UAB Universitat Autònoma de Barcelona

Geological Engineering I: Rock Mechanics

Code: 101054
Credits: 6

2026/2027

Degree programme	Type	Course
Geology	OP	3

Contact lecturer

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Group languages

You can consult this information at the end of the document.

Prerequisites

This is a biannual course. It is assumed that the students have basic competences on mathematics and physics, acquired during previous courses.

Objectives

This optative course is part of the "Geotechnics and Geological Resources" mention.

The main aims of this course are to provide a basic overview of the rock mechanics and their practical application to geological and engineering problems. On successfully completing this course, the students will knowledge the basic procedures to collect, describe and interpret the geological information required to predict the strength and stability of rocks under natural or anthropogenic actions (i.e. excavations, fluid injection, reservoir mechanic, etc)

Learning outcomes

- CM36 (Propose solutions to the problems arising from the exploitation of geological resources in the context of the global energy transition.) Propose solutions to the problems arising from the exploitation of geological resources in the context of the global energy transition.
- CM37 (Develop specialised geotechnical reports to characterise the subsoil in construction and civil works areas.) Develop specialised geotechnical reports to characterise the subsoil in construction and civil works areas.
- CM38 (Quantify the degree of potential instability of a natural or anthropic terrain for proper planning and land management.) Quantify the degree of potential instability of a natural or anthropic terrain for proper planning and land management.
- KM43 (Describe the areas of geology with special economic interest in today's industrialised societies.) Describe the areas of geology with special economic interest in today's industrialised societies.
- SM42 (Use the different physicochemical properties of geological materials to estimate their real market value.) Use the different physicochemical properties of geological materials to estimate their real market value.

Contents

Theoretical formation

Preliminary

Introduction. Objectives of the Rock Mechanics. The discontinuous and heterogeneous characteristics of the rock systems.

Block I. Fundamentals of the Rock Mechanics

- Overview of continuum media: stress and deformation.
- Strength and deformability of rocks. Ideal behaviours: elasticity, plasticity and viscosity. Fracture criteria. Onset and propagation of fractures.
- Discontinuities. Geometrical and mechanical properties.
- Experimental techniques at laboratory. Uniaxial compressive and tensile experiments. Triaxial experiments. Influence of the scale and geometry of the rock samples. Influence of fluid pressure, confining pressure, temperature and strain rate. Geophysical techniques.
- Rock behaviour in extreme conditions. Deformation mechanisms at microscale.

Bloc II: Aplicacions a l'Enginyeria de Roques

- Reservoir Geomechanics. Pore pressure at depth. Wellbore stability and failure.
- Geomechanical classifications of rocks (RMR, ESR, Q). Strength of the rock masses. Hoek-Brown criteria.
- Safety factor and fracture probability.
- Surface excavations. Types of slope instabilities. Stability analysis: kinematic and mechanical methods.
- Underground excavations. Stability of tunnels. Numerical approaches. Settlement and subsidence curves.
- In-situ techniques to measure principal deformation and stress directions.
- Stability measurements in ground. Instruments and auscultations of ground problems.

Practical Formation

- Exercises and problems related with the theoretical formation
- Numerical methods applied to slope stability, tunnel deformability and rock mass strength. Introduction to the Rockscience suite of programmes (RocLab, Examine 2D, etc) and Itasca FLAC code. These practical sessions will be conducted using specialised rock mechanics programmes.
- Description and interpretation of the geomechanical properties of a rock borehole core.

Field Practical Formation

The course includes a one-day field trip near to the Barcelona Metropolitan area. The goals of the field trip are (1) to visit a rock quarry currently in exploitation and observe the practical application of rock mechanics, (2) to perform practical geomechanical characterisation of rock masses and (3) to inspect rock slope instabilities and stability measures. Acquired data during the field trip will be used to elaborate a geomechanical study and a technical report based on a hypothetical construction project.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Field and practical case report	30	1.2	CM36, CM37, CM38, SM42

Lectures (TE)	22	0.88	CM38, KM43, SM42
Practical sesions (PAUL)	22	0.88	CM36, CM38, KM43, SM42
Study and reading of specialised lectures, Virtual campus utilities, etc	30	1.2	CM38, KM43, SM42
Field practical sessions (PCAM)	7	0.28	CM36, CM37, CM38, SM42
Complete of the exercises and problems	30	1.2	CM36, CM38

This course is structured in 10 four-hour sessions, each organised into a theoretical component (1-2 hours), a problem-solving component under the supervision of the teaching staff (1-2 hours), and an assessment component focused on the exercises completed during the session (1 hour). Throughout these sessions, the course topics will be presented, and guidance will be provided to help students consolidate their learning and independently complete the proposed problems.

In addition to the recommended bibliography, students will have access to supplementary materials (figures, graphs, and scientific articles) through the course virtual learning environment. During the semester, two additional readings will be assigned to expand on course content. Students will be required to present and discuss these readings orally as part of the assessment process.

The fieldwork component will consist of: (1) the practical application of geomechanical classification systems in the field; and (2) the identification of different types of rock-slope instabilities and the study of the measures proposed for slope stabilisation and land rehabilitation. The field trip will take place within the Barcelona metropolitan area (Costablanca residential area, Martorell). It will also include a visit to an active quarry to study stability issues in temporary excavations (Vallirana). At each outcrop, the teaching staff will provide an introduction, followed by a supervised collection of geomechanical data (lithology, structural features, etc.) by the students. The data collected in the field will be used to prepare the geological study for a hypothetical engineering project. The practical case study will focus on the stability of surface and underground excavations associated with the construction of a road and/or a tunnel. The fieldwork assignment may be completed individually or in pairs.

Following the field trip, a practical classroom session will be held to interpret the field data and provide guidelines for preparing the field report. Attendance at the field trip is mandatory in order to pass the course.

A methodological objective of the course is to develop students' competence in using specialised software.

For this course, the use of Artificial Intelligence (AI) technologies is permitted exclusively for support tasks (e.g., literature and information searches, text summarisation, comparison of readings, proofreading, and translation). Students must clearly identify any parts of their work that have been generated using these technologies, specify the tools employed, and include a critical reflection on how these tools influenced both the process and the outcome of the activity.

Failure to disclose the use of AI in an assessed activity will be considered a breach of academic integrity and may result in a partial or total reduction of the grade for the activity, or, in serious cases, more severe disciplinary measures.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Final Exam (Block II)	25	2	0.08	CM36, CM38, KM43, SM42

Reassessment exam	màx. 60	0	0	CM36, CM38, KM43, SM42
Field and practical case report	25	0	0	CM36, CM37, CM38, KM43, SM42
Midterm exam (Block I)	25	2	0.08	CM36, CM38, KM43, SM42
Readings and watchings documentaries (presentation/discussion)	10	2	0.08	CM36, KM43
Exercises and problems of practical sessions	15	3	0.12	CM36, CM37, CM38, SM42

Assessment will be based on continuous evaluation and will include written examinations, a portfolio of problem-solving and practical exercises, a fieldwork report, and the presentation and discussion of the assigned readings and/or videos.

Two individual written midterm examinations will be held. The first will take place halfway through the semester and will cover the first thematic block. The second will be conducted at the end of the course and will cover the second thematic block. Together, these assessments will account for 50% of the final grade.

The fieldwork report and practical case study will account for 25% of the final grade. The report must include both the collection of field data and its processing and interpretation to address the problems posed in the engineering project. Assessment criteria will include the quality of the writing (organisation, clarity, synthesis, and conclusions), the quality of the graphical information provided, and the appropriate use of the bibliography and digital resources consulted.

The portfolio of problems and exercises completed during the practical sessions will account for 15% of the final grade and must reflect the student's individual and independent work.

The remaining 10% of the final grade will be based on the oral presentation and/or discussion of the readings, teaching materials, scientific papers, and videos assigned throughout the course.

Only the activities assessed through the midterm examinations and those related to the assigned article readings may be reassessed. Students must sit all reassessable activities that they have not successfully completed during the continuous assessment process. Reassessment will consist of an examination including short-answer questions and practical exercises. The maximum grade that may be obtained through reassessment will represent 60% of the final course grade.

Mandatory Attendance Requirements for Scheduled Teaching Activities

Scheduled teaching activities constitute a substantial component of the learning process. In order to be eligible for assessment, students must attend at least:

- 60% of the theoretical sessions.

- 60% of the practical sessions.

- The field trip, which is compulsory.

Students who have completed assessment activities accounting for more than 35% of the total course grade may not be recorded as "Not Assessed" in the official course records.

Single Assessment

The single-assessment option will consist of a final examination comprising:

- Theory examination: 25%.

- Problem-solving examination: 35%.

- Submission of the practical exercise portfolio: 15%.

- Submission of the fieldwork report: 25%.

The last two components will not be eligible for reassessment.

Plagiarism and Inappropriate Student Conduct

Students who engage in plagiarism (in whole or in part), copying of assignments, misappropriation of other people's work, unauthorized use of mobile devices, or any other form of academic misconduct during assessed activities will automatically receive a failing grade for the corresponding assessment. Plagiarism is defined as the total or partial reproduction of ideas, texts, data, images, or any other material obtained from a source without proper acknowledgement or referencing, and its presentation as the student's own original work. Plagiarism constitutes a serious academic offence and may result in disciplinary proceedings. Students are therefore expected to respect intellectual property rights, properly acknowledge all sources of information used, and assume responsibility for the originality and authenticity of all submitted work.

Bibliography

* Main reference textbooks

González de Vallejo, L. I. (2002) Ingeniería Geológica. Person Educación. Madrid. *

Goodman, RE (1989) Introduction to Rock Mechanics. John Wiley & Sons.

Hoek, E. (2000) Practical Rock Engineering. Online version.
https://www.rocscience.com/assets/resources/learning/hoek/Practical-Rock-Engineering-Full-Text.pdf

Hudson, J. A. & Harrison, J.P. (1997) Engineering Rock Mechanics. An introduction to the Principles. Pergamon, Elsevier.*

Harrison, J.P. and Hudson, J. A. (2000) Engineering rock mechanics: Illustrative worked examples. Pergamon, Elsevier. 506 p.

Twiss, RJ. & Moores, EM. (1992) Structural Geology.

Wyllie, D.C. (2004) Rock slope engineering, civil and mining. Spon Press.

Zoback, M. D. (2007) Reservoir Geomechanics. Cambridge University Press. 449 p.

Software

Matlab (Mathworks; campus academic license)

CloudCompare (3D point cloud and mesh processing software, open source)

Stereonet, FaultKin (Allmendiger, R. W; https://www.rickallmendinger.net/stereonet, freeware)

Google Earth, QGIS, Global Mapper (if campus license is avalaible)

Rock Mechanics specific software

Flac/Slope 8.10 (Itasca, freeware)

RocLab, Examine 2D (Rocscience, freeware)

Adonis, Hyrcan (freeware)

Field Work

Clino Field Move (Petex, free)

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE