phase, steady state flow (**8**

Hours)

5. Shear strength of unsaturated soils: Failure envelope for unsaturated soils, Triaxial and direct shear tests on unsaturated soils **(8 Hours)**

6. Stress-deformation analysis for unsaturated soils: Swelling pressure determination, 1-D Heave estimation, Foundation design in expansive soil **(6 Hours)**

Laboratory/practical/tutorial Modules: None

3. Textbooks:

1. Fredlund, D.G., Rahardjo, H., and Fredlund, M.D., “Unsaturated Soil Mechanics in Engineering Practice”, 2nd Edition, John Wiley & Sons, Inc., USA, 2012.
2. Lu, N., and Likos, W.J., “Unsaturated Soil Mechanics”, 1st Edition, John Wiley & Sons, Inc., USA, 2004.

4. References:

1. Ng, Charles, W.W., and Menzies, B., “Advanced Unsaturated Soil Mechanics and Engineering”, Taylor and Francis, USA, 2007.
2. Blight, G.E., “Unsaturated Soil Mechanics in Geotechnical Practice”, Taylor and Francis, UK, 2013
3. Refereed publications in the field of unsaturated soil mechanics

5. Similarity with the existing courses: None
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Name	Course Code	Similarity Content	Approx. % of Content
1.	-	-	-	-

6. Justification of new course proposal if cumulative similarity content is >30%: Not applicable