**CIV\_ENG\_450-1**

**Soil Mechanics I**

***Fall Quarter 2022***

This course addresses advanced aspects of the mechanics of geomaterials, with emphasis on the processes and phenomena that shape the structure, properties, and behavior of soils. Specifically, this course focuses on the advanced analysis of the mechanics of soils subjected to mechanical, hydraulic, and thermal loading. The course comprises theoretical sessions and practical sessions. The theoretical sessions develop foundational concepts, theories, and approaches underpinning the characterization, analysis, and prediction of the structure, properties, and behavior of soils. The practical sessions apply the gathered theory to solve a variety of geomechanics and geotechnical engineering problems, with an outlook on the interplay between the structure, properties, and behavior of soils and the engineering performance of natural and built environments.

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

1. Understand the fundamental structural composition of soils
2. Know the essential mechanical, hydraulic, and thermal properties of soils
3. Understand the response of soils subjected to mechanical, hydraulic, and thermal loading
4. Know the theoretical essentials behind key analytical approaches, laboratory experiments, and field tests to analyze the structure, properties, and behavior of soils
5. Apply key analytical approaches, laboratory experiments, and field tests to simulate the loading conditions and response of soils in practical geomechanics and geotechnical engineering problems
6. Communicate in oral, written, and graphical form the knowledge gathered in this course with both technical and non-technical audiences
7. Employ software and computer techniques for design and communication
8. Work individually and in a team to solve problems related to geomechanics and geotechnical engineering
9. Structure and write reports summarizing the results of technical calculations and analyses

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| **Instructor** | Prof. Alessandro ROTTA LORIA  Office: Tech A120  E-mail: [af-rottaloria@northwestern.edu](mailto:af-rottaloria@northwestern.edu)  Office hours: Wednesday 11:00 am to 12:15pm, Tech A120 or via Zoom by appointment |
| **Class times & location** | Mondays (M) and Wednesdays (W) from 12:30 to 13:50 am, Technological Institute LG72 |
| **Suggested textbooks** | Holtz, R. D., and Kovacs, W. D. (1981). *An introduction to geotechnical engineering*. Pearson  Lambe T.W., and Whitman, R.V. (1979) *Soil Mechanics*. Wiley  Mitchell, J. K. and Soga, K. (2005). *Fundamentals of Soil Behavior*. Wiley |
| **Course assessment** | **1) Class attendance – 5%**. 5 points will be assigned for every attended class on M and W after the first introductory session; one “freebie” absence for which no points will be deducted from the attendance grade is granted (graded from A to D).  **2) Homework assignments – 15%**. Assessed through the quality of technical reports summarizing the results of homework problems to be solved individually (graded from A to D). 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 instructor by the specified deadline.  **3) Research project – 15%**. Student groups will develop an research project of their choice from a list of proposed subjects (see at the end of this document) and run a literature review on the considered subject. This literature review will need to be summarized in the form of a scientific paper totaling 10-12 pages written in a double column format, 12 font size, Times New Roman (graded from A to D). The paper will need to include an abstract of up to 250 words, an introduction, any relevant number of sections to develop a clear and rigorous digression on the chosen subject, and a closure and perspectives sections. The results of the research project will be discussed in front of the class through a presentation. Both the form and content of such deliverables will be evaluated. Both the paper and presentation should be sent to the instructor by the end of the class.  **4)** **Mid-term exam – 25%**. Assessed through the results of a quiz composed of 25 questions to be answered in 50 minutes (graded from A to D)  **5) Think tank presentation – 5%**. Assessed through 10-minute group presentations about the role of Earth Surface Engineering in the talks featured at the Northwestern Sustainability Lecture Series (graded from A to D). Each students composing the group will be required to share their thoughts about one or more of the lectures presented at the event by discussing the ways the content of this course is involved and can support the resolution of problems in the broad field of sustainability.  **6) 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 A to D).  *Remark*: Student groups will need to be composed of 2 people maximum. 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* | *Exam* | *Special session***

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| Week | Day | Lecture | Remarks |
| 1 | W | **1. An introduction to Soil Mechanics** |  |
| 2 | M | **2. Phase relations, classification, and index properties of soils** |  |
| W | **3. Stresses in soils** |  |
| 3 | M | **4. Mass transfer in soils** |  |
| W | **5. Heat transfer in soils** |  |
| 4 | M | **6. Deformations of soils** |  |
| W | **7. Stress-strain relationships and strength of soils** |  |
| 5 | M | **8. Advanced laboratory testing of soils** |  |
| W | **9. Compressibility of soils** |  |
| 6 | M | **10. Analysis of the compressibility and consolidation of soils** | *Homework #1 assigned* |
| W | ***Mid-term exam*** |  |
| 7 | M | ***2022 Sustainability Lecture Series*** |  |
| W | **11. Deformation and strength of soils under drained conditions** |  |
| 8 | M | **12. Stress paths under drained conditions** | ***Homework #1 due*** |
| W | ***Think tank session*** | ***Presentations by students*** |
| 9 | M | **13. Analysis of the shearing resistance of soils** | *Homework #2 assigned* |
| W | **14. Deformation and strength of soils under undrained conditions** |  |
| 10 | M | **15. Stress paths under drained conditions** |  |
| W | **16. Advanced aspects of soil behavior** |  |
| 11 | M | ***Research projects session*** | ***Presentations by students***  ***Homework #2 due*** |
| W | ***Final summary of foundational course content*** | ***Research paper and related presentation due*** |

**Proposed research projects**

1. Advanced analysis of soils via microscopic and nanoscopic imaging techniques
2. Advanced analysis of soils via large-scale imaging techniques serving terrestrial and extraterrestrial studies
3. Advanced analysis of soils via particulate modeling techniques
4. Advanced laboratory testing of soils with environmental control
5. Proposed subject

**Statements**

**Academic Integrity**

Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit:<https://www.northwestern.edu/provost/policies-procedures/academic-integrity/index.html>

**Accessibility**

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university’s established accommodation process (e: [accessiblenu@northwestern.edu](mailto:accessiblenu@northwestern.edu); p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

**COVID-19 Classroom Expectations Statement**

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| Students, faculty and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the [COVID-19 Expectations for Students](https://www.northwestern.edu/communitystandards/about-us/northwestern-university-student-expectations-covid-19.html). With respect to classroom procedures, this includes:   * Policies regarding masking, social distancing and other public health measures evolve as the situation changes. Students are responsible for understanding and complying with current University, state and city requirements. * In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.   If a student fails to comply with the [COVID-19 Expectations for Students](https://www.northwestern.edu/communitystandards/about-us/northwestern-university-student-expectations-covid-19.html) or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.  **Diversity, Equity, and Inclusion**  In this course, we embrace diversity and foster equity and inclusion. In line with the Northwestern vision on diversity, equity, and inclusion, we believe that the best way to get a good idea is to have many diverse ideas, and the best way to foster a diversity of ideas is through a culture in which there is synergy and inclusion among a diverse group of people.  We are committed to ensuring that students of all ages, backgrounds, religions, races, ethnicities, gender identities/expressions, national origins, sexual orientations, physical abilities, and all other visible and non-visible differences feel welcome and respected, are treated equitably, and are able to fully engage with the learning and research communities.    **Exceptions to Class Modality**  Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.    Maintaining the health of the community remains our priority.  If you are experiencing any symptoms of COVID do not attend class. Follow the steps outlined on this site for testing, isolation and reporting a positive case. Next, contact your instructor as soon as possible to arrange to complete coursework.    Students who experience other personal emergencies should contact the instructor as soon as possible to arrange to complete coursework.    Should public health recommendations prevent in-person class from being held on a given day, the instructor or the university will notify students. |

**Prohibition of Recording of Class Sessions by Students**

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](https://www.northwestern.edu/accessiblenu/). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University’s [Copyright Policy](https://www.invo.northwestern.edu/invention-disclosure/policies-forms/copyright-policy/), faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

**Support for Wellness and Mental Health**

Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health.  If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

<https://www.northwestern.edu/counseling/>

<https://www.northwestern.edu/religious-life/>

<https://www.northwestern.edu/care/>