Transport Infrastructure (250235)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	7.5 ECTS
Programs	GRAU EN ENGINYERIA D'OBRES PÚBLIQUES (pla 2010)
Course	2023/24

Main teaching language at each group

- Group 10Q2 Spanish (Q1)

Faculty

Responsible Faculty: Adriana Haydee Martinez Reguero
Faculty: Carles Casas Esplugas, Eduardo Fernandez De Villalta Ferrer-dalmau, 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. 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

Competencies

Especific

Ability to construct, conserve, dimension and design roads and the items comprising basic road provision
Ability to construct and conserve railway lines with knowledge of the application of the specific technical regulations, differentiating the characteristics of the rolling stock
Ability to construct, conserve, dimension and design roads and the items comprising basic road provision
Ability to construct and conserve railway lines with knowledge of the application of the specific technical regulations, differentiating the characteristics of the rolling stock

Transversal

ENTREPRENEURSHIP AND INNOVATION - Level 1. Showing enterprise, acquiring basic knowledge about organizations and becoming familiar with the tools and techniques for generating ideas and managing organizations that make it possible to solve known problems and create opportunities.
ENTREPRENEURSHIP AND INNOVATION - Level 2. Taking initiatives that give rise to opportunities and to new products and solutions, doing so with a vision of process implementation and market understanding, and involving others in projects that have to be carried out.
SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Generic

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.
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.
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.
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.
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 phases. Students will learn to write progress reports for a design process, use a range of project management tools and prepare final reports, and will be expected to show an awareness of the basic economic concepts associated with the product, process or service in question.
Students will learn to identify user requirements, to draft definitions and specifications of the product, process or service in question, including a product design specification (PDS) document, and to follow industry-standard design management models. Students will be expected to show advanced knowledge of the steps involved in the design, execution and operation phases and to use the knowledge and tools covered in each subject area to the design and execution of their own projects. Finally, students will assess the impact of national, European and international legislation applicable to engineering projects.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	45.0 h	54.55 %
	Medium group	15.0 h	18.18 %
	Laboratory classes	15.0 h	18.18 %
	Guided Activities	7.5 h	9.09 %
Self Study		105.0 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 studies. Average recurrence interval. Runoff coefficient. Rainfall intensity. Reference flow.
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. Analitical methods. Empirical methods. Norma 6.1.-IC "Secciones de firme".
Pavment design problems. Norma 6.1-IC "Secciones de Firme".

5. Work units

Work units. Materials and tests.
Materials and tests.

6. Circulation

Traffic Variables. Relationships between traffic variables

7. Traffic studies

Traffic forecasting. Traffic studies "in situ"

8. Capacity and levels of services

Level of service (L.O.S.) in freeways.
Exercises

9. Introduction of geometric design

- Administration managing road infraestructures.
- 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.

10. 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

11. Vertical alignment

* Calculation axis.
* Grade inclination.
* Ramps and slopes
* The parabola.

Minimum parameters of the agreements.

Sag vertical curve.
Crest vertical curve

12. Cross section

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

Superelevation transition.

13. RAILWAYS

Rail networks and operational difficulties

14. RAILWAYS. Track and material

Main features of a road
Type of railway track

15. Circulation and increased cornering speed

Uncompensated acceleration and cant deficiency. Transition curves.
Uncompensated acceleration and cant deficiency. Transition curves.
Systems to increase velocity

16. Geometric quality

Parameters that define the geometric quality of the track. UIC criteria.

17. Vertical forces and track design

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.
Design of track components.

18. Turnouts

Equation of lateral displacement of the track.
Equation of the lateral displacement of the track. Derailment of a vehicle.

19. Turnouts

Turnouts.

20. Bridges and tunnels

Bridges and tunnels

Control

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

3h 30m

Traffic and geometric design

Dedication

4h

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.

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 directed activities.

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

Subject grade = 2/3 C grade + 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 2 mid-term exams and some evaluable activities to be carried out

during the course.

The grade for C will be obtained by weighting the marks for the mid-term exams at 80% and the assessable activities at 20%:

Grade C = 0.80 Mid-term exams + 0.20 assessable activities.

In the case of Railways (FC), there will also be one or two mid-term exams (depending on the distribution of classes during the course) and assessable activities. The FC mark will be obtained by weighting the marks for the mid-term exams at 80% and the assessable activities at 20%:

FC grade = 0.80 Control exams + 0.20 assessable activities.

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

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- Almazán Cruzado, D. Firmes y pavimentos : problemas resueltos. Madrid: García Maroto, 2015. ISBN 978-84-15793-86-1.
- Recuenco Aguado, E. Firmes y pavimentos : de carreteras y otras infraestructuras. Madrid: Colegio de Ingenieros de Caminos, Canales y Puertos, 2014. ISBN 978-84-1545-283-6.
- López Pita, Andrés. Infraestructuras ferroviarias. Barcelona: CENIT, Universitat Politècnica de Catalunya : Edicions UPC, 2006. ISBN 9788483018774.

Complementary

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