Degree competences to which the subject contributes

Specific:
8211. The ability to address and solve advanced mathematical problems in engineering, from the scope and context of the problem to its statement and implementation in a computer program. In particular, the ability to formulate, program and apply advanced analytical and numerical calculation models to the design, planning and management of a project, as well as the ability to interpret the results obtained in the field of mining engineering.
8217. Ability to conduct land management studies, including the construction of tunnels and other underground infrastructures.
8241. Adequate knowledge of modelling, assessment and management of geological resources, including groundwater, mineral and thermal resources.

Teaching methodology

The course consists of 3 hours a week of lectures in the classroom.

55% of the time is devoted to theoretical contents, when the teacher explains the basic concepts, presents examples and exercises.

30% of the time is devoted to exercises aimed at solving practical problems and to field work having more interaction with students.

There are also planned activities for mentoring, supervision and assessment of the Case Study

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
Adequate knowledge of modeling, assessment and management of geological resources, including groundwater, mineral and thermal resources.

Ability to conduct land management studies, including the construction of tunnels and other underground infrastructures.

Ability to address and solve advanced mathematical engineering problems, from problem statement to formulation development and its implementation in a computer program. In particular, the ability to formulate, plan and implement advanced analytical models and numerical calculation, project planning and management, and the ability to interpret the results in the context of mining engineering.

Specialized knowledge on Geotechnics to be able to apply advanced techniques and methodologies. The aim is to deepen the knowledge on geotechnical engineering to design and build any geotechnical structure such as the design of stable slopes and tunnels, as well as to enhance the knowledge related to ground infrastructure engineering and earthquake engineering.

Geomechanics and Geotechnical Engineering, Design and Construction of geotechnical projects, slope stability, geotechnical engineering related to infrastructures, seismic engineering.

Ability to identify instability features in natural slopes and embankments as well as the type of failure mechanism.

Knowledge of procedures and tests to determine the strength parameters of soils and rocks.

Ability to perform the analysis of the landslide runout.

Ability to analyze the stability of a natural slope or artificial cut.

Knowledge of techniques for landslide monitoring as well as the stabilization, retention and protection measures.

Capability to perform the quantitative risk analysis.

### Study load

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

<table>
<thead>
<tr>
<th>Classification and characterization of landslides</th>
<th>Learning time: 7h 11m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
</tr>
<tr>
<td>Classification of mechanisms of instability of embankments and slopes.</td>
<td></td>
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<tr>
<td>Parts of a landslide. Susceptible lithologies.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Identification of unstable slopes and embankments</th>
<th>Learning time: 7h 11m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
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<tr>
<td>Criteria and indicators of instability of unstable slopes. Recognition techniques</td>
<td></td>
</tr>
<tr>
<td>Criteria for defining the boundary conditions.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Resistant properties</th>
<th>Learning time: 7h 11m</th>
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</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
</tr>
<tr>
<td>Resistant properties of soils. Tests. Resistant properties of rock joints</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Stability Analysis</th>
<th>Learning time: 21h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td></td>
</tr>
<tr>
<td>Limit equilibrium analysis.</td>
<td></td>
</tr>
<tr>
<td>Tutoring limit equilibrium methods</td>
<td></td>
</tr>
<tr>
<td>Workshop on methods for remote capture of geological data</td>
<td></td>
</tr>
<tr>
<td>Vulnerability and exposure. Analysis of consequences. Quantitative risk assessment</td>
<td></td>
</tr>
<tr>
<td>Problems of quantitative risk assessment</td>
<td></td>
</tr>
</tbody>
</table>
### Dynamic movements

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

**Description:**  
Propagation mechanisms and strength loss. Earthflows and debris flows

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### Analyses of propagation

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

**Description:**  
Tutorial stability analysis and trajectography

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### Instrumentation and monitoring

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

**Description:**  
Topographic and geodesic surface.  
Geotechnical techniques. Remote sensing

---

### Containment and correction techniques

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

**Description:**  
Stabilization and reinforcement of slopes and cuttings. Protective structures.

---

### Practices

**Learning time:** 9h 36m  
*Laboratory classes: 4h  
Self study : 5h 36m*

**Description:**  
Observation of different instability mechanisms: rock falls (Montserrat), landslides (Vallcebre), as well as monitoring techniques and protection and stabilization works
### Hazard and Risk Analyses

**Description:**
Susceptibility and hazard.

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

### Evaluation

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

### Qualification system

The mark of the course is based on the oral presentation and the written report on the analysis of the stability of a road cut or slope, the runout analysis of rockfalls and landslides, or the risk assessment due to the instability of natural slopes.

### 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:**

