250821 - Aquifer Mechanics

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 5

Teaching languages: Spanish, English

Teaching staff

Coordinator: FRANCISCO JAVIER SANCHEZ VILA
Others: 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).

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.
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**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

<table>
<thead>
<tr>
<th></th>
<th>Total learning time: 125h</th>
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<tbody>
<tr>
<td>Hours large group:</td>
<td>19h 30m</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>9h 45m</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>9h 45m</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>6h</td>
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<tr>
<td>Self study:</td>
<td>80h</td>
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<tr>
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<th>15.60%</th>
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<tbody>
<tr>
<td>Hours large group:</td>
<td>7.80%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>7.80%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>4.80%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>64.00%</td>
</tr>
</tbody>
</table>

Total learning time: 125h

Hours large group: 19h 30m (15.60%)

Hours medium group: 9h 45m (7.80%)

Hours small group: 9h 45m (7.80%)

Guided activities: 6h (4.80%)

Self study: 80h (64.00%)
# Content

## Flow and transport in porous media

**Description:**


**Learning time:** 26h 24m

- Theory classes: 8h
- Practical classes: 3h
- Self study: 15h 24m

## Unsaturated and multiphase flow

**Description:**


**Learning time:** 28h 47m

- Theory classes: 9h
- Practical classes: 3h
- Self study: 16h 47m

## Flow and transport in heterogeneous media

**Description:**


**Learning time:** 38h 24m

- Theory classes: 9h
- Practical classes: 4h
- Laboratory classes: 3h
- Self study: 22h 24m
Qualification 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.

Regulations for carrying out activities

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:
