Degree competences to which the subject contributes

Specific:
3087. Knowledge of and ability to design and dimension hydraulic works and facilities, energy systems and the harnessing of hydroelectric energy, and plan and manage surface and underground hydraulic resources.

3088. Knowledge and understanding of the functioning of ecosystems and environmental factors.

General:
3105. Students will learn to identify, formulate and solve a range of engineering problems. They will be expected to show initiative in interpreting and solving specific civil engineering problems and to demonstrate creativity and decision-making skills. Finally, students will develop creative and systematic strategies for analysing and solving problems.

3106. Students will learn to assess the complexity of the problems examined in the different subject areas, identify the key elements of the problem statement, and select the appropriate strategy for solving it. Once they have chosen a strategy, they will apply it and, if the desired solution is not reached, determine whether modifications are required. Students will use a range of methods and tools to determine whether their solution is correct or, at the very least, appropriate to the problem in question. More generally, students will be encouraged to consider the importance of creativity in science and technology.

3107. Students will learn to identify, model and analyse problems from open situations, consider alternative strategies for solving them, select the most appropriate solution on the basis of reasoned criteria, and consider a range of methods for validating their results. More generally, students will learn to work confidently with complex systems and to identify the interactions between their components.

3111. Students will learn to plan, design, manage and maintain systems suitable for use in civil engineering. They will develop a systematic approach to the complete life-cycle of a civil engineering infrastructure, system or service, which includes drafting and finalising project plans, identifying the basic materials and technologies required, making decisions, managing the different project activities, performing measurements, calculations and assessments, ensuring compliance with specifications, regulations and compulsory standards, evaluating the social and environmental impact of the processes and techniques used, and conducting economic analyses of human and material resources.

3112. Students will develop an understanding of the different functions of engineering, the processes involved in the life-cycle of a construction project, process or service, and the importance of systematising the design process. They will learn to identify and interpret the stages in preparing a product design specification (PDS), draft and optimise specifications and planning documents, and apply a systematic design process to the implementation and operation phases. Students will learn to write progress reports for a design process, use a range of project management tools and prepare final reports, and will be expected to show an awareness of the basic economic concepts associated with the product, process or service in question.

3113. Students will learn to identify user requirements, to draft definitions and specifications of the product, process or service in question, including a product design specification (PDS) document, and to follow industry-standard
Students will acquire an understanding of surface and groundwater hydrology.

**Hydrology pathway**

Specialised knowledge of basic surface and groundwater hydrology concepts covered in an earlier subject on water technologies.

### Teaching methodology

The course consists of 3 hours per week of classroom activity.

The teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

Some hours are 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.

There are 4 hours of practical activities in the computer classrooms.

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

Students will acquire an understanding of surface and groundwater hydrology.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Theory classes: 27h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical classes: 8h</td>
<td></td>
<td>7.11%</td>
</tr>
<tr>
<td>Laboratory classes: 10h</td>
<td></td>
<td>8.89%</td>
</tr>
<tr>
<td>Guided activities: 4h 30m</td>
<td></td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study: 63h</td>
<td></td>
<td>56.00%</td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th><strong>Introduction</strong></th>
<th><strong>Learning time:</strong> 2h 24m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 1h 24m</td>
</tr>
</tbody>
</table>

**Description:**
Description of the teaching methodology and assessment. Review of elementary concepts presented in previous courses.

**Specific objectives:**
Revision of needed previous knowledge.

<table>
<thead>
<tr>
<th><strong>Recharge and unsaturated zone</strong></th>
<th><strong>Learning time:</strong> 14h 23m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 8h 23m</td>
</tr>
</tbody>
</table>

**Description:**
Level and Pressure, Wettability and retention, Unsaturated Darcy's Law, Richards equation, Infiltration according to Horton and Green Ampt
Radiation (long and short wave, radiation balance, albedo, calculation of radiation), Vapor (saturated vapor, relative humidity), Evaporation, Penman evapotranspiration (reference and actual), Penman-Monteith, Thornthwaite, Hargreaves.
Steady state in a basin, water balance models in soil
A example for calculation of recharge

**Specific objectives:**
Knowing the basics of unsaturated flow. Knowing how to apply infiltration models
Knowing the basics of evapotranspiration. Knowing how to apply models of evapotranspiration.
Knowing how to apply aquifers recharge models

<table>
<thead>
<tr>
<th><strong>Evaluation</strong></th>
<th><strong>Learning time:</strong> 9h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h 36m</td>
</tr>
<tr>
<td>Analysis of precipitation and rainfall--runoff transformation</td>
<td>Learning time: 9h 36m</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Description: Use and characteristics of the different statistical distributions used in flood hydrology. Obtaining and use of Clark synthetic unit hydrographs. Exercises and homework previously supplied.</td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>Specific objectives: Knowledge of the bases and application of the statistical distributions more commonly used in surface hydrology. Knowledge of a commonly used unit hydrograph. Resolution of doubts raised by students.</td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h 36m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urban Hydrology</th>
<th>Learning time: 14h 23m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description: Description of the hydrological processes of urban drainage. Rational method when applied to urban areas. Inlet design Exercises grate and inlets. Models deposits and wave kinematics. Exercises in urban hydrology.</td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td>Specific objectives: Specifics of urban hydrology. Rational model in urban area.</td>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study: 8h 23m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools and software for surface hydrology</th>
<th>Learning time: 21h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description: Spatial data for hydrological studies HEC-HMS Geo-HMS</td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 7h</td>
</tr>
<tr>
<td></td>
<td>Self study: 12h 36m</td>
</tr>
</tbody>
</table>
### Solute transport

**Description:**
- Advection, diffusion, dispersion, ADE, analytical solutions, matrix diffusion
- Definition and classification of contamination, adsorption and degradation processes, reactive ADE, vulnerability and protective perimeters
- Example for a calculation of contamination

**Specific objectives:**
- Knowing the solute transport processes in groundwater.
- Knowing how to formulate an PDE for solute transport and how to solve it by analytical methods.
- Knowing how to interpret a tracer test.
- Knowing the relevant processes of aquifer contamination.

**Learning time:** 19h 12m
- Theory classes: 7h
- Practical classes: 1h
- Self study: 11h 12m

### Numerical groundwater models

**Description:**
- Types of models, numerical methods, using models
- Example of a numerical model
- Modflow workshop

**Specific objectives:**
- Understanding what does a numerical model and know its capabilities and limitations.
- Evaluation
- Become familiar with the code Modflow

**Learning time:** 16h 48m
- Theory classes: 2h
- Practical classes: 1h
- Laboratory classes: 4h
- Self study: 9h 48m
Qualification system

The continuous assessment will take into account the following factors:

- Exams (NA)
- Exercises performed at home (NP1)

50% of the grade will be the surface hydrology and the other 50% of the groundwater hydrology.

The rating of both parts is the weighted average: \( NF = 0.7 \cdot NA + 0.3 \cdot NP \) where NA is the average obtained in the exams, NP is the average mark obtained in the practical exercises.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

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:


Complementary:


