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250134 - CAMIFERR - Roads and Railways

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering

Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering

Academic year: 2018

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)

ECTS credits: 7,5 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: ADRIANA HAYDEE MARTINEZ REGUERO, JOSE RODRIGO MIRO RECASENS

Others: RAMON BOTELLA NIETO, CARLES CASAS ESPLUGAS, EDUARDO FERNANDEZ DE VILLALTA FERRER-DALMAU, BENEDICTO LIZCANO NUÑEZ, ADRIANA HAYDEE MARTINEZ REGUERO, FRANCESC XAVIER MASSALLE PUIG, JOSE RODRIGO MIRO RECASENS, JOSEP PEDRET RODES

Degree competences to which the subject contributes

Specific:

3041. Ability to construct, conserve, dimension and design roads and the items comprising basic road provision.

3042. Understanding of and ability to quantify the road and traffic variables determining the safety, quality and sustainability of road transport infrastructures.
3043. Ability to construct and conserve railway lines with knowledge of the application of the specific technical regulations, differentiating the characteristics of the rolling stock.
3044. Understanding of the theoretical models explaining the mechanical behaviour of the tracks, the interaction between track and train, and their influence on design specifications.

Generical:

3104. 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.
3110. 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 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.
3113. 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.

Transversal:

585. 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.
586. 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.
589. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
594. 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.
584. 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.

Teaching methodology

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

The 3.9 hours are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, and the 0.7 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. 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

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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

Study load

Total learning time: 187h 30m	Theory classes:	49h	26.13%
	Practical classes:	18h	9.60%
	Laboratory classes:	8h	4.27%
	Guided activities:	7h 30m	4.00%
	Self study:	105h	56.00%

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Content

0. Presentation subject

Learning time: 2h 24m

Laboratory classes: 1h
Self study : 1h 24m

1. ROADS - Traffic

Learning time: 19h 12m

Theory classes: 7h
Practical classes: 1h
Self study : 11h 12m

Description:
Circulation
Traffic Studies
Capacity and Service Levels
Traffic Exercises

Specific objectives:
Acquiring knowledge about:
Traffic Variables
Relations between traffic variables
Acquiring knowledge about:
Traffic forecasting
"In situ" Traffic studies
Acquiring knowledge about:
Definitions and determinants
Highways service levels
Service levels in 2-lane roads
Acquiring practical knowledge about:
Problems

Control

Learning time: 16h 48m

Laboratory classes: 7h
Self study : 9h 48m

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2. Alignment

Learning time: 33h 36m

Theory classes: 9h
Practical classes: 5h
Self study : 19h 36m

Description:
Fundamental parameters: speed and sight distance
Horizontal alignment
Practice of alignment sequence types
Practice of Horizontal alignment
Vertical alignment
Practice of vertical alignment
Cross section
Coordinated link design

Specific objectives:
Acquiring knowledge about:
Fundamental parameters: speed and sight distance
Acquiring knowledge about:
Horizontal alignment
Acquire knowledge:
problems of alignment sequence types
Acquiring practical knowledge about:
Horizontal alignment problems
Acquiring knowledge about:
Vertical alignment
Acquiring practical knowledge about:
Vertical alignment problems
Acquiring knowledge about:
Cross section
Acquiring practical knowledge about:
Coordinated link design

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3. Subgrades

Learning time: 19h 12m

Theory classes: 6h
Practical classes: 2h
Self study : 11h 12m

Description:

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.
Previous operations to earthworks. Removal, loading and transport. Embankment construction. Soil compaction machinery. Quality control. Rockfills. Transition material. Completion and refinement. Erosion protection.
CBR test. Plate load test.
Subgrade formation. Soil stabilization with lime and cement. Standard 6.1-IC "Secciones de firme." Deflections. Problems about subgrade bearning capacity..

Specific objectives:

Adquiring knowledge about: Cut and fill. Subgrade. Geological and geotechnical surveillance.Soil characteristics. Characterization tests. Soil classification (PG-3, ASTM, AASHTO, etc.).
Acquiring practical knowledge about:
Soil classification problems.
Acquiring knowledge about:
Factors affecting the process of compaction: moisture, compaction type and energy, soil type. Proctor test. Moisture and density measurement.
Acquiring knowledge about:
Previous operations to earthworks. Removal, loading and transport. Embankment construction. Soil compaction machinery. Quality control. Rockfills. Transition material. Completion and refinement. Erosion protection.
Acquiring knowledge about:
CBR test. Plate load test.
Acquiring practical knowledge about:
Subgrade formation. Soil stabilization with lime and cement. Standard 6.1-IC "Secciones de firme." Deflections. Problems about subgrade bearning capacity.

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4. Drainage	Learning time: 2h 24m Practical classes: 1h Self study : 1h 24m

Description:

Hydrological studies. Average recurrence interval.Runoff coefficient. Rainfall Intensity. Reference flow. Hydraulic studies. Cross drainage culverts. Surface drainage. Instruction 5.2-IC "Drenaje superficial". Water effect on the deterioration of the pavements. Design and calculation of sub-surface drainage. Underground drainage elements. Construction layout. Geotextiles: types, functions and applications. Drainage practice.

Specific objectives:

Acquiring practical knowledge about:
Hydrological studies. Average recurrence interval.Runoff coefficient. Rainfall Intensity. Reference flow. Hydraulic studies. Cross drainage culverts. Surface drainage. Instruction 5.2-IC "Drenaje superficial". Water effect on the deterioration of the pavements. Design and calculation of sub-surface drainage. Underground drainage elements. Construction layout. Geotextiles: types, functions and applications. Drainage practice.

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5. Pavements

Learning time: 33h 36m

Theory classes: 12h
Practical classes: 1h
Laboratory classes: 1h
Self study : 19h 36m

Description:

Description and functions of pavements. Factors that must be considered in the project. Basic materials and construction units. Pavement types: flexible, semi-rigid and rigid concrete. Shoulders. Surface and structural characteristics.
General principles of structural design. Analytical methods. Empirical methods. Instruction 6.1-IC "Secciones de firmes".
Pavement design problems.
Nature and source of aggregates. Properties of aggregates. Characterization tests. The filler. Functional characteristics of the mineral skeleton. Specifications.
Typology. Bitumen. Cut-backs. Fluidized bitumen and flux. Bituminous emulsions. Modified binders. Characterization tests. Specifications and applications of bituminous binders.
General characteristics of granular layers. Macadam. Graded aggregates. Specifications. General characteristics of the treated layers. Cement treated bases. Emulsion stabilized gravel. Other layers treated. Specifications.
Definition and purpose of surface treatments. Tack coats. Chip seals. Slurry seals. Specifications.
Definition and purpose. Types of bituminous mixtures. Properties. Dosage. Manufacturing hot and cold mixes. Laying, compaction and quality control of bituminous mixtures. Specifications.
Mixtures problems.
General characteristics. Pavement types. Underlying layers of pavement. Joints. Materials. Placing and quality control. Specifications.

Specific objectives:

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Acquiring knowledge about:
Description and functions of pavements. Factors that must be considered in the project. Basic materials and construction units. Pavement types: flexible, semi-rigid and rigid concrete. Shoulders. Surface and structural characteristics
Acquiring practical knowledge about:
General principles of structural design. Analytical methods. Empirical methods. Instruction 6.1-IC "Secciones de firmes".
Acquiring practical knowledge about:
Pavement design problems.
Acquiring knowledge about:
Nature and source of aggregates. Properties of aggregates. Characterization tests. The filler. Functional characteristics of the mineral skeleton. Specifications.
Acquiring knowledge about:
Typology. Bitumen. Cut-backs. Fluidized bitumen and flux. Bituminous emulsions. Modified binders. Characterization tests. Specifications and applications of bituminous binders.
Acquiring knowledge about:
General characteristics of granular layers. Macadam. Graded aggregates. Specifications. General characteristics of the treated layers. Cement treated bases. Emulsion stabilized gravel. Other layers treated. Specifications.
Definition and purpose of surface treatments. Tack coats. Chip seals. Slurry seals. Specifications.
Acquiring knowledge about:
Definition and purpose. Types of bituminous mixtures. Properties. Dosage. Manufacturing hot and cold mixes. Laying, compaction and quality control of bituminous mixtures. Specifications.
Acquiring practical knowledge about:
Mixtures problems.
Acquiring knowledge about:
General characteristics. Pavement types. Underlying layers of pavement. Joints. Materials. Placing and quality control. Specifications.

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6. RAILWAYS

Learning time: 52h 48m

Theory classes: 14h
Practical classes: 8h
Self study : 30h 48m

Description:

Rail networks and operational difficulties
Main features of a railway track
Types of rolling stock
Uncompensated acceleration and cant deficiency. Transition curves
Practice of Uncompensated acceleration and cant deficiency
Systems to increase the speed of movement
Parameters that define the geometric quality of the track. UIC criteria
Evaluation of vertical forces exerted by the vehicles
Mechanical analysis of the behavior of the railway track in front of vertical stress
Component design of the track
Equation of the lateral displacement of the track. Derailment of a vehicle
Practice of Equation of the lateral displacement of the track. Derailment of a vehicle
Lateral efforts and track design
Bridges and tunnels

Specific objectives:

Acquiring knowledge about:
Rail networks and operational difficulties
Acquiring knowledge about:
Main features of a railway track
Acquiring knowledge about:
Types of rolling stock
Acquiring knowledge about:
Uncompensated acceleration and cant deficiency. Transition curves
Acquiring practical knowledge about:
Uncompensated acceleration and cant deficiency problems
Acquiring knowledge about:
Systems to increase the speed of movement
Acquiring knowledge about:
Parameters that define the geometric quality of the track. UIC criteria
Acquiring knowledge about:
Evaluation of vertical forces exerted by the vehicles
Acquiring knowledge about:
Mechanical analysis of the behavior of the railway track in front of vertical stress
Acquiring practical knowledge about:
Component design of the track
Acquiring knowledge about:
Equation of the lateral displacement of the track. Derailment of a vehicle
Acquiring practical knowledge about:
Equation of the lateral displacement of the track. Derailment of a vehicle
Acquiring knowledge about:
Lateral efforts and track design
Acquiring knowledge about:
Bridges and tunnels

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Qualification system

For assessment purpose, the course consists of three parts: Traffic and Geometric Design, Earthworks and Pavements, and Railways.

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. Otherwise, the Mark will be the harmonic mean of the mark obtained in each of the three parts. 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 in the corresponding exam and assessable activity carried out during the course, weighted as 90% and 10% respectively for the part Railways, as 85% and 15% respectively for the part Traffic and Geometric Design, and for the part Earthworks and Pavements, in which there will be a supervised activity that will be developed during the course, its mark will be weighted as 80% and the supervised activity as 20%.

Students who do not attend any of the exams of the subjects will not have a numerical mark and their qualification will be NP.

Furthermore, at the end of the course, there will be a retaking exam for the students that, having a numerical mark, this is not equal to or higher than 5,0.

The retaking exam will be compulsory for the students that have one part mark lower than 4,0 and simultaneously 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.

Once the retaking exam has been carried out, the mark of the course will be obtained by applying the average, arithmetic or harmonic according to the marks of the parts obtained in this exam, of which the mark of the part obtained in the course will be considered only if it is equal to or greater than 4,0.

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.

The same evaluation method will be applied to the English group.

Regulations for carrying out activities

Students who do not attend any of the exams of the subjects will not have a numerical mark and their qualification will be NP.

Students that having attended the Earthworks and Pavements exam fail to perform the supervised activity in the scheduled period will result in a mark of zero in that activity. Similarly, students who have attended to the exam of Traffic and Geometric Design or Railways and have not participated in the assessable activities at the time established, will obtain a mark of zero in these activities.

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Bibliography

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Yoder, E.J.; Witczak, M.W. Principles of pavement design. New York, [NY] [etc.]: John Wiley & Sons., 1975. ISBN 0471977802.