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

Learning objectives of the subject

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.

Teaching methodology

The course consists of three classes a week in the classroom.

The classes are divided into lectures and exercises. The latter will be dedicated to solve the doubts about the exercises provided as homework.

Support materials will be provided through the virtual campus ATENEA.
<table>
<thead>
<tr>
<th>Study load</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>112h 30m</td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>25h</td>
<td>22.22%</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>10h</td>
<td>8.89%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>10h</td>
<td>8.89%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>4h 30m</td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>63h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
# Content

## Introduction

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

## Concepts hydro-geological and hydro-geochemical

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

**Learning time:** 14h 23m  
Theory classes: 4h  
Practical classes: 2h  
Self study: 8h 23m  

**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.

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# Hydraulics of wells

**Learning time:** 9h 36m  
Theory classes: 2h  
Practical classes: 1h  
Laboratory classes: 1h  
Self study: 5h 36m  

**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:**  
Formulas Thiem, and Dupuit Glee.  
Interpretation of pumping tests. Graphic methods.  
Permeameter, probes, groundwater models / sandbox

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# Evaluation

**Learning time:** 12h  
Laboratory classes: 5h  
Self study: 7h
### Hydrogeology and civil engineering

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

**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

### SURFACE HYDROLOGY

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

**Description:**  
Hydrograph characteristics

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

### Run-off

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

**Description:**  

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

**Learning time:** 14h 23m  
Theory classes: 4h  
Laboratory classes: 2h  
Self study: 8h 23m

**Description:**  
- Rain over an area. Arithmetic average. Thiessen polygons  
- Method of Isohyets. Inverse square distance method. Curve of average mass in a watershed. Rainfall duration curve area. Transpose a tormenta. Ejercicios  
- Area rainfall duration curve  
- Probability. Assigning the return period. Relationship between the intensity duration and frequency (return period). Probability distributions. IDF Curves intensity-duration-return period. Exercise IDF curve  
- Analysis of rainfall. Exercises

**Specific objectives:**  
- Stations and networks for measuring precipitation. Concepts of pluviograph and hietograph  
- Statistical analysis of precipitation.  
- Construction of the IDF curve and probability assignment  
- Exercises on the analysis of precipitation and obtaining synthetic hietographs

## Rainfall Runoff

**Learning time:** 4h 48m  
Theory classes: 1h  
Practical classes: 1h  
Self study: 2h 48m

**Description:**  
- Runoff coefficient. Rational Formula. The isochrones. Time of concentration. Exercise  
- The rational method. Exercises

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

**Learning time:** 4h 48m  
Theory classes: 1h  
Practical classes: 1h  
Self study: 2h 48m

**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

### The unit hydrograph

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

**Description:**  
Regionalization of flow rates. Myers method. Method Francou-Rodier. The concept of Unit Hydrograph  
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

### Flood routing

**Learning time:** 4h 48m  
Theory classes: 1h  
Laboratory classes: 1h  
Self study: 2h 48m

**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.
The continuous assessment will take into account the following factors:

- Tests conducted on lab hours (NA)
- Exercises performed at home (NP1)
- Exercises done in class (NP2)
- Test the short end of the class (np3)

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

The rating of the hydrology of surface is the weighted average: \( NF = 0.5NP + 0.5NA \) where NA is the average obtained in the regular assessment exercises and examinations, NP is the average mark obtained in practical exercises made (NP1, NP2, np3).

The final grade of the groundwater part will be given by:

\[ 0.4*T1 + 0.6*T2 \]

where T1 is a class activity regarding flow net drawing and T2 is a comprehensive test on topics related to Groundwater.

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:


