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
3089. Knowledge of the design of urban services and utilities to do with water distribution and sewage treatment
3090. Knowledge and understanding of supply and treatment systems, and of how to dimension, construct and conserve them

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...
Students will acquire an understanding of the applied concepts of surface and groundwater hydrology and learn to apply this knowledge to engineering problems.

Upon completion of the course, students will have acquired the ability to: 1. Carry out a hydrological modelling study of a basin, including aspects of water resource quality and management. 2. Carry out a hydrological modelling study of an aquifer and contaminant transport, including aspects of water resource quality and management.

Description of physical processes associated with drainage basins and their quantification, using professional tools such as HEC-HMS; Basic concepts of groundwater flow and solute transport in soil, including both qualitative and quantitative aspects; Darcy's law, Fick's law, and equations for flow and solute transport in aquifers; Well hydraulics.
### Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>25h</th>
<th>22.22%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>10h</td>
<td>8.89%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>10h</td>
<td>8.89%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>4h 30m</td>
<td></td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>63h</td>
<td></td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Content

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

**Description:**
Introducing Surface Hydrology in the context of the subject. Objectives. Prerequisites and evaluation methodology.

**Specific objectives:**
Introducing Surface Hydrology in the context of the subject. Objectives. Prerequisites and evaluation methodology.

<table>
<thead>
<tr>
<th>Concepts hydro-geological and hydro-geochemical</th>
<th>Learning time: 16h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 5h</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study: 9h 48m</td>
<td></td>
</tr>
</tbody>
</table>

**Description:**
Movement of water in the hydrosphere.
Underground reservoirs.
Chemical components of groundwater
Aquifer contamination.
Study and management of chemical analysis.
Hydrogeological exploration

**Specific objectives:**
Aquifer contamination. Pollution sources: landfills, agriculture, toxic waste, and others. Accidental spills. Solute transport by advection and transit time
Study and management of chemical analysis. Representation of chemical data. Aquifer contamination.
Determination of transit times
# The flow of groundwater

**Description:**
- Water flow in porous media.
- Continuity Equation.
- Solutions 1D flow in porous media.
- Springs.
- Flow Networks.
- Piezometric surface layout and flow networks.

**Specific objectives:**
- Transmissivity.
- Continuity Equation. The coefficient of storage. Steady state and transient state. Some particular solutions.
- Solutions 1D flow in porous media.
- Flow Networks. Definition. Path. Qualitative and quantitative interpretation.
- Piezometric surface layout and flow networks.

## Learning time:
- Theory classes: 4h
- Practical classes: 2h
- Self study: 8h 23m

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# Hydraulics of wells

**Description:**
- Hydraulic Basics deposits.
- Hydraulic transient deposits: confined aquifer, semi-confined and free.
- Interpretation of pumping tests. Graphic methods.
- Permeameter, probes, groundwater models / sandbox.

**Specific objectives:**
- Interpretation of pumping tests. Graphic methods.
- Permeameter, probes, groundwater models / sandbox.

## Learning time:
- Theory classes: 2h
- Practical classes: 1h
- Laboratory classes: 1h
- Self study: 5h 36m

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# Evaluation

## Learning time:
- Laboratory classes: 5h
- Self study: 7h
### Hydrogeology and civil engineering

**Description:**
- Impact of public works on the flow and quality of groundwater
- Stability of slopes and dams, soils and rocks.
- Drainage excavation

**Specific objectives:**
- Drainage excavation

| Learning time: | 7h 11m |
| Theory classes: | 2h |
| Practical classes: | 1h |
| Self study: | 4h 11m |

### SURFACE HYDROLOGY

**Description:**

**Specific objectives:**
- Review the water cycle and introduce the concept of hydrological basin. Components. Hydrologic balance at basin level.

| Learning time: | 2h 24m |
| Theory classes: | 1h |
| Self study: | 1h 24m |

### Run-off

**Description:**

**Specific objectives:**
- Knowing the characteristics of runoff in a watershed. Baseflow, direct runoff flow and methodologies to measure.

| Learning time: | 7h 11m |
| Theory classes: | 3h |
| Self study: | 4h 11m |
### Precipitation

**Description:**

**Area rainfall duration curve**

**Specific objectives:**

### Rainfall Runoff

**Description:**
Runoff coefficient. Rational Formula. The isochrones. Time of concentration. ejercicios
The rational method. Ejercicios

**Specific objectives:**
Calculation of runoff by the rational methods. Assumptions and limitations. Calculation in accordance with ACA. Application of the rational method.
### Infiltration

**Description:**
Infiltration concept. The infiltration method SCS. Antecedent moisture conditions. Using the SCS method for determining the direct runoff hydrograph.

**Specific objectives:**
- Knowing the effect of surface runoff infiltration and know the most commonly used method for evaluation.
- Learn to use the method of the SCS.

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>4h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Self study:</td>
<td>2h 48m</td>
</tr>
</tbody>
</table>

### The unit hydrograph

**Description:**
- Synthetic unit hydrograph. The hydrograph of the SCS. The S curve and its application.
- Unit hydrograph. Exercises.

**Specific objectives:**
- Concept and application of unit hydrograph.
- Definition of synthetic unit hydrograph. SCS unit hydrograph. The S curve and its application.
- Practical application of the unit hydrograph method.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
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<td>2h</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Self study:</td>
<td>4h 11m</td>
</tr>
</tbody>
</table>

### Flood routing

**Description:**
- Description of an avenue. Laminating a concept avenida. El Puls method or spread in reservoirs. The Muskingum method or propagation channels.
- Propagation methods training.

**Specific objectives:**
- Concept of propagation of hydrographs through rivers and reservoirs. Muskingum and Modified Puls method.
- Learning to use the propagation methods in rivers and reservoirs.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>1h</td>
</tr>
<tr>
<td>Self study:</td>
<td>2h 48m</td>
</tr>
</tbody>
</table>
In the continuous evaluation the following factors will be taken into account:

- Exams performed during laboratory hours (NA)
- Exercises performed at home (NP1)
- Exercises done in class (NP2)
- Short tests at the end of the class (NP3)

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

The qualification of the exercises of periodic evaluation or exams, NP is the average grade obtained in the practical exercises carried out (NP1, NP2, NP3).

Criteria for qualification and admission to re-evaluation: Students suspended in the ordinary evaluation who have been regularly submitted to the evaluation tests of the suspended subject will have the option to perform a re-evaluation test in the period fixed in the academic calendar. Students who have already passed the test or students who are classified as not being presented may not take the re-evaluation of a subject. The maximum qualification in the case of taking the re-evaluation test will be five (5.0). The non-attendance of a student summoned to the reevaluation test, held during the period established, may not lead to another test with a later date. Extraordinary evaluations will be carried out for those students who due to force majeure have not been able to perform any of continuous assessment tests.

These tests must be authorized by the corresponding head of studies, at the request of the teacher responsible for the subject, and will be carried out within the corresponding academic period.

### Bibliography

#### Basic:


#### Complementary: