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250146 - ENGGEOLOG - Geological Engineering

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 4,5 Teaching languages: English

Teaching staff

Coordinator: MARCEL HURLIMANN ZIEGLER

Others: CLÀUDIA ABANCÓ MARTÍNEZ DE ARENZANA, MARCEL HURLIMANN ZIEGLER, JOAN MARTÍNEZ BOFILL, ROSA MARIA PALAU BERASTEGUI

Opening hours

Timetable: Monday from 10 to 12 am

Degree competences to which the subject contributes

Specific:

3029. Knowledge of soil and rock geotechnics and mechanics and the ability to apply this knowledge in carrying out studies, projects, constructions and exploitations in which earthmoving, foundations and retention structures are necessary.
3046. Students will acquire the skills needed to build geotechnical works.

Generical:

3104. Students will learn to identify, formulate and solve a range of engineering problems. They will be expected to show initiative in interpreting and solving specific civil engineering problems and to demonstrate creativity and decision-making skills. Finally, students will develop creative and systematic strategies for analysing and solving problems.
3106. Students will learn to assess the complexity of the problems examined in the different subject areas, identify the key elements of the problem statement, and select the appropriate strategy for solving it. Once they have chosen a strategy, they will apply it and, if the desired solution is not reached, determine whether modifications are required. Students will use a range of methods and tools to determine whether their solution is correct or, at the very least, appropriate to the problem in question. More generally, students will be encouraged to consider the importance of creativity in science and technology.
3107. Students will learn to identify, model and analyse problems from open situations, consider alternative strategies for solving them, select the most appropriate solution on the basis of reasoned criteria, and consider a range of methods for validating their results. More generally, students will learn to work confidently with complex systems and to identify the interactions between their components.
3110. Students will learn to plan, design, manage and maintain systems suitable for use in civil engineering. They will develop a systematic approach to the complete life-cycle of a civil engineering infrastructure, system or service, which includes drafting and finalising project plans, identifying the basic materials and technologies required, making decisions, managing the different project activities, performing measurements, calculations and assessments, ensuring compliance with specifications, regulations and compulsory standards, evaluating the social and environmental impact of the processes and techniques used, and conducting economic analyses of human and material resources.
3112. Students will develop an understanding of the different functions of engineering, the processes involved in the life-cycle of a construction project, process or service, and the importance of systematising the design process. They will learn to identify and interpret the stages in preparing a product design specification (PDS), draft and optimise

specifications and planning documents, and apply a systematic design process to the implementation and operation phases. Students will learn to write progress reports for a design process, use a range of project management tools and prepare final reports, and will be expected to show an awareness of the basic economic concepts associated with the product, process or service in question.
3113. Students will learn to identify user requirements, to draft definitions and specifications of the product, process or service in question, including a product design specification (PDS) document, and to follow industry-standard design management models. Students will be expected to show advanced knowledge of the steps involved in the design, execution and operation phases and to use the knowledge and tools covered in each subject area to the design and execution of their own projects. Finally, students will assess the impact of national, European and international legislation applicable to engineering projects.

Transversal:

585. ENTREPRENEURSHIP AND INNOVATION - Level 1. Showing enterprise, acquiring basic knowledge about organizations and becoming familiar with the tools and techniques for generating ideas and managing organizations that make it possible to solve known problems and create opportunities.
586. ENTREPRENEURSHIP AND INNOVATION - Level 2. Taking initiatives that give rise to opportunities and to new products and solutions, doing so with a vision of process implementation and market understanding, and involving others in projects that have to be carried out.
589. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
594. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
584. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Teaching methodology

The course consists of 1.5 hours per week of classroom activity (large size group) and 0.7 hours weekly with half the students (medium size group).

The 1.5 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 0.7 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to field work and supervised design.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Learning objectives of the subject

Students will acquire an understanding of geological engineering and geology applied to engineering. They will also learn to solve soil engineering problems.

Upon completion of the course, students will have acquired the ability to: 1. Draw up a site-investigation plan that includes the variables to be measured, equipment needed, the points of measurement, the timing of the measurements, and the way in which the results are to be used. 2. Analyse geotechnical problems in linear work and determine the stability of slopes, embankments, cut slopes and masonry foundations. 3. Analyse geotechnical problems in underground work such as tunnels and retaining structures.

250146 - ENGGEOLOG - Geological Engineering

Surficial formations, from both geological and geotechnical viewpoints, including the orders of magnitude of their mechanical and hydrological properties; Rock mechanics, as relates to the matrix, joints and fractures, as well as hydraulic properties; Site-investigation techniques; Relationship between the properties and concepts of excavatability, stability and, in general, the conditioning factors in geotechnical projects; Geological and engineering-related aspects in linear work such as cut slopes and embankments; Geological aspects in underground work; Geological control during earthworks; Geological aspects in dams; Slope stability; Infiltration problems

Study load

Total learning time: 112h 30m	Hours large group:	22h	19.56%
	Hours medium group:	12h	10.67%
	Hours small group:	11h	9.78%
	Guided activities:	4h 30m	4.00%
	Self study:	63h	56.00%

250146 - ENGGEOLOG - Geological Engineering

Content

Surficial Formations	Learning time: 7h 11m Theory classes: 3h Self study : 4h 11m

Description:

Geomecànical properties associated to the genesis of glacial and colluvial deposits: grading, permeability, strength and deformability. Spatial layout and implications for site investigation
Geomecànical properties associated to the genesis of torrential, alluvial and coastal deposits: grading, permeability, strength and deformability. Spatial layout and implications for site investigation

Specific objectives:

Discuss the influence of processes that generate residual, glacial and colluvial deposits on their hydraulic and mechanical properties. Provide criteria for understanding the spatial distribution and geometry of these deposits
Discuss the influence of processes that generate torrential, alluvial and coastal deposits on their hydraulic and mechanical properties. Provide criteria for understanding the spatial distribution and geometry of these deposits

Intact Rock and Rock mass	Learning time: 14h 23m Theory classes: 4h Laboratory classes: 2h Self study : 8h 23m

Description:
Strength and deformability of the rock matrix: phases.
Effect of mineralogical and textural components.
Properties of the main groups of rocks
Rock hardness and abrasiveness and their determination. Weak rocks. Durability tests. Franklin classification of weak rocks.
Goal
Rock Quality Designatin
Q Index
Rock Mass Rating
Concept rock mass
Types of discontinuities and their properties
Strength of the joints. Criterion Barton and Choubey.
Shear tests
Using the compass
Application of the geomechanical classifications

Specific objectives:
Discuss the deformational behavior of rocks (elastic, plastic, elasto-plastic) and the phases up to the failure.
Explain the influence of textural parameters such as porosity or foliation on the rock strength.
Present mineralogical and textural components that determine the hardness, abrasiveness and durability of rocks, and tests for their determination
Provide elements for the characterization and assessment of the rock mass quality by means of simple procedures
Introduce the concept of rock mass. Explain how the geometric characteristics of the discontinuities (roughness, undulation, weathering) govern their shear strength.
Identifying different types of discontinuities of the rock mass. Learning ho w to measure discontinuities with compass. Field data collection for the geomechanical classitications

Site investigation	Learning time: 12h Theory classes: 2h Practical classes: 2h Laboratory classes: 1h Self study : 7h

Description:
Objectives of terrain analysis: phases.
Photo interpretation and remote sensing.
Geological and geotechnical mapping
Geophysical techniques: electrical prospecting and its arrays. Seismic refraction. Georadar
Criteria for selecting sampling points, in outcrops, trenches and boreholes
Description of geological outcrops and trenches
Core logging
Constructing a geological geotechnical model of the terrain
Workshop to review work in progress

Specific objectives:
Provide the basis for planning the reconnaissance campaign , according to the geological characteristics of the area and the available techniques
Provide criteria for sampling. Provide criteria for the identification and description of relevant parameters of the ground for construction works
Prepare a geological-geotechnical cross.section of the terrain based on data from surface mapping, geophysical prospecting and mechanical drilling
Review the work done by students on the course project.

Excavacions-Foundations	Learning time: 36h Theory classes: 7h Practical classes: 8h Self study : 21h

Description:

Digging Systems
Terrain Parameters
Seismic criteria. Criterion of Petiffer and Fookes
Mechanisms of instability in natural slopes and cut slopes
Analysis of plane and wedge failure
Assessment of instability: local and structural instability.
Criteria for stabilization, interception and protection
Geological constraints of foundations: soil-rock contact.
Soil heterogeneity and consequences in ground deformability.
Dissolution and collapse: solubility of salts, gypsum and limestones
Expansive mechanisms: Oxidation of pyrites. Gypsum growth.
Environmental impact of the foundation works on groundater flow
Geological constraints for linear insfrastructures: relief and geological structure
Identification of critical points
Earthworks. Formations suitable for embankments.
Linear insfrastructures and natural hazards
Environmental impact of linear insfrastructures
Introduction to stereographic projection.
equiangular and equiareal
Plotting lines and planes
Measurement of angles between lines and planes
Density plots
Planar and wedge failure: Markland test and Hocking refinement Toppling: Goodman Test
Representation of the friction cone.
Stability analysis of planar and wedge failure.
Calculation of the safety factor

Specific objectives:

Identify and assess the terrain parameters that determine the feasibility and performance of different procedures and machinery for ground excavation
Review the mechanisms of instability of slopes and cuts. Analysis of the stability of the most common mechanisms and provide criteria for rock stabilization and protection.
Review the geological parameters that influence the selection of superficial or deep foundations and the mechanisms of failure. Identify favorable contexts for expansive phenomena and describe the processes involved. Present examples of environmental impact of foundations.
Analyze the influence of the geological context for large liniear infrastructures. Provide elements for the recognition and characterization of the terrain
Presenting the principles of stereographic projection and its applications
Analysis of field data and identification of the main joint sets in the rock mass by means of the stereographic projection
Application of kinematic tests to assess the risk of slope failure for different instability mechanisms
Evaluation of the stability of blocks and wedges with streographial and analytical solutions

Tunnels and underground works	Learning time: 9h 36m Theory classes: 3h Practical classes: 1h Self study : 5h 36m

Description:
Geology and tunnels: specificities
Lithological control of the excavation of tunnels: brittle, creeping and soluble rocks
Geological structure: roof stability. Dilatancy
Portal Characterization
Tensions in the tunnels: origin. Lithostatic pressure. Tectonic stresses.
Faults. Detection
Water in tunnels. Karstification. Detection
Geological control of the front.

exercise of selection of the most favourable alternative in tunnels

Specific objectives:
Presentation of some examples of different geological problems in tunnels. Review of the performance of the main types of rocks. Analysis of the geological structure and the fracture pattern of the rock mass on the stability of the excavation.
Review the origin and distribution of stress and the effect of water in the underground excavation. Present criteria for the early detection of fault and potential water inflows.
Identification of favorable and problematic aspects of the ground
Analysis of alternatives
Selecting the most favorable path

Dams and reservoirs	Learning time: 7h 11m Theory classes: 2h Practical classes: 1h Self study : 4h 11m

Description:
Geology and dams: specificity.
Dam foundations. Strength, deformability
Leakeage. Infiltration tests.
Identifying directions of leakage. Eraso's method
Reservoirs and stability of slopes
Leakage in dams sites and reservoirs

Specific objectives:
Presentation of some examples taken in difficult ground. Understanding the most relevant geological aspects taking into account the dam typology and the lithology involved.
Present the most favorable geological contexts for leakage in reservoirs and the available methods to determine the direction of leakage. Discuss the mechanisms of slope instability associated to changes in water level of reservoirs
Determining the direction of leakage.
Design of cutoffs

Field trip-visit	Learning time: 9h 36m Laboratory classes: 4h Self study : 5h 36m

Description:
visit of a road, tunnel or dam under construction

Specific objectives:
Get an overview of the importance of land in large infrastructure projects.
Fix the concepts given to the subject.
See practical applications and other engineering related topics

Exams	Learning time: 12h Laboratory classes: 5h Self study : 7h

Qualification system

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Several assessments will be carried out during the course.

The final mark will be given by the following terms:
FINAL MARK= Theoryx 0,4 + Exercises 0,2 + Oral presentations and report of Course Project 0,4

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods. These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

250146 - ENGGEOLOG - Geological Engineering

Regulations for carrying out activities

The delivery of the memory of the Course Project is mandatory.

Bibliography

Basic:

González de Vallejo, L.I. Ingeniería geológica [on line]. Madrid: Prentice Hall, 2002 [Consultation: 06/05/2019]. Available on: <http://www.ingebook.com/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1237>. ISBN 84-205-3104-9.

Goodman, R.E. Engineering geology: rock in engineering construction. New York: John Wiley and Sons, 1993. ISBN 0471544248.

Blyth, F.G.H.; De Freitas, M.H. A geology for engineers. 7th ed. London: Edward Arnold, 1984. ISBN 0713128828.