Course guide
330603 - MES - Modeling of Underground Excavations

Last modified: 30/06/2023

Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: MASTER'S DEGREE IN MINING ENGINEERING (Syllabus 2013). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Parcerisa Duocastella, David

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. (ENG) Coneixement adequat d'aspectes científics i tecnològics de geotècnia.
2. (ENG) Capacitat per a la realització d'estudis de gestió del territori i espais subterranis, incloent la construcció de túnels i altres infraestructures subterrànies.

TEACHING METHODOLOGY

The practices are carried out exclusively in the computer rooms with the support of the teaching staff and video tutorials. Initially, the use of different software tools is explained, it is proposed to carry out various tasks related to the software that must be delivered through the ATENEA digital platform and later they are corrected and qualified. In a complementary way, a field trip devoted to the understanding of the geomechanical classifications of rock masses can be carried out.

Theoretical classes consist essentially of masterful presentations through Power Point, encouraging, as far as possible, the active participation of the students by posing questions related with the class presentetion. All Power Points are available on the ATENEA virtual campus for consultation.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the Underground Excavation Modeling course, the student should be able to:
· Identify the different types of terrain, their characteristics and the influence on possible excavations.
· Recognize the distortions produced by excavations in the stress state of the ground.
· Know the basic excavation and support techniques and when they should be applied depending on the terrain and the work to be carried out.
· Make a 3D model of the geological/geotechnical units of the subsoil through the use of software.
· Make models of deformations and stress distortion around an underground excavation through the use of software.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	45,0	36.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

Title of content 1: Introduction to Underground Infrastructures

Description:
This content works:
Basic definitions of Underground Works.
Basic types of underground works.
Examples of underground works and associated engineering problems.

Specific objectives:
Upon completion of this topic, the student will be able to:
1. Understand what an Underground Infrastructure is.
2. Understand the main problems associated with the construction of these infrastructures.

Related activities:
Activity 3 and 4

Full-or-part-time: 5h
Theory classes: 2h
Self study : 3h

Title of content 2: Terrain Characterization

Description:
This content works:
The concept of soil, rock and rock mass and how to make a characterization and study as a preliminary step to the construction of a tunnel.
Analysis of discontinuities and other parameters in rock masses.
Characterization of stratified subsoils.

Specific objectives:
Upon completion of this topic, the student will be able to:
1. Distinguish between a rock and a soil subsurface.
2. Know the basic ground characterization tests.
3. Manage the data provided by field investigation surveys.
4. Model a stratigraphic subsoil from the data of the drillings.

Related activities:
Activities 1, 3, 4 and 5

Full-or-part-time: 26h
Theory classes: 6h
Laboratory classes: 5h
Self study : 15h

Content Title 3: Tensions Around an Excavation

Description:
This content works:
The evolution of the principal stresses around a tunnel and how these stresses are modified when applying a support.

Specific objectives:
Upon completion of this topic, the student will be able to:
1. Understand what the state of stresses, the principal stresses and the law of stresses are in dry, moist and saturated soils.
2. Understand how these stresses are modified around an excavation.

Related activities:
Activities 2, 3, 4 and 5

Full-or-part-time: 19h
Theory classes: 4h
Laboratory classes: 3h
Self study : 12h

Content Title 4: Construction and Support Techniques

Description:
This content works:
The main techniques and machinery to carry out an excavation and the different types of supports depending on the type of terrain.

Specific objectives:
Upon completion of this topic, the student will be able to:
1. Know the main types of excavation methods.
2. Know the main types of supports.

Related activities:
Activities 2, 3 and 4

Full-or-part-time: 29h
Theory classes: 6h
Laboratory classes: 3h
Self study : 20h

Content title 5: Interaction between excavations and supports

Description:
This content works:
Interaction of supports with the terrain and determination of support curves.

Specific objectives:
Upon completion of this topic, the student will be able to:
1. Understand a sustain curve.
2. Analyze the risk of falling blocks in tunnels built in rocky massifs.

Related activities:
Activities 2, 3 and 4

Full-or-part-time: 22h
Theory classes: 4h
Laboratory classes: 3h
Self study : 15h

Title of content 6: Risk control and monitoring

Description:
This content works:
Monitoring of a tunnel based on ground monitoring tests and risk management during tunnel construction.

Specific objectives:
Upon completion of this topic, the student will be able to:
1. Identify the main risks during the excavation of a tunnel.
2. What are the ground auscultation tests. Functioning and understanding of results in inclinometric, strain gauge, pressure cell and strain gauge tests.

Related activities:
Activities 3 and 4

Full-or-part-time: 24h
Theory classes: 6h
Laboratory classes: 3h
Self study : 15h

ACTIVITIES

TITLE OF ACTIVITY 1: Making a 3D model of the subsoil using Vulcan

Description:
Several sessions will be devoted to develop a 3D model of the subsurface geological/geotechnical units in a specific area by means of specialized software (Maptek Vulcan) in the Computer classrooms.

Specific objectives:
At the end of the practice the student should be able to:
· Use Maptek Vulcan software to make a 3D model of the subsoil.

Delivery:
Each student will have to submit a 3D model through the ATENEA digital campus.

Full-or-part-time: 11h
Laboratory classes: 5h
Self study: 6h

TITLE OF ACTIVITY 2: Making a 3D model of stresses and deformations in a tunnel using Rocscience software

Description:
It is proposed to use different programs from the Rocscience suite to model forces and deformations around an underground excavation.

Specific objectives:
At the end of the directed activity, the student should be able to make 3D models of deformations and stress distortion around an underground excavation.

Delivery:
Students will have to submit various tasks through the ATENEA digital campus.

Full-or-part-time: 10h
Laboratory classes: 5h
Self study: 5h

TITLE OF ACTIVITY 3: Exam on the theoretical contents of the subject

Description:
In the final part of the course, a questionnaire is made to evaluate the theoretical content taught.

Specific objectives:
Demonstrate that the theoretical knowledge has been acquired.

Delivery:
Students submit the completed exam.

Full-or-part-time: 3h
Laboratory classes: 2h
Self study: 1h

TITLE OF ACTIVITY 4: final evaluation test of the subject

Description:
Individual test in a classroom where the achievement of the theoretical knowledge of the subject and/or the realization of a 3D model of the subsoil with Maptek Vulcan must be demonstrated in case of not having passed the tests carried out during the course.

Specific objectives:
At the end of the test, the student must have demonstrated that they have acquired basic knowledge about modeling underground excavations.

Delivery:
Solved exam.

Full-or-part-time: 15h
Practical classes: 3h
Self study: 12h

TITLE OF ACTIVITY 5: Field trip

Description:
A visit to an outcrop is made and the determination of various geomechanical classifications is made. This is an optional activity.

Specific objectives:
At the end of the practice the student should be able to:
· Understand how the geomechanical classifications of rock masses are determined.

Full-or-part-time: 7h
Laboratory classes: 3h
Self study: 4h

GRADING SYSTEM

Various assessment tasks are carried out throughout the course that consist of:

1. An exam on the concepts presented in the theory classes. You have 3 hours to do it and if you fail, you have the right to attend a final exam where the achievement of the theoretical knowledge of the course will be evaluated again.

2. The realization of a 3D subsoil model using the Vulcan software. This model will be carried out in various practical sessions and through autonomous work and will be delivered as a task through the ATENEA digital campus. In case of failing, you will have the right to the evaluation of this part of the course in a final exam where a 3D subsoil model will have to be made during the time span of the exam.

3. Carrying out various tasks using the Rocscience software. Submission of these assignments is mandatory.

The final grade is the sum of the following partial grades:

Nfinal = 0.4 NeT + 0.4 NpV + 0.2 NpR

Nfinal: final grade.
NeT: qualification of the theoretical exam.
NpV: Vulcan practical task rating.
NpR: Rocscience practical assignments rating.

EXAMINATION RULES.

· It is prevented to use any type of annotations and formulae lists in the theoretical exam or in the final theory test.
· If you have to do the Vulcan project in a final exam, you will have the right to consult notes and video tutorials.
· Rocscience assignments are mandatory.

BIBLIOGRAPHY

Basic:
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Complementary:
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