UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
250821 - 250821 - Aquifer Mechanics

Last modified: 25/01/2024

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

Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Optional subject).

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

LECTURER

Coordinating lecturer: FRANCISCO JAVIER SANCHEZ VILA

Others: JESUS CARRERA RAMIREZ, FRANCISCO JAVIER SANCHEZ VILA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13308. To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
13310. To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory testing programmes.
13311. To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.
13315. To calculate, evaluate, plan and regulate surface and groundwater resources.(Specific competence of the specialization in Groundwater Hydrology).
13323. To model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

Generical:
13300. To apply advanced knowledge in sciences and technology to the profesional or research practice.
13301. To lead, coordinate and develop integrated projects in Geo-Engineering.
13302. To identify and design solutions for geo-engineering problems within ethical, social and legislative frameworks.
13303. To evaluate the impact of Geo-engineering on environment, sustainable social development and the significance of working within reliable and consciensous profesional environment.
13304. To incorporate new techncologies and advanced tools in Geo-engineering into profesional and research activities.
13305. To conceive Geo-engineering as a multi-disciplinary field that includes relevant aspects from geology, sismology, hydrogeology, geotechnical and earthquake engineering, geomechanics, physics of porous media, geophysics, geomatics, natural hazard, energy and climate interactions.
13306. To promote innovation for the development of methodology, analyses and solutions in Geo-engineering
13307. To tackle and solve advanced mathematical problems in engineering from the drafting of the problem to the development of formulation and further implementation in computer programs. Particularly, to formulate, code and apply analytical and numerical advanced computational tools to project calculations in order to plan and manage them as well as to interpret results in the context of Geo-engineering and Mining engineering.

TEACHING METHODOLOGY

The course consists of 1,8 hours per week of classroom activity (large size group) and 0,3 hours weekly with half the students (medium size group).

The 1,8 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 0,3 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 laboratory practice.

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

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
To characterize the geological environment and its interaction with civil works.
To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose testing programmes.
To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.
To analyze, discriminate and integrate geological and geotechnical information in studies and projects.
To calculate, evaluate, plan and regulate surface and groundwater resources.(Specific competence of the specialization in Groundwater Hydrology).
To model, assess and manage geological resources, including mineral and thermal groundwater. (Specific competence of the specialization in Groundwater Hydrology).

* To manipulate the theoretical concepts of multiphase flow, heat flow and reactive transportation.
* To manipulate the theoretical concepts in geo-statistics.
* To analyze the stochastic data in hydrology and hydrogeology.
* To analyze the flow and reactive transportation processes in aquifers.
* To calculate the groundwater balance.
* To carry out practical aquifer reloading calculations.
* To apply hydrogeochemical and isotopic techniques to the study of aquifer reloading.
* To suggest general studies in groundwater hydrology.

- Analysis of flow and transport processes in saturated and unsaturated zones.
- Analysis of conservative transport processes in aquifers.
- Analysis of reactive transport processes in aquifers.
- Application to real cases.

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

Flow and transport in porous media

Description:
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The flow of water in porous media. Hydraulic potential. Law of Darcy. Flow equation. Processes coupled. Transport of solutes. Mechanisms of transport. Discussion of detail on dispersion. Advection-dispersion equation. Basic solutions. Adsorption and reactions. Flow and transport in fractured media. Flow between parallel sheets. On-site transportation. Models. Reactive transport: reactions, equilibrium equations, kinetics. Reactive transport equations.
Problems about flow and transport of solutes

Full-or-part-time: 31h 12m
Theory classes: 8h
Practical classes: 5h
Self study : 18h 12m

Unsaturated and multiphase flow

Description:
The unsaturated zone. Potential. Characteristic curves. Forms of the flow equation. Transfer of energy: enthalpy, specific heat. Mechanisms of heat transport. Effect of variable density. Natural convection. Evaporation. Multiphase flow. Balance Equations. Coupled phenomena. The Mechanical Coupling: Compatibility Equations and Hooke's Law.
Problems on multiphase flow and transport

Full-or-part-time: 33h 36m
Theory classes: 9h
Practical classes: 5h
Self study : 19h 36m

Flow and transport in heterogeneous media

Description:
Natural heterogeneity. Basic concepts on heterogeneity. Regionalized variables. Geostatistics. Basic methodologies. Some results related to flow. Transport. Macrodispersion. Limitations of the transport equation. Other forms of transport equation.
Non-local transport and macrodispersion parameters

Full-or-part-time: 43h 12m
Theory classes: 9h
Practical classes: 6h
Laboratory classes: 3h
Self study : 25h 12m

GRADING SYSTEM

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

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.

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:
- Marsily, Ghislain de. Quantitative hydrogeology : groundwater hydrology for engineers. Orlando [etc]: Academic Press, 1986. ISBN 0122089162.
- Jacob Bear. Dynamics of fluids in porous media. New York: Dover, 1988. ISBN 0486656756.