Course guide
250829 - 250829 - Groundwater and Environment

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: MAARTEN WILLEM SAALTINK

Others: PAULA FELICIDAD RODRIGUEZ ESCALES, MAARTEN WILLEM SAALTINK, CRISTINA VALHONDO GONZALEZ

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
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).
13316. To assess and manage environmental impacts from waste disposal, soil contamination and groundwater pollution. (Specific competence of the specialization in Groundwater Hydrology).
13320. To design and execute hydraulic systems, including transportation facilities, distribution and storage of solids, liquids and gases, water treatment plants and waste management (urban, industrial or hazardous). (Specific competence of the specialization in Groundwater Hydrology).
13321. To assess and manage projects, plants and water facilities for the environmental point of view. (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 lectures in which the teacher explains the concepts and basic material, presents examples and exercising.
In addition to the lectures, there are three exercises that consist of making calculations related to the topics explained in the lectures, which the students have to do at home and m are explained in class after having been deliverd.
There is a class that uses computer codes to do some exercises

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

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
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 assess and manage environmental impacts from waste disposal, soil contamination and groundwater pollution. (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 recognize the relationship between soil mechanics and hydrogeology.
* To evaluate the impacts caused by civil works (excavations, walls, tunnels) in aquifers and vice versa.
* To acquire concepts on exceptional contamination of aquifers and remediation techniques.
* To gather knowledge on the mathematical models to evaluate the impact of works on aquifers.
* To recognize the main technologic options available to grant economical and efficient services with regards to the basin.
* To suggest solutions to benefit from the local natural resources taking into account the economical, social and environmental sustainability.
* To understand the chemical balance and kinetic processes from a rigorous mathematical point of view.
* To suggest and solve the reactive transport equations in simple cases .
* To recognize the most frequent processes and sources of contamination in soils, aquifers, rivers, dykes, coasts and wetlands.
To suggest solutions to remediate the contamination of water masses using numerical modelling.
* To acquire advanced knowledge on the problems regarding urban and especial solid waste management.
* To understand the extent of the studies on environmental impact.
* To understand the atmosphere-soil hydrological processes.
* To model the hydrological processes at a local, basin and regional scale.
* To know the differences among different types of hydrological modelling.
* To understand the effects of precipitation on soil stability.
* To admit the possibility of natural disasters occurring due to water and to be able to estimate the vulnerability and risk of a ground when facing flooding or debris flow.

- The chemical equilibrium. Thermodynamics. Types of reactions. Law of mass action. Mixtures.
- Chemical Kinetics. Reaction rates. Kinetic equations.
- Reactive transport. Matrix components and stochiometry. Transport equations. Solution.
- Contamination of soil and aquifers. Contaminants. Sources of contamination. Degradation processes and remediation. Toxicology. Dose. Environmental risk assessment.
- Contamination of rivers and reservoirs. Contamination of coastal waters and moisture.
- Global cycles. Carbon cycle.
- Waste management. Municipal solid waste. Special waste.
- Numerical methods and modeling .
- Environmental impact studies. Legal framework. Environmental inventory. Methodology.

STUDY LOAD

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

Total learning time: 125.1 h

CONTENTS

Processes

Description:
Mass balances and field theory
Mass balances and field theory
Review flow and Water quantity
Review of water flow and quantity
Pollutants and environmental Impact
Contaminants and environmental impact
Vulnerability and catchment perimeters
Vulnerability and catchment perimeters
Plumes of pollutants
Plumes of pollutants
Multiphase flow
Multiphase flow
Hydrogeochemical review
Hydrogeochemical review
Hydrogeochemical systems
Hydrogeochemical systems
Isotopes
Isotopes

Full-or-part-time: 64h 48m
Theory classes: 18h
Practical classes: 9h
Self study : 37h 48m

Cases

Description:
Acid mine drainage
Acid mine drainage
Nuclear waste
Nuclear waste

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

evaluable

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

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:

- Bear, J., Cheng, A.H.D. Modeling groundwater flow and contaminant transport. Dordrecht [etc.]: Springer, 2010. ISBN 9781402066818.
- Foster, S. [et al.]. Protección de la calidad del agua subterránea : guía para empresas de agua, autoridades municipales y agencias ambientales. Madrid: Mundi-Prensa, 2003. ISBN 8484761460.
- Langmuir, D. Aqueous environmental geochemistry. Upper Saddle River (N.J.): Prentice Hall, 1997. ISBN 0023674121.
- B.J. Merkel; Planer-Friedrich, B. Groundwater geochemistry: a practical guide to modeling of natural and contaminated aquatic systems. 2nd ed. Berlin ; Heidelberg: Springer, 2008. ISBN 978-3-540-74667-6.
- Peavy, H.S.; Rowe, D.R.; Tchobanoglous, G. Environmental engineering. New York: McGraw-Hill, 1985. ISBN 0070491348.
- Stumm, W.; Morgan, J.J. Aquatic chemistry: chemical equilibria and rates in natural waters. 3a edición. New York: John Wiley and sons, 1996. ISBN 978-0-471-51185-4.
- Valsaraj, K.T. Elements of environmental engineering: thermodynamics and kinetics. 3rd ed. Boca Raton, FL: CRC Press, 2009. ISBN 9781420078190.
- Younger, P.L., Banwart, S.A., Hedin, R.S. Mine water : hydrology, pollution, remediation. Dordrecht: Kluwer Academic Publishers, 2002. ISBN 140200138X.