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).

General:
13300. To apply advanced knowledge in sciences and technology to the professional 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 conscientious professional environment.
13304. To incorporate new technologies and advanced tools in Geo-engineering into professional 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

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<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours medium group</td>
<td>9,8</td>
<td>7.83</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.80</td>
</tr>
<tr>
<td>Hours large group</td>
<td>19,5</td>
<td>15.59</td>
</tr>
<tr>
<td>Hours small group</td>
<td>9,8</td>
<td>7.83</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>63.95</td>
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</tbody>
</table>

Total learning time: 125.1 h
<table>
<thead>
<tr>
<th>CONTENTS</th>
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<tbody>
<tr>
<td><strong>Topic 0</strong></td>
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</tbody>
</table>
| **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:**

**Specific objectives:**
The basic principles of water flow are set out in the unsaturated zone and hydrologic balance in soil 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
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<tr>
<th>Topic 8</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Consideration in the balance. Questions on the previous session</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>Identify the impact of the agricultural management in recharge and water balance according to crops</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 6h 57m</td>
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<tr>
<td>Theory classes: 2h 54m</td>
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<td>Self study: 4h 03m</td>
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<th>Topic 9</th>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Obtaining terms of water balance. Application and evolution. Questions on the previous session</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<td>Application of new airborne technologies in obtaining water balance</td>
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<td><strong>Full-or-part-time:</strong> 6h 57m</td>
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<td>Theory classes: 2h 54m</td>
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<td>Self study: 4h 03m</td>
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<th>Topic 10</th>
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<td><strong>Description:</strong></td>
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<tr>
<td>Particularities. Paleo-recharge. Effects of climate change. Preguntes específiques sobre el tema anterior. Questions on the previous session</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>Approach to recharge in arid areas and the effects of the climate change</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 6h 57m</td>
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<td>Theory classes: 2h 54m</td>
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<td>Self study: 4h 03m</td>
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<tr>
<th>Practical work</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>Application recharge methods</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
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<tr>
<td>Simple exercises for recharge calculation by various methods</td>
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<tr>
<td><strong>Full-or-part-time:</strong> 19h 12m</td>
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<tr>
<td>Practical classes: 8h</td>
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<tr>
<td>Self study: 11h 12m</td>
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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: