Degree competences to which the subject contributes

Specific:

3079. Knowledge of the different types and basis for calculating prefabricated items and its application to the manufacturing processes
3080. Knowledge of the design, calculation, construction and maintenance of building works in regard to their structure, finishes, installations and equipment.
3084. Ability to use the appropriate construction procedures, construction machinery and planning techniques in carrying out works

General:

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 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:**

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 3 hours per week of classroom activity.

Two assessment activities (homework)

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of assessment activities and bibliography.

**Learning objectives of the subject**

Introduir a l'alumne en els aspectes relacionats amb la vida útil i comportament en servei de les estructures d'enginyeria civil (inspecció, manteniment i reparació d'estructures existents). L'objectiu és complementar els aspectes previs de planificació, projecte i construcció que s'han vist en altres assignatures de la titulació.

Introduce students to aspects of service-life and performance during operation of civil engineering structures, complementing the previous aspects of their planning, design and construction that have been seen in other subjects of the degree.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Theory classes:</th>
<th>42h</th>
<th>37.33%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical classes:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>3h</td>
<td></td>
<td>2.67%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>4h 30m</td>
<td></td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>63h</td>
<td></td>
<td>56.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Major defects and pathologies in structures</th>
<th>Learning time: 28h 47m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 11h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 16h 47m</td>
</tr>
</tbody>
</table>

**Description:**
Most common defects are presented through examples of real structures and highlight the most important points to keep in mind when doing the first visual inspection of a damaged structure.

The most common forms to reflect in a report the results of the inspection are presented, including an initial diagnosis of possible causes of deterioration. To this end, bibliographic material that may help in the process is presented.

- Defects in design phase (design of the structure, analysis and dimensioning)
- Defects in the quality of materials.
- Defects due to construction process
- Defects related to formwork and construction detailing

<table>
<thead>
<tr>
<th>Inspection and testing of concrete structures</th>
<th>Learning time: 14h 23m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Self study: 8h 23m</td>
</tr>
</tbody>
</table>

**Description:**
The basis of operation of non-destructive testing techniques most used in concrete structures are described. The technique of core sampling is explained and the main applications and several factors influencing the outcome of the compression tests are presented.

Main methods for estimating compressive strength of concrete based on the measurement of surface hardness are presented. The most relevant factors that can influence the outcome of the tests are also discussed. The ultrasonic methods for the assessment of compressive strength and modulus of deformation of existing concretes are presented. The main factors that may effect the results of the test are also presented and discussed.

<table>
<thead>
<tr>
<th>Inspection and testing of steel structures</th>
<th>Learning time: 4h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 2h 48m</td>
</tr>
</tbody>
</table>

**Description:**
The main methods of non-destructive inspection of steel structures are presented: penetrating liquids, magnetic particles, ultrasonic waves, radiography (X-ray), acoustic emission.
## Summary on non-destructive testing of concrete and steel structures

**Description:**
Summary. Comparison and applicability criteria of the NDT methods presented

**Learning time:** 2h 24m  
Theory classes: 1h  
Self study: 1h 24m

| Load Tests | Learning time: 9h 36m  
Theory classes: 3h  
Laboratory classes: 1h  
Self study: 5h 36m |
| --- | --- |
| **Description:**
Objectives of the static test. Verification of structural models. Load sources. Measuring instruments. Interpretation of results |
Objectives of the dynamic test. Dynamic excitation. Main sensors for measuring vibration. Interpretation of results |

| Materials for repair and strengthening | Learning time: 4h 48m  
Theory classes: 2h  
Self study: 2h 48m |
| --- | --- |
| **Description:**
Objectives of the surface preparation. Mechanical, thermal and chemical methods |
Mortars and concretes with inorganic base, organic base (organic polymer) and with added thermoplastic and thermostable polymers |

| Strengthening with reinforced concrete | Learning time: 7h 11m  
Theory classes: 3h  
Self study: 4h 11m |
| --- | --- |
| **Description:**
Introduction to the strengthening of structures. Variables to take into account in the strengthening of existing structures |
Jacketing methods for strengthening members in compression and bending are presented as well as additional methods of flexural strengthening |
<table>
<thead>
<tr>
<th>Topic</th>
<th>Learning time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengthening with structural steel</strong></td>
<td>7h 11m</td>
<td>It is explained how to take into account the changes in the structural layout of load transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strengthening of members in bending. Main issues and specific concepts</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Summary of repair and strengthening techniques</td>
</tr>
<tr>
<td><strong>Strengthening with prestressing and composite materials</strong></td>
<td>7h 11m</td>
<td>Introduction to the external prestressing. Main problems of on-site implementation: construction of deviators and anchoring blocks. Protection of cables for durability. Design problems. Introduction to composite materials (FRP). Main types of composite materials. Strengthening procedures for members in compression and bending. Failure modes. Failure by peeling and delamination</td>
</tr>
<tr>
<td><strong>Summary of repair and strengthening methods</strong></td>
<td>2h 24m</td>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Summary of repair and strengthening techniques</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Description:</strong></td>
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<td></td>
<td></td>
<td><strong>Learning time:</strong> 7h 11m</td>
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<td></td>
<td></td>
<td><strong>Learning time:</strong> 2h 24m</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Learning time:</strong> 9h 36m</td>
</tr>
</tbody>
</table>
Pathology and repair of pavements | Learning time: 9h 36m  
Theory classes: 3h  
Laboratory classes: 1h  
Self study: 5h 36m

Description:
Loads to be considered. Types of joints and linking details.  
Typical defects in execution stage: thickness placed, reinforcing and location. Characterization of concrete.  
Working stresses to be adopted.  

Qualification system
The mark of the course is obtained from the ratings of continuous assessment tests.
Continuous assessment consists on 3 evaluation tests and 2 activities, done individually, of additive and training characteristics, carried out during the year (both in and out of the classroom).
The evaluation tests consist on questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding.
Final grade is obtained with 80% of the evaluation tests and 20% of the activities.
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
Failure to perform a continuous assessment activity in the scheduled period will result in a mark of zero in that activity.
Bibliography

Basic:


Complementary:


