Degree competences to which the subject contributes

Specific:

3082. Ability to construct, conserve, dimension and design roads and the items comprising basic road provision

3083. Ability to construct and conserve railway lines with knowledge of the application of the specific technical regulations, differentiating the characteristics of the rolling stock

3091. Ability to construct, conserve, dimension and design roads and the items comprising basic road provision

3092. Ability to construct and conserve railway lines with knowledge of the application of the specific technical regulations, differentiating the characteristics of the rolling stock

Generical:

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
Students will acquire an understanding of highway construction, preservation, design and planning, as well as the various basic roadway elements. They will acquire an understanding of railway construction and preservation, and also learn to apply specific technical regulations and to distinguish between different types of rolling stock.

Upon completion of the course, students will have acquired the ability to: 1. Design a road according to traffic and other conditioning factors. 2. Design the horizontal layout and vertical profile of transport infrastructure. 3. Carry out a railway infrastructure project, including the layout and design of the elements that make up the section.

Horizontal layout and vertical profile of highways, and coordination between the two aspects; Design of highway cross sections; Traffic; Movement of vehicles; Traffic flow and capacity; Earthworks, including surface and subsurface drainage; Design and sizing of roads; Characteristics of railway infrastructure; Stiffness and deformability of roadways; Basic characteristics of railway vehicles; Layout of railways; Mixed traffic and tilting vehicles; Stress on roadways; Mechanical behaviour of a roadway under vertical stress; Incorporation of transverse stress; Design of roadway infrastructure and
superstructure; High-speed railways; ICT-assisted analysis of highway and railway demand, transport operations and services, financing, and pricing of tolls and tickets

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group: 44h 30m</th>
<th>23.73%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>22h 30m</td>
<td>12.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>8h</td>
<td>4.27%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>7h 30m</td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>105h</td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Module</th>
<th>Learning time:</th>
<th>Description:</th>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0. Presentation</strong></td>
<td>2h 24m</td>
<td></td>
<td>Presentation of the course: objectives, faculty, calendar, system evaluation, bibliography.</td>
</tr>
</tbody>
</table>
4. Pavements

**Description:**

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

---

5. Basic materials.

**Description:**

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

---

6. Work units

**Description:**

**Learning time:** 21h 36m
- Theory classes: 2h
- Practical classes: 2h 30m
- Laboratory classes: 4h 30m
- Self study: 12h 36m
### 7. Circulation

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

**Description:**  
Traffic Variables  
Relationships between traffic variables

### 8. Traffic studies

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

**Description:**  
Traffic forecasting  
Traffic studies "in situ"

### 9. Capacity and levels of services

**Learning time:** 9h 36m  
Theory classes: 3h  
Practical classes: 1h  
Self study: 5h 36m

**Description:**  
Definitions and conditions  
Level of service (L.O.S.) in freeways.  
L.O.S. in 2-way roads  
Exercises
### 10. Introduction of geometric design

**Description:**
- Administration managing road infrastructures.
- Coding the road networks.
- Context of the geometric design within the scope of the sector.
- Geometric design standards: international context.
- La Instrucción 3.1-IC: approach and presentation.
  * Horizontal alignment.
  * Vertical alignment.
  * Cross section.
  - Speed Reference.
  - Visibility.
  - Terrain.
  - Coordination horizontal-vertical alignment.

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

### 11. Horizontal alignment

**Description:**
- Straight alignments.
- Circular curves.
- Transition curves.
- Relationship between radius and superelevations.
  - Shape and characteristic parameters.
  - Minimum length.
- Alignments
  - Straight - Circular
  - Reverse curve (S-shaped curve)
  - C curve (spiral connecting two circular curves with different radius)
  - Combination of two spirals

**Learning time:** 14h 23m
- Theory classes: 2h
- Practical classes: 4h
- Self study: 8h 23m
### 12. Vertical alignment

**Description:**
- Calculation axis.
- Grade inclination.
- Ramps and slopes
- The parabola.
- Minimum parameters of the agreements.

- Sag vertical curve.
- Crest vertical curve

- Exercise to improve the vertical alignment design
- Vertical alignment with fixed-elevation points

**Learning time:** 9h 36m
- Theory classes: 1h
- Practical classes: 3h
- Self study: 5h 36m

### 13. Cross section

**Description:**
- Number of lanes of reference section.
- Cross section on the ground.
- Superelevation transition.

- Superelevation laws

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

### 14. RAILWAYS. Track and material

**Description:**
- Rail networks and operational difficulties
- Main features of a road
- Type of railway track

**Learning time:** 9h 36m
- Theory classes: 4h
- Self study: 5h 36m
<table>
<thead>
<tr>
<th>Topic</th>
<th>Learning time:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Circulation and increased cornering speed</td>
<td>16h 48m</td>
<td>Uncompensated acceleration and cant deficiency. Transition curves. Systems to increase velocity</td>
</tr>
<tr>
<td>16. Geometric quality</td>
<td>2h 24m</td>
<td>Parameters that define the geometric quality of the track. UIC criteria.</td>
</tr>
<tr>
<td>17. Vertical forces and track design</td>
<td>12h</td>
<td>Evaluation of vertical forces exerted by the vehicles. Mechanical analysis of the behavior of a railway track in front of vertical forces. Design of track components.</td>
</tr>
<tr>
<td>18. Turnouts</td>
<td>7h 11m</td>
<td>Equation of lateral displacement of the track. Derailment of a vehicle.</td>
</tr>
</tbody>
</table>
### 19. Turnouts

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></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:**
Turnouts.

### 20. Bridges and tunnels

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></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:**
Bridges and tunnels

### Control

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></th>
<th>19h 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory classes:</td>
<td>8h</td>
</tr>
<tr>
<td>Self study:</td>
<td>11h 12m</td>
</tr>
</tbody>
</table>
Qualification system

For assessment purpose, the course consists of three parts: Traffic and Geometric Design (TT), Earthworks and Pavements (EF), and Railways (FC).

The Mark of the course will be the arithmetic mean of the mark of each of these three parts if the student has got a mark equal to or higher than 4.0 in each one of them:

\[
\text{Mark of the course} = \frac{\text{Mark TT} + \text{Mark EF} + \text{Mark FC}}{3}
\]

Otherwise, the Mark will be the harmonic mean of the mark obtained in each of the three parts:

\[
\text{Mark of the course} = \frac{3}{\frac{1}{\text{Mark TT}} + \frac{1}{\text{Mark EF}} + \frac{1}{\text{Mark FC}}}
\]

To pass the course, the student's course Mark must be equal to or higher than 5.0.

The mark of each part will be obtained as described below.

In the case of the part Traffic and Geometric Design (TT) there will be some assessable activities in the topic Geometric Design. The mark of Traffic and Geometric Design (TT) will be the weighted mean of the exam of Traffic (38%) and the mark obtained in Geometric Design (62%). This last mark (Geometric Design mark) will be obtained by weighting the corresponding exam (80%) and assessable activities (20%):

\[
\text{Mark TT} = 0.38 \times \text{Traffic Exam} + 0.62 \times \text{Geometric Design Mark (0.80 Geometric Design Exam + 0.20 Geometric Design Activities)}
\]

The mark of the part Earthworks and Pavements (EF), as well as that of Railways (FC), will be the weighted mean obtained in the corresponding exam and the assessable activities that will be developed during the course, so the exam will be weighted as 80% and the assessable activities as 20%:

\[
\text{Mark EF} = 0.80 \times \text{EF Exam} + 0.20 \times \text{Activities}
\]

\[
\text{Mark FC} = 0.80 \times \text{FC Exam} + 0.20 \times \text{Activities}
\]

The Mark will be NP when the student does not attend any of the three exams described above and there will be no mark for the student.

Furthermore, at the end of the course, there will be a retaking exam exclusively for the students that, having a numerical Mark, this is not equal to or higher than 5.0.

Once this retaking exam has been taken the mark of each part will be the highest one obtained either in the course or in the retaking exam only if one of them is higher than 4.0. Otherwise, the mark considered will be the one obtained in the retaking exam.

The retaking exam will be compulsory for the students that have one or more of the partial marks lower than 4.0 and the Mark of the course also lower than 4.0. The Mark will be NP when being compulsory the attendance at one of the retaking exams, the student does not attend it.

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

The Mark will be NP when the student does not attend any of the three exams described above and there will be no mark for the student.

The Mark will be NP when being compulsory the attendance at one of the retaking exams, the student does not attend it.

### Bibliography

#### Basic:


#### Complementary:
