

Transport Infrastructure (2500029)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	6.0 ECTS
Programs	GRAU EN ENGINYERIA CIVIL (pla 2020) PARS: ENGINYER/A DE CAMINS, CANALS I PORTS (pla 2022)
Course	2025/26

Main teaching language at each group

- Group 11Q2 Spanish (Q2)
- Group 12Q2 Spanish (Q2)
- Group 21Q2 Spanish (Q2)
- Group 22Q2 Spanish (Q2)
- Group 31Q2 English (Q2)
- Group 32Q2 English (Q2)

Faculty

Responsible Faculty: Adriana Haydee Martinez Reguero

Faculty: Xavier Espinet Alegre, Zacarias Grande Andrade, Benedicto Lizcano Nuñez, Teresa López Montero, Adriana Haydee Martinez Reguero

Objectives of Education

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.

Knowledge of road layout, both in plan and elevation, and the coordination between both. Design of road cross sections. Knowledge about traffic. Vehicle movements. Traffic flow and capacity. Earthworks including surface and subsurface drainage. Design and dimensioning of pavements. Knowledge of the characteristics of a railway infrastructure.

Stiffness and deformability of the track. Knowledge of the fundamental characteristics of railway vehicles. Layout of railway. Mixed traffic and tilting vehicles. Stress on roadways. Knowledge of mechanical behavior of a roadway under vertical stresses. Incorporation of transverse stresses. Knowledge of design of the infrastructure and superstructure of the road. High speed railways. Ability to analyze the demand for roads and railways, transport operations and services with the help of ICT, its financing and pricing of tolls.

Competencies

Specific

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)

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)

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)

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)

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)

Generic

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.

Ability to project, inspect and direct works, in their field.

Ability to carry out territorial planning studies and environmental aspects related to infrastructure, in its field.

Capacity for maintenance, conservation and exploitation of infrastructure, in its field.

Identify, formulate and solve engineering problems. Pose and solve construction engineering problems with initiative, decision-making skills and creativity. Develop a systematic and creative method of analysis and problem solving. (Additional school competition).

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).

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	30.0 h	50.00 %
	Medium group	30.0 h	50.00 %
	Laboratory classes	0.0 h	0.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		90.0 h	

Contents

0. Presentation

Objectives, faculty, calendar, evaluation system, bibliography.

Specific Objectives

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

1. ROADS. Construction of earthworks

Cut and fill. Subgrade. Geological and geotechnical surveillance. Soil characteristics. Characterization tests.

Soil classification (PG-3, ASTM, AASHTO, etc.).

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

2. Subgrades

CBR test. Plate load test. Subgrade design. Lime and cement-treated soil layers.
Bearing capacity and subgrade design problems.

3. Drainage

Hydrological and hydraulic studies. Cross drainage culverts. Surface drainage. Instrucción 5.2-IC "Drenaje superficial"; Water effect on the deterioration of pavements. Design and calculation of sub-surface drainage.

4. Pavements

Description and functions of road pavements. Factors that must be considered in the project. Basic materials and construction units. Pavement types: flexible, semi-rigid and rigid. Shoulders. Functional and structural characteristics. General design principles. Analytical methods. Empirical methods. Norma 6.1-IC "Secciones de firme".

Work units. Materials and tests.

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

Work units. Materials and tests.

5. Circulation

Traffic Variables. Relationships between traffic variables

6. Traffic studies

Traffic forecasting. Traffic studies "in situ"

7. Capacity and levels of services

Definitions and conditions. Level of service (L.O.S.) in freeways.

Exercises

8. Introduction of geometric design

- La Instrucción 3.1-IC: approach and presentation.

* Horizontal alignment.

* Vertical alignment.

* Cross section.

* Speed Reference.

* Visibility.

* Terrain.

* Coordination horizontal-vertical alignment.

9. Horizontal alignment

* 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

10. Vertical alignment

* Calculation axis.

* Grade inclination.

* Ramps and slopes

* The parabola.

Minimum parameters of the agreements.

Sag vertical curve.
Crest vertical curve

11. Cross section

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

12. RAILWAYS. Introduction

General concepts, organization of the sector and services.

13. Track and Rolling Stock

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.

14. Rail curve circulation

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

15. The geometric quality of the track

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.

16. Railway infrastructure and superstructure

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.

17. Turnouts

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

Activities

Earthmoving and Pavements

Solving a problem of structural design of the road. Presentation of the problem and delivery of individual data. Evaluation criteria. Monitoring.

Dedication

2h

Traffic and geometric design

Dedication

2h

Railways

Planning and determination of design criteria for a new railway line.

Dedication

2h

Teaching Methodology

The course consists of 4 hours per week of classroom activity.

The 2.5 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).

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.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

Grading Rules

(The evaluation calendar and grading rules will be approved before the start of the course.*

For assessment purposes, the course consists of two parts: Roads (C) and Railways (FC). Each part will be assessed through partial exams and assessable activities could be carried out.

The mark for the course will be the weighted arithmetic mean of the mark for each of these two parts:

Subject grade = $\frac{2}{3}$ C grade + $\frac{1}{3}$ FC grade.

In order to pass, the grade for the subject must be equal to or higher than 5.0.

The grade for each part will be obtained as described below:

In the case of Roads (C) there will be two midterm exams. The grade of C will be obtained by averaging both grades (50% each).

In the case of Railways (FC), one or two partial exams will also be carried out (depending on the distribution of classes during the course) and there could be evaluable activities. The FC grade will be obtained by weighting the grades from the exam or exams and, if any, from the evaluable activities in the percentages indicated by the professor in charge of teaching these classes.

In addition, once the course has been completed, a re-evaluation exam will be held for those students who, having obtained a numerical mark for the subject, do not obtain a mark of 5.0 or higher.

Once the re-evaluation exam has been carried out, the mark for the part will be considered to be the higher of the two obtained, per course and in the re-evaluation.

Grading criteria and admission to the re-evaluation: students failed in the ordinary assessment who have regularly sat the assessment tests for the failed subject will have the option to take a re-evaluation test in the period set in the academic calendar. Students who have already passed the re-evaluation test of a subject and students who have been marked as failed may not take the re-evaluation test of a subject. The maximum grade in the case of taking the re-evaluation exam shall be five (5.0) and shall be the grade obtained only in the re-evaluation exam. The non-attendance of a student summoned to the re-evaluation test, held in the fixed period, may not give rise to the taking of another test at a later date. Extraordinary evaluations will be carried out for those students who, due to accredited force majeure, have not been able

to take any of the continuous assessment tests.

These tests must be authorised by the corresponding Head of Studies, at the request of the lecturer responsible for the subject, and will be held within the corresponding teaching period.

Office Hours

Office hours will be announced at the beginning of each semester and published in the ATENEA. Consultations can be in person or online.

Bibliography

Basic

- Kraemer, C. [et al.]. [Ingeniería de carreteras: vol. I](#). 2a ed. Madrid: Mc Graw Hill, 2009. ISBN 9788448161101.
- Kraemer, C. [et al.]. [Ingeniería de carreteras: vol. II](#). Madrid: McGraw-Hill, 2003. ISBN 9788448139988.
- Ministerio de Fomento. [Secciones de firme: instrucción de carreteras Norma 6.1 IC](#). Madrid: Ministerio de Fomento. Dirección General de Carreteras, 2004. ISBN 8449806941.
- Transportation Research Board. [Highway capacity manual: a guide for multimodal mobility analysis](#). 7th ed. Washington, DC: National Academies Press, 2022. ISBN 9780309275620.
- López Pita, A. [Infraestructuras ferroviarias](#). Barcelona: Edicions UPC, 2006. ISBN 8483018535.
- López Pita, A. [Alta velocidad en el ferrocarril](#). Barcelona: Edicions UPC, 2010. ISBN 9788498804164.

Complementary

- Yoder, E.J.; Witczak, M.W. [Principles of pavement design](#). 2nd ed. New York, [NY] [etc.]: John Wiley & Sons, 1975. ISBN 0471977802.
- Huang, Y.H. [Pavement analysis and design](#). 2nd ed. Upper Saddle River: Pearson Prentice Hall, 2012. ISBN 9780132726108.