Course guides
250823 - 250823 - Aquifers Balance and Recharge

Last modified: 07/10/2020

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: 2020 **ECTS Credits:** 5.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: DANIEL FERNANDEZ GARCIA

Others: DANIEL FERNANDEZ GARCIA

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.
13312. To analyze, discriminate and integrate geological and geotechnical information in studies and projects.
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 1,9 hours per week of classroom activity (large size group) and 0,5 hours weekly with half the students (medium size group).

The 1,9 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 0,5 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.

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.

- Scientific fundamentals for aquifer recharge techniques and methods of groundwater balance.
- Methods of calculations applied to practical problems.
- Application of hydrogeochemical and isotopic study of groundwater recharge techniques.
- Bases for general studies of groundwater hydrology.

a) Overview of the scientific basis of natural recharge of aquifers and groundwater balance. b) Discussion of the calculation methods applied to solving practical problems. c) Application of hydrogeochemical and isotopic study of recharge techniques. d) Provide the basis for focusing the thesis work and studies Hydrogeology.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	9,8	7.83
Guided activities	6,0	4.80
Hours large group	19,5	15.59
Hours small group	9,8	7.83
Self study	80,0	63.95

Total learning time: 125.1 h

CONTENTS

Topic 0

Description:
Overview . Content of the syllabus. Work to be done .

Specific objectives:
Overview

Full-or-part-time: 4h 33m
Theory classes: 1h 54m
Self study : 2h 39m

Topic 1

Description:
Concepts and definitions.Unsaturated zone: characteristics, flow and mass transport. Measurements.

Specific objectives:
Tthe basic principles of water flow are set out in the unsaturated zone and hydrologic balance insoil is calculated. simple calculations in simplified situations are made, and how they can deal with more complex cases

Full-or-part-time: 4h 33m
Theory classes: 1h 54m
Self study : 2h 39m

Theme 2

Description:
Actual and potential evapotranspiration. Measurement and calculation. Phreatic evapotranspiration. Questions on the previous session

Specific objectives:
Understand the evapotranspiration process and learn how to be estimated

Full-or-part-time: 9h 21m
Theory classes: 3h 54m
Self study : 5h 27m

Tema3

Description:
Measurement and calculation of components. Recharge as a residual term. Sequential calculation. Models and visual-Balan. Special situations: concentrated recharge in fissures and discontinuities; repellency. Questions on the previous session

Specific objectives:
To introduce and understand the key concept of soil-water balance as a mean to evaluate water resources

Full-or-part-time: 6h 57m
Theory classes: 2h 54m
Self study : 4h 03m

Topic 4

Description:
Principles. Profiles of salinity in the soil and the unsaturated zone. Limitations and causes of error.Questions on the previous session

Specific objectives:
Water balance in the soil media by applying chemical methods

Full-or-part-time: 4h 48m
Theory classes: 2h
Self study : 2h 48m

Item 5

Description:
Isotopic and thermal effects. Applications. Limitations. Tracer tests. Questions on the previous session

Specific objectives:
Analysis of the processes of natural recharge and application of tracer tests

Full-or-part-time: 9h 21m
Theory classes: 3h 54m
Self study : 5h 27m

Topic 6

Description:
Measurement and observation time. Phreatic level answer to recharge. Modeling. Questions on the previous session

Specific objectives:
Recharge assessment from soil moisture. Measurement methods and modelling

Full-or-part-time: 6h 57m
Theory classes: 2h 54m
Self study : 4h 03m

Topic 7

Description:
Effect of heterogeneities. Recharge from surface water. Loser rivers, swamp and Piedmont areas. Questions on the previous session

Specific objectives:
Assessment of the processes due to surface water recharge and its estimate. Study of the effect of heterogeneity

Full-or-part-time: 6h 57m
Theory classes: 2h 54m
Self study : 4h 03m

Topic 8

Description:
Consideration in the balance.Questions on the previous session

Specific objectives:
Identify the impact of the gricultural management in recharge and water balance according to crops

Full-or-part-time: 6h 57m
Theory classes: 2h 54m
Self study : 4h 03m

Topic 9

Description:
Obtaining terms of water balance. Application and evolution. Questions on the previous session

Specific objectives:
Application of new airborne technologies in obtaining water balance

Full-or-part-time: 6h 57m
Theory classes: 2h 54m
Self study : 4h 03m

Topic 10

Description:
Particularities. Paleo-recharge. Effects of climate change.Preguntes específiques sobre el tema anterior. Questions on the previous session

Specific objectives:
Approach to recharge in arid areas and the effects of the climate change

Full-or-part-time: 6h 57m
Theory classes: 2h 54m
Self study : 4h 03m

Practical work

Description:
Application recharge methods

Specific objectives:
Simple exercises for recharge calculation by various methods

Full-or-part-time: 19h 12m
Practical classes: 8h
Self study : 11h 12m

GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment. Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (in the classroom). 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 practical work.
All theoretical sessions will be preceded by one hour of discussion and comments regarding the previous subject. The objective is to introduce to motivate discussion and comprehension of the previous subject

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:

- Custodio, E.; Llamas, M.R. (eds.). Hidrología subterránea. 2a ed. corr. Barcelona: Omega, 2001. ISBN 8428204462.
- Custodio, E.; Llamas, M.R.; Samper, J. La evaluación de la recarga a los acuíferos en la planificación hidrológica: textos del seminario celebrado en Las Palmas de Gran Canaria, enero de 1997. Madrid: Instituto Tecnológico GeoMinero de España, 1997. ISBN 8478402926.
- De Jong, S.; van der Kwast, H.; Addink, E.; Su, B. "Remote sensing for hydrological studies". Bierkens, M.; Dolman, H.; Troch, P. Climate and the hydrological cycle. Wallingford, Oxfordshire: IAHS, 2008. cap. 15.
- Eagleson, P.S. "Climate, soil and vegetation". Water resources research [on line]. 1978, vol. 14, issue 5, pp. 705-776 [Consultation: 02/02/2021]. Available on: https://agupubs.onlinelibrary.wiley.com/toc/19447973/1978/14/5.
- Jyrkama, M.L.; Sykes, J.F. "The impact of climate change on groundwater". Delleur, J.W. (ed.). The handbook of groundwater engineering. oca Raton; London; New York: CRC Press, 2007. pp. 28-1/28-42.
- Bierkens, M.F.P.; Dolman, A.J.; Troch, P.A. (eds.). Climate and the hydrological cycle. Wallingford: International Association of Hydrological Sciences, 2008. ISBN 9781901502541.
- Candela, L.; Varela, M. La Zona no saturada y la contaminación de las aguas subterráneas : teoría, medición y modelos. Barcelona: CIMNE, 1993. ISBN 8487867278.