CIV_ENG_250-0 – Earth Surface Engineering
Fall Quarter 2024

Course description: This course addresses the fundamentals of the mechanics of geomaterials, with emphasis on the processes and phenomena that govern the equilibrium of the Earth's surface. The course focuses on the analysis of the structure and properties of soils and rocks, and the way these materials respond to loading (mechanical and hydraulic loading). The course comprises theoretical sessions, practical sessions, and laboratory sessions. The theoretical sessions develop foundational concepts, theories, and approaches underpinning the characterization, analysis, and prediction of the structure, properties, and behavior of geomaterials. The practical sessions apply the gathered theory to solve a variety of earth surface engineering problems, with an outlook on the interplay between the structure, properties, and behavior of geomaterials and the engineering performance of natural and built environments. The laboratory sessions propose and guide through hands-on activities and laboratory tests of geomaterials to address basic earth surface engineering problems.

Course goals: At the end of this course, students will be able to:

1) Compute the properties of three-phase materials including soils
2) Classify the properties of soils through the analysis of experimental data and the development of appropriate laboratory tests
3) Calculate stresses at depth in the presence and absence of water
4) Determine the direction and magnitude of seepage flows in soils
5) Characterize the compression and consolidation behavior of soils through the analysis of experimental data and the development of appropriate laboratory tests
6) Characterize the shearing behavior of soils, rocks, and discontinuities through the analysis of experimental data and the development of appropriate laboratory tests
7) Relate the treated content of earth surface engineering with grand challenges in sustainability and resilience
8) Communicate in oral, written, and graphical form with appropriate means
9) Employ computer software and techniques for design and communication
10) Work individually and in a team to solve problems related to earth surface engineering
11) Structure and write reports summarizing the results of technical calculations and analyses

Course outcomes: The following Course Assessment Table (CAT) relates Course Goals to Accrediting Board for Engineering and Technology (ABET) Outcomes as follows:

Course Goals	ABET Outcome	ABET Outcome Description	Assessment	Performance indicator
1, 3, 4, 6	1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	80%	Goal 1, 3, 4, 5, 6 Mid-term exam Final exam
8, 9, 10, 11	3	An ability to communicate effectively with a range of audiences	80%	Homework assignments – Form
			80%	Think tank presentation – Form
2, 5	6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	80%	Homework assignments – Content Laboratory worksheets

Course structure and materials:

Instructor	Prof. Alessandro ROTTA LORIA Office: Tech A120 E-mail: af-rottaloria@northwestern.edu Office hours: To be defined upon request and held in Tech A120 or via Zoom by appointment
Teaching Assistant	Ms. Naghmeh MEHRAEEN E-mail: NaghmehMehraeen2026@u.northwestern.edu Office hours: Thursday 11:00 am to 12:00 pm, Tech AG32 or via Zoom by appointment
Class times & location	Mondays (M), Wednesdays (W), and Fridays (F) from 2:00 to 2:50 pm, Tech L160
Lab times & location	Tuesdays (T) on selected dates, from 9:30 am to 12:20 pm, Tech AG40
Suggested textbooks	Holtz, R. D., and Kovacs, W. D. (1981). *An introduction to geotechnical engineering*. Pearson (HKS) Lambe T.W., and Whitman, R.V. (1979) *Soil Mechanics*. Wiley (LW)
Course assessment	**1) Class attendance – 5%**. 3.33 points will be assigned for every attended class on M, W, and F (total classes considered: 30); one "freebie" absence for which no points will be deducted from the attendance grade is granted (graded from 0 to 100). **2) Homework assignments – 20%**. Assessed through the quality of individual technical reports summarizing the results of homework problems to be solved individually (graded from 0 to 100). The reports must be written in digital format and composed of three sections: 1) Problem statement and definition of unknowns; 2) Solution; 3) Summary of results and concluding remarks. They should be sent to the T.A. by the specified deadline. Both the content and form of the reports will be evaluated, accounting for 80% and 20% of the grade, respectively. **3) Laboratory sessions – 15%**. Lab sessions will involve the resolution of practical problems in groups through hands-on activities. However, the results of laboratory sessions will need to be summarized in the form of individual technical lab worksheets (graded from 0 to 100). The quality of the reports will be assessed by considering its content and will account for 50% of the grade; attendance will count the remaining 50% of the grade. **4) Mid-term exam – 25%**. Assessed through the results of a quiz composed of 25 questions to be answered in 50 minutes (graded from 0 to 100) **5) Final written exam – 35%**. Assessed through the quality of a written exam lasting two hours and including two broad problems: one theoretical problem and one practical problem (graded from 0 to 100). *Remark*: Student groups will need to be composed of 4 people. Potential exceptions will be discussed upon the need. Course grading: A = 100-93, A- = 92-90, B+ = 89-87, B = 86-83, B- = 82-80, C+ = 79-77, C = 76-73, C- = 72-70, D+ = 69-67, D = 66-65

Course content

Color meaning: **Theoretical session** | ***Practical session*** | **Lab session** | **Remote session** | ***Exam***

Week	Day	Lecture	Laboratory	Remarks
1	W	**An introduction to earth surface engineering**		
	F	***No Class***		Alessandro delivers a TED talk (https://www.tedxchicago.com), which you are welcome to attend
2	M	**Origin, exploration, and characterization of geomaterials** HKS (3.1, 3.2, 3.3, 11.6, 12.6, 5) LW (7)		
	W	**Phase relations** HKS (2.1, 2.2, 2.3) LW (3.1)		
	F	**Classification and index properties of soils** HKS (2.4-2.10, 4.1-4.9, 4.11-4.13) LW (3.2-3.5, 4)		
3	M	***Determination of phase relations, index, and classification properties***		
	T		**Lab #1: soil classification**	*Lab work #1 assigned*
	W	**Stresses in the subsurface without and with hydrostatic water** HKS (6.1, 6.2, 6.9-6.11) LW (8.1, 8.2; 16 except 16.3)		
	F	***Characterization of stress state in field conditions***		*Homework #1 assigned*
4	M	**Analysis of the stress state in the subsurface** HKS (11.1-11.2) LW (8.4, 8.5)		
	W	**Principles of mass transfer in the subsurface** HKS (7.1-7.6) LW (17, 19.1-19.3)		
	F	***Stress analysis with the Mohr's circles of stress***		*Homework #2 assigned*; ***Lab #1 worksheet due***
5	M	**Analysis of groundwater seepage in the subsurface** HKS (8.1-8.3) LW (9, 11.3, 12, 20, 26)		***Homework #1 due***
	W	**Deformation of soils and rocks** HKS (7.1-7.6) LW (17, 19.1-19.3)		
	F	***Analysis of problems of groundwater seepage***		
6	M	**Analysis of the compressibility of soils** HKS (8.1-8.7, 8.10, 8.11) LW (10, 12.2)		***Homework #2 due***
	T		**Lab #2: oedometer test**	*Lab work #2 assigned*
	W	***Interim summary of course content***		

	F	***Mid-term exam***		
7	M	**Analysis of the consolidation of soils** HKS (9.1) LW (27.1-27.4)		
	W	**Settlement analysis of soils**		
	F	***Analysis of oedometer test results***		***Lab #2 worksheet due*** *Homework #3 assigned*
8	M	**Strength of soils** HKS (11.5) LW (9.2 and 9.3)		
	W	**Analysis of the deformation and strength of soils under drained conditions** HKS (12.1-12.5, 12.8, 12.9) LW (10, 11, 20, 21)		
	F	***Analysis of drained triaxial test results***		
9	M	**Mohr circles and stress paths under drained conditions** HKS (12.1-12.5, 12.8, 12.9) LW (10, 11, 20, 21)		
	T		**Lab #3: triaxial test**	*Lab work #3 assigned*
	W	**Analysis of the deformation and strength of soils under undrained conditions** HKS (12.10,12.11,12.14, 12.17, 13.10) LW (26.1, 28, 29)		
	F	***Analysis of undrained triaxial test results***		***Homework #3 due*** *Homework #4 assigned*
10	M	**Mohr circles and stress paths under undrained conditions** HKS (12.10,12.11,12.14, 12.17, 13.10, 13.1-13.6) LW (26.1, 28, 29, 8.6)		
	T		**Lab #4: direct shear test**	*Lab work #4 assigned*
	W	***Thanksgiving vacation***		***Lab #3 worksheet due***
	F	***Thanksgiving vacation***		
11	M	**Analysis of the deformation and strength of rocks and discontinuities** HKS (11.4.4, 13.16, 12.15)		***Homework #4 due***
	W	**Preliminary analysis of geotechnical problems**		
	F	***Final summary of foundational course content***		***Lab #4 worksheet due***

Statements

Please see the materials here: https://www.registrar.northwestern.edu/registration-graduation/northwestern-university-syllabus-standards.html