Course guides
2500029 - GECINFTRAN - Transportation Infrastructures

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.
Degree: BACHELOR’S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).
Academic year: 2021 ECTS Credits: 6.0 Languages: Catalan, Spanish, English

LECTURER
Coordinating lecturer: ADRIANA HAYDEE MARTINEZ REGUERO
Others: ADRINA BACHILLER SAÑA, EDUARDO FERNANDEZ DE VILLALTA FERRER-DALMAU, ADRIANA HAYDEE MARTINEZ REGUERO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14413. Capacity for the construction and conservation of roads, as well as for the dimensioning, the project and the elements that make up the basic road equipment. (Specific technology module: Civil Construction)
14414. Capacity for the construction and conservation of railway lines with knowledge to apply specific technical regulations and differentiating the characteristics of the mobile material. (Specific technology module: Civil Construction)
14422. Capacity for the construction and conservation of roads, as well as for the dimensioning, the project and the elements that make up the basic road equipment. (Specific technology module: Urban Transport and Services)
14423. Capacity for the construction and conservation of railway lines with knowledge to apply specific technical regulations and differentiating the characteristics of the mobile material. (Specific technology module: Urban Transport and Services)
14426. Knowledge of the design and operation of infrastructures for modal exchange, such as ports, airports, railway stations and transport logistics centers. (Specific technology module: Urban Transport and Services)

General:
14380. Scientific-technical training for the exercise of the profession of Technical Engineer of Public Works and knowledge of the functions of advice, analysis, design, calculation, project, construction, maintenance, conservation and exploitation.
14383. Ability to project, inspect and direct works, in their field.
14385. Ability to carry out territorial planning studies and environmental aspects related to infrastructure, in its field.
14386. Capacity for maintenance, conservation and exploitation of infrastructure, in its field.
14391. Conceive, project, manage and maintain systems in the field of construction engineering. Cover the entire life cycle of an infrastructure or system or service in the field of construction engineering. (Additional school competition).

TEACHING METHODOLOGY

The course consists of 5 hours per week of classroom activity.

The 3 hours are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, and the 1.5 hours are devoted to show examples and solves exercises (average).

The rest of weekly hours devoted to tests.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of assessment activities and conducted learning, literature.
**LEARNING OBJECTIVES OF THE SUBJECT**

Students will acquire an understanding of highway construction, preservation, design and planning, as well as the various basic roadway elements. Introduction to railway construction and preservation.

1. Ability to design a road according to traffic and other conditions.
2. Ability to design the horizontal layout and vertical profile of a transport infrastructure.


**STUDY LOAD**

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

**CONTENTS**

0. **Presentation**

Description:
Objectives, faculty, calendar, evaluation system, bibliography.

Specific objectives:
Presentation of the course: objectives, faculty, calendar, system evaluation, bibliography.

**Full-or-part-time:** 4h 48m
Theory classes: 2h
Self study: 2h 48m
1. ROADS. Construction of earthworks

Description:
Soil classification problems.
Factors affecting the process of compaction, moisture, compaction type and energy, soil type. Proctor test. Moisture and density measurement.
Soil compaction problems

**Full-or-part-time:** 12h
Theory classes: 3h
Practical classes: 2h
Self study : 7h

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2. Subgrades

Description:
Bearing capacity and subgrade design problems.

**Full-or-part-time:** 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study : 4h 11m

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3. Drainage

Description:

**Full-or-part-time:** 4h 48m
Practical classes: 2h
Self study : 2h 48m

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4. Pavements

Description:
Pavement design problems. Norma 6.1-IC "Secciones de Firme".

**Full-or-part-time:** 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m
### 5. Circulation

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

**Full-or-part-time:** 4h 48m
Theory classes: 2h
Self study : 2h 48m

### 6. Traffic studies

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

**Full-or-part-time:** 4h 48m
Theory classes: 2h
Self study : 2h 48m

### 7. Capacity and levels of services

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

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

### 8. 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.

**Full-or-part-time:** 4h 48m
Theory classes: 2h
Self study : 2h 48m
### 9. 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

**Full-or-part-time:** 16h 48m
- Theory classes: 2h
- Practical classes: 5h
- Self study: 9h 48m

### 10. 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.

**Full-or-part-time:** 12h
- Theory classes: 1h
- Practical classes: 4h
- Self study: 7h

### 11. Cross section

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

Superelevation laws

**Full-or-part-time:** 4h 48m
- Theory classes: 1h
- Practical classes: 1h
- Self study: 2h 48m
### 12. RAILWAYS. Introduction

**Description:**
General concepts, organization of the sector and services.

**Full-or-part-time:** 4h 48m  
Theory classes: 2h  
Self study : 2h 48m

### 13. Track and Rolling Stock

**Description:**  
The difficulties of operating a railway line. Main characteristics of a track, both of the infrastructure and of the railway superstructure. Plate track and ballast track. Characteristics of the rolling stock.

**Full-or-part-time:** 9h 36m  
Theory classes: 4h  
Self study : 5h 36m

### 14. Rail curve circulation

**Description:**  
The principles of circulation in curves. Geometric design criteria for railway lines. Pendulum and tipping vehicles. Systems to increase the speed of circulation in a railway line.  
Problems

**Full-or-part-time:** 9h 36m  
Theory classes: 2h  
Practical classes: 2h  
Self study : 5h 36m

### 15. The geometric quality of the track

**Description:**  
Parameters that define the geometric quality of the track. Track geometry registration systems. Numerical quantification of the state of the geometric quality of the road. Construction, service and control tolerances. The case of high speed lines.

**Full-or-part-time:** 4h 48m  
Theory classes: 2h  
Self study : 2h 48m
16. Railway infrastructure and superstructure

Description:
Evaluation of the vertical efforts of a railway line (Interaction track-vehicle): Movements of the railway vehicle, vertical efforts transmitted by the vehicles in the lane, first expressions for the evaluation of the vertical efforts, the works of Birmann and Eisenmann, Prud homme formula and its impact on the design of the track and railway vehicles.
Mechanical analysis and design of the railway infrastructure and superstructure: mechanical analysis of the behavior of the track against the vertical efforts and design of the track. Structural catalogs.
Transversal dynamics: guidance of vehicles, analysis of transversal efforts, practical expressions, lateral resistance of a track and design criteria.
Problems.

Full-or-part-time: 16h 48m
Theory classes: 5h
Practical classes: 2h
Self study : 9h 48m

17. Turnouts

Description:
Types of turnouts. The railway diversion and elements that make it up. Characteristics of high speed deviations.

Full-or-part-time: 2h 24m
Theory classes: 1h
Self study : 1h 24m
GRADING 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:

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

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%):

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

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%:

\[
\begin{align*}
\text{Mark EF} &= 0.80 \times \text{EF Exam} + 0.20 \times \text{Activities} \\
\text{Mark FC} &= 0.80 \times \text{FC Exam} + 0.20 \times \text{Activities}
\end{align*}
\]

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.

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.
EXAMINATION RULES.

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: