CE 645 – FALL 2025 SYLLABUS

CE 645 – 001 – Rock Mechanics Fall 2025

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Office Hours: Mondays 2:00-5:00pm
(In person)

Room: **COLT 416** Day and Time: **Mondays 6:00 - 8:50 pm**

Prerequisite: Permission of instructor for approved undergraduate or graduate course in soil mechanics or geology or construction engineering within the last seven years or equivalent.

Required Textbook

Goodman, R.E. (1989) Introduction to Rock Mechanics, 4nd Edition, 2007, John Wiley and Sons, ISBN#: ISBN: 978-0-632-05759-7

Other Recommended Texts & Reading

Jaeger, J.C., Cook, N.G.W., Zimmerman, R.W. (2007). Fundamentals of Rock Mechanics, 4th Edition, Blackwell Publishing, ISBN#: 978-0-632-05759-7.
Hoek, E., Bray, J.W. (1981). Rock Slope Engineering, 3rd Edition, ISBN#: 978-0-419-16010-6.
Norrish, N.I., Wyllie, D.C. (1996). Landslides: Investigation and Mitigation. Transportation Research Board Special Report, 247, pp 391-425. Transportation Research Board of the National Academy of Sciences.
Willey, D., (2018). Rock Slope Stability: Civil Applications, 5th Edition, CRC Press, ISBN#: 978-1498786270.

Course Description *(from NJIT's course catalog)*

The integrity of large buildings, dams, tunnels, bridges, and many other forms of engineering infrastructure is vitally dependent upon the rock behavior under loading conditions that impact their foundations. This course focuses on theoretical and experimental rock mechanics and rock engineering; review of laboratory and field rock testing; empirical and analytical methods for describing strength; deformability and conductivity of intact rock and rock masses; fracture mechanics and mechanics of discontinuous media, including fluid flow through discontinuous media; and design and analysis of rock slopes/rock fall, underground engineering structures in rock and foundations on rock. Includes numerical modeling software training and a term paper/design project.

Course Objectives (General)

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

- **Properties of intact rock and rock masses:** Distinguish between intact rock and rock masses. Prescribe laboratory and field tests to understand rock mechanical properties. determine strength, deformability, permeability, and state of stress of intact rocks and rock masses.
- **Rock fractures:** Prescribe field and laboratory tests to estimate the toughness and attitude of rock fractures.
- **Rock slope stability:** Identify failure mechanisms and determine the safety of rock slopes and design measures to stabilize them.

- **Underground openings & Foundation engineering:** Design underground openings in rock, including grouting, rock bolts and anchors. Apply rock mechanics to foundation engineering.
- **Rock mechanical modeling**: Independently conduct rock mechanical modeling using geomechanics software for the analysis of large deformations, fracturing, and stability in rock masses; for addressing engineering problems related to excavations, slope stability, tunneling, dynamic analysis, mining, and subsurface geomechanics.

Course Schedule:

Week(s)	Topic(s)
1	Introduction to Rocks: intact rock vs rock mass Rocks and minerals Importance of Rock mechanics to geotechnical engineering Field applications of rock mechanics in civil engineering Natural features in rocks Rocks & Rock Mass Classifications Properties of rocks – physical, hydraulic, thermal properties Rock permeability – fundamentals & measurements Rock porosity – fundamentals & measurements Rock mechanical properties – elastic vs inelastic properties
2 & 3	Modes of failure in rocks & rock-like materials Geomaterial strength introduction Laboratory testing & sample preparation Testing of rock strength and rock mechanical parameters Rock Quality Designation (RQD) Index
3 &4	Geological Strength Index (GSI) Deformability of rocks Stress-strain relationship Elasto-visco-plasticity behavior of rocks Rock Creep Behavior - creep, stress relaxation, & strain-rate dependent stiffness Mechanics of underground rock-fluid interactions & effect on rock failure
4	Rock elastic deformation Rock elastic properties (Young's, shear, & bulk moduli; Poisson's ratio) Rock failure criteria & predictions (Mohr-Coulomb, Hoek & Brown, etc.) Importance of Mohr-Coulomb criterion in geotechnical engineering
5	Applied engineering geophysics in rock mechanics In-situ stress Stress regimes In-Situ stress impact on geotechnical engineering projects Stress concentration around deep underground borehole Compaction subsidence in rocks & underground In-situ stress measurement and estimations
6 & 7	Stereographic projection Mechanics of Slope Engineering & Landslide Slope stability analysis Slope failure mechanisms Slope stability predictions Slope instability recognition, analysis, zonation, & prediction

6 & 7	Mechanics of slopes & rock fall Rock slope stabilization and techniques Mechanics of permafrost
8	Midterm Examination
9 & 10	Application of rock mechanics to underground openings & tunnels State of stress and strain around underground tunnels & boreholes through rocks Mechanics of underground tunneling through rocks
11	Application of rock mechanics to foundation engineering Application of rock mechanics in underground drilling Application of rock mechanics to highways, dams, tunnels & rock blasting
12	Fracture mechanics and discontinuities in rocks Measurement of rock fracture properties and discontinuities
13	Rock hydro-mechanical fracture behavior (hydraulic fracturing)
	Hydraulic fracturing design
14	Term Project Presentation and Revision
15	Final Exam

Syllabus Information:
The dates and topics of the syllabus are subject to change; however, students will be consulted with and must agree to any modifications or deviations from the syllabus throughout the course of the semester.

POLICIES & PROCEDURES

Academic Integrity:
Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:
http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university**. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Plagiarism and Copying:
Plagiarism and copying will NOT be tolerated in this course. Homework problems and term project reports require written responses, and each student is expected to write their own response. Plagiarism is not tolerated. If you are not familiar with citations, please work with an NJIT librarian to learn more. Assignments and reports will be submitted via plagiarism detection software. Any evidence of plagiarism, copying, or cheating during exams, on homework, or on project reports will result in an immediate grade of zero for the assignment and will be reported to the Dean of Students. A second instance of this will result in a failing grade for the course.

Plagiarism is the dishonest presentation of the work of others as if it were one's own. Writers, speakers, musicians, artists, or computer programmers – whether students or professionals – commit plagiarism when they present, without acknowledgement, all or part of another person's work as if it were their own. Because plagiarism violates the expectations of trust and honesty necessary for academic work in an ethical community, it is a serious offense. In addition, plagiarism undercuts the basic purposes of higher education by short-circuiting the process of inquiry, reflection and communication that leads to learning.

Plagiarism can take several forms, including but not limited to:

- Using the exact words of another writer in part of a paper without both citation and quotation marks (or block indentation in the case of longer quotations).
- Cutting and pasting material from internet or other electronic resources without proper citation of sources.
- Including the paraphrased or summarized idea of another writer without acknowledging its source.
- Accepting excessive assistance from another person in writing a paper without informing readers of the nature and extent of that collaboration.
- Submitting for credit a complete paper or portion of a paper written by another person, no matter whether the paper was purchased, shared freely, stolen, found, or acquired by other means.
- Submitting a copy or relying closely on the work of other people, without explicitly citing the original source.
- Writing a computer program that is the same or closely similar to existing sources.
- Accepting credit for a project, multimedia presentation, poster, or other assignment that draws dishonestly on the work of others.

Duplicate submission is also a violation of academic integrity, because every assignment presumes that a new inquiry and effort will produce new learning, and submitting a paper already written for another occasion subverts this learning. Submitting the same original paper for credit in more than one class in the same semester, without the expressed permission of both instructors involved, is not acceptable. Using the same paper or closely similar material from one semester to fulfill a requirement in another semester is normally not allowed without specific permission from the instructor. If students receive the same or similar assignments in a different course, they should consult with the professor about alternate assignments.

Eating and Drinking: Eating and drinking in class is prohibited during lectures. They are only allowed during class breaks.

Communication: All communications by the instructor will be during the class and via NJIT e-mail. It is your responsibility to check your NJIT e-mail regularly. Expect an e-mail response/reply from the instructor only on Mon - Fri between 9am - 5pm.

Attendance: Attendance at all lecture/class periods is compulsory, regardless of location or modality. A student is permitted a maximum of two (2) unexcused absences throughout the semester. If a student is absent for more than two (2) classes for the entire semester without a DOS-approved excused absence, the student will receive a final grade of "**F**."

Lectures/Class: Some weekly lectures will start with quizzes. During the class, the instructor can often ask you to work on a problem or brainstorm ideas with the people next to you and you will be called on to provide one or more of your answers. The goal of this in-class work and discussion is to get you started on a problem (not necessarily to finish) and improve how you think about the problem which will then be discussed. Lectures will NOT be recorded for subsequent access to students; therefore, students have the burden of making up for missed lectures. Please be respectful to the course instructor and your classmates. You should always bring a pencil and calculator with you to class. Please put your cell phones on silent or turned off during class.

Lecture Notes: Copies of the notes used in class will be posted on Canvas throughout the semester before lecture. It is highly recommended that you download or print out the set of notes to follow along during the lecture.

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Homework: All homework MUST be presented in an organized manner and **submitted online via canvas in pdf format using recommended HW submission template provided**. Submissions to the instructor's email will **NOT be accepted**. **Late Submissions will NOT be accepted after the due date and time**. Homework assignments MUST be submitted at the due date and time. Assignments MUST be typed, however, hand sketches (as necessary) may be submitted in certain cases based on my approval. If plots or calculations are required, either use hand calculations of the problem in your submitted HW solution or you can use Excel program and attach the solution excel files along with pdf homework submissions. Begin each problem on a new page and number all pages; collate all homework pages together and have your name written clearly on the front page. It is your responsibility to make sure you understand how to solve the problems by attending office hours with the instructor or asking questions in class. As with many conceptual problems, multiple solutions may be possible. This means that all rational solutions to the assignments may be considered for acceptance.

Late Homework: Homework will be due at the beginning of class on the date it is due. Late Homework will NOT be accepted after the due date. The homework should be turned in as instructed before 6 pm.

Exams: There will be one midterm exam held during class time and one comprehensive final exam as scheduled by the University Registrar. All exams in this course will be in-person. No electronic device (such as laptops/cellphones/tablets/smart watches, etc.) are allowed during quizzes/exams. No recording devices shall be allowed during class or examinations.

Term Project: There will be a term project that should be done individually, and should have 12-15 pages, in addition to the reference list. Figures must be used to clarify written concepts and explanations. The term project must focus on an engineering failure related to Rock Mechanics. The purpose of the term paper is 1) To give students the opportunity to thoroughly treat a rock mechanics topic and to present their work in a clearly understandable and technically well-founded manner; 2) To provide the students with a further opportunity to analyze a problem, integrated previous knowledge of other areas, and critically judge source materials and data; 3) To develop the ability of the students to synthesize the findings, present logical discussion of results, and present coherent conclusions from findings; 4) To provide students with an opportunity to develop their report into a manuscript for possible conference/journal publication.

AI Usage in this Course: This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this content area. As such, AI usage is not permitted throughout this course under any circumstance.

Homework	15% (Total 150 points)
Term project	20% (Total 200 points)
Class Participation	15% (Total 150 points)
Midsemester Exam	25% (Total 250 points)
Final Exam	25% (Total 250 points)
Total:	**100% (Total 1000 points)**

Calculation of Course Grade: A weighted average grade will be calculated as follows:

The final letter grades are computed as follows:

A = > 90.0%, B+ = 85.0% - 89.9%, B = 80.0% - 84.9%, C+ = 75.0% - 79.9%, C = 70.0% - 74.9%, F = < 69.9%

Grades are not curved in computing the final grade. It is theoretically possible for everyone in the class to get an A (or an F). Your performance depends only on how you do and how much you learn, not on how everyone else in the class does.

Instructor Commitment: You can expect the instructor to be courteous, punctual, organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during office hours or to notify you beforehand if office hours are moved; to provide a suitable guest lecturer or pre-recorded lecture when they are traveling or unavailable; and to grade uniformly, fairly, and consistently.

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Students with Documented Disabilities: NJIT is committed to providing students with documented disabilities with equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification, documentation and accommodation processes can be found on the webpage at:
(http://www.njit.edu/counseling/services/disabilities.php)

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarships among our faculty and students
- to promote service to the engineering profession and society

Program Educational Objectives

Our **Program Educational Objectives** are reflected in the achievements of our recent alumni:

1. **Engineering Practice:** Alumni will successfully engage in the ethical practice of civil engineering within industry, government, and private practice, working towards safe, practical, resilient and sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
2. **Professional Growth:** Alumni will advance their technical and interpersonal skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as academia, business, and law through further education.
3. **Service:** Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Student Outcomes

Our **Student Outcomes** are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusion
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies