Course guide
250MEA016 - 250MEA016 - Geomechanics for Energy and Environment

Last modified: 22/06/2024

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2024). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: SEBASTIAN OLIVELLA PASTALLE

Others: Folch Sancho, Albert
Olivella Pastalle, Sebastian

PRIOR SKILLS

Skils derived from bachelor in engineering.

TEACHING METHODOLOGY

The course consists of 3 hours per week of classroom activity consisting in theory sessions, solving of problems and the study of real cases.
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.
Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

Learn to conceptualize engineering in the environmental and sustainable development framework. Learn to direct, coordinate and develop complete projects in the field of Environmental Engineering related to energy and the ground. In this subject you will learn how the properties and processes that take place in the subsoil give rise to different energy uses and help to manage certain environmental problems. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context in the field of energy and environment, taking into account the geo-mechanical behavior of the terrain. Ability to apply the acquired knowledge and problem-solving skills in new or little-known environments within broader (or multidisciplinary) contexts related to this area of â□□â□□study. Ability to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections linked to the application of knowledge and judgments. Ability to communicate conclusions, knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way. Learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	63.95
Hours large group	25,5	20.38
Hours medium group	9,8	7.83

Type	Hours	Percentage
Hours small group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

title english

Description:
content english

Full-or-part-time: 0h 30m
Theory classes: 0h 30m

Theme 2. Fundamental contents

Description:
Description of the geological media and external geological processes
Geological materials, tectonics and structural geology.
Water, gas and heat on the ground
Mass and energy flows in geological media
Displacements and land deformations
Conservation equations for mass, momentum and energy
Numerical solution of THM problems

Full-or-part-time: 6h
Theory classes: 6h

Theme 3. Behaviour of Geomaterials

Description:
Stresses and strains, tensors and invariants
Deformation due to changes in effective stress, temperature and suction
Water and heat flow in geomaterials
Basic mechanical models for floors
Basic mechanical models for rocks

Full-or-part-time: 6h
Theory classes: 6h

title english

Description:
Use and storage of energy on the ground
Water-steam equations of state
Heat storage in the ground. Reversible systems
High enthalpy geothermal energy
Low enthalpy geotherma systems

Full-or-part-time: 8h
Theory classes: 8h

Theme 5. Energy and CO2

Description:
Energy and fluids on the ground
Equations of state for fluids under non-ideal conditions
Injection and extraction of fluids in geological formations
THM couplings: ground surveys, induced seismicity
Applications and examples

Full-or-part-time: 4h 30m
Theory classes: 4h 30m

Tema 6. Nuclear waste isolation

Description:
Nuclear energy, description and environmental problems
Storage of waste in geological environments.
Engineered clay barriers for waste isolation
THM coupled models applied to engineering barriers

Full-or-part-time: 3h 30m
Theory classes: 3h 30m

Theme 7. Cavities in saline rocks

Description:
Storage of fluids in cavities.
Mechanical behavior of salt rocks. Creep. Temperature
Convergence of cavities in salt mines
Coupled thermo-mechanical problems in rock formations
Applications and examples

Full-or-part-time: 3h 30m
Theory classes: 3h 30m

Theme 8. Other applications in environmental engineering

Description:
Earth Dams and Hydroelectric Power
Geomembranes and geotextiles for waste containment
Mining waste dams
Bituminized waste
Others

Full-or-part-time: 9h
Theory classes: 9h

Training

Description:
In each topic, practices related to tasks that may involve individual or group work will be carried out.
Part of the practice will be during school hours and part will be independent work.

Full-or-part-time: 6h
Practical classes: 6h

Global exam

Description:
There will be a global exam to confirm the knowledge acquired during the development of the subject.

Full-or-part-time: 3h
Theory classes: 3h

GRADING SYSTEM

EXAMINATION RULES.

Failure to perform continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

BIBLIOGRAPHY

Basic:
- Banks, D. An introduction to thermogeology: ground source heating and cooling [on line]. 2nd ed. Wiley, 2012 [Consultation: 20/06/2024]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118447512. ISBN 9780470670347.
- Vidal, R.; Olivella, S.; Saaltink, M.W.; Diaz-Maurin, F. "Heat storage efficiency, ground surface uplift and thermo-hydro-mechanical phenomena for high-temperature aquifer thermal energy storage". Geothermal Energy [on line]. Volume 10, article number 23, (2022) [Consultation: 17/09/2024]. Available on: https://link.springer.com/article/10.1186/s40517-022-00233-3.- Vilarrasa, V.; Silva, O.; Carrera, J.; Olivella, S. "Liquid CO2 injection for geological storage in deep saline aquifers". International Journal of Greenhouse Gas Control [on line]. Volume 14, May 2013, Pages 84-96 [Consultation: 17/09/2024]. Available on: https://www.sciencedirect.com/science/article/pii/S1750583613000315.