250109 - QUIMATER - Materials Chemistry

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 2017). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 7,5
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: LUCIA FERNANDEZ CARRASCO, SUSANA VALLS DEL BARRIO
Others: DIEGO FERNANDO APONTE HERNÁNDEZ, ANDREU CODINA MENDOZA, LUCIA FERNANDEZ CARRASCO, PATRICIA ROVIRA BASTUS, ISAAC TAN BACHS, SUSANA VALLS DEL BARRIO

Opening hours
Timetable: By appointment with the teachers responsible for each topic.
Coordinating Professor: Susanna Valls del Barrio.

By appointment with the professors responsible for each topic
Responsible English group: Prof. Ignasi Casanova.
B-1 109 - office

Degree competences to which the subject contributes

Specific:
3023. Theoretical and practical knowledge of the chemical, physical, mechanical and technological properties of the materials most commonly used in construction.

Transversal:
591. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
597. EFFECTIVE USE OF INFORMATION RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.
600. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
250109 - QUIMATER - Materials Chemistry

Teaching methodology

The course consists of 2.3 hours per week of classroom activity (large size group) and 2.3 hours weekly with half the students (medium size group).

The 2.3 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 2.3 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

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

Learning objectives of the subject

Students will acquire a theoretical and practical understanding of the chemical, physical, mechanical and technological properties of the most common construction materials.

On completion of the course, students will have acquired the ability to:
1. Identify and determine the composition and structure of construction materials using a variety of experimental techniques;
2. Design programs for analysing the materials of a specific structure or infrastructure;
3. Conduct critical appraisals of the results.

Basic scientific principles of materials chemistry (heat, equilibrium, atomic structure, crystals, polymers and gels); Structure, types and properties of construction materials (conglomerates, phase diagrams, corrosion); Experimental methods for determining the composition and structure of construction materials. Capacity of enforcement and quality control of construction materials, and understanding of its foundations.

Theoretical and practical knowledge of chemical, physical, mechanical and technological qualities of materials used in construction. 4.1 Identify, obtain the composition and structure of building materials, using different experimental techniques. 2.4. Design a program of analysis of materials of a structure or infrastructure. 4.3. Perform a critical assessment of the results of a materials testing program conducted in a structure. Basic scientific knowledge of chemistry of materials (heat, balance, spatial atomic crystals, polymers and gels). Knowledge of structure, type and properties of building materials (binders, phase diagrams, corrosion). Knowledge of experimental methods for determining the composition and structure of building materials.

Establish and consolidate basic chemistry concepts studied in the secondary school. If necessary, adequate tools will be provided to students so that they can follow the subject properly. Provide basic knowledge of the structure of matter and the interpretation of the chemical, physical and mechanical properties of materials from the atomic interactions to the establishment of relations between the microscopic structure and macroscopic properties. To study the main types of chemical processes, the factors that influence the performance of materials under service conditions. To provide basic knowledge and understand the chemistry of the most common building materials and processes of degradation they may suffer. To introduce students to the study of building materials used by the public works engineer in their professional practice, from the study of cementitious materials.
<table>
<thead>
<tr>
<th>Study load</th>
<th>Hours large group: 40h</th>
<th>21.33%</th>
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<tr>
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<td>Hours medium group: 22h</td>
<td>11.73%</td>
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<td>Hours small group: 13h</td>
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<td>Guided activities: 7h 30m</td>
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<td>Self study: 105h</td>
<td>56.00%</td>
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Total learning time: 187h 30m
## Content

<table>
<thead>
<tr>
<th>Module</th>
<th>Learning time</th>
<th>Description</th>
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| **Fundamentals of Chemistry** | 12h | Theory classes: 5h  
Self study : 7h |
| **Phase diagrams** | 9h 36m | Theory classes: 2h  
Practical classes: 2h  
Self study : 5h 36m |
| **Metallic materials and their durability** | 31h 12m | Theory classes: 7h  
Practical classes: 6h  
Self study : 18h 12m |
| **Binders (I)** | 14h 23m | Theory classes: 4h  
Practical classes: 2h  
Self study : 8h 23m |

### Fundamentals of Chemistry
- Atomic structure. Periodic table. Solids

### Phase diagrams
- Quantification of phases and compositions

### Metallic materials and their durability
- Interpretation Fe-C diagram, description of the different phases and microstructure as cooling temperature, percentage of phases formed, carbon content in the alloy and formed at each stage.
- Oxidation-reduction. Corrosion
- Electrochemical processes. Redox

### Binders (I)
- Clays: mineralogy, chemistry and applications in construction
- Plaster: mineralogy, chemistry and applications in construction. Standard
- Lime: mineralogy, chemistry and applications in construction
- Exercises
**Binders (II). Portland cement**

**Description:**
- Phase diagrams. Components and structure of clinker. Formation reactions.
- Hydration reactions. Determination of the heat of hydration. Stages in the development of the microstructure.
- Components and structure phases of hydrated cement paste. Techniques for monitoring hydration. Microstructure characterization techniques. Determination of $Ca / Si$.

**Learning time:** 33h 36m
- Theory classes: 9h
- Practical classes: 5h
- Self study: 19h 36m

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**Binders (III). Other cements and regulations**

**Description:**
- Cement with special characteristics. Cements with additions. Calcium aluminate cement.
- $RC-16$ cement regulations. Regulatory tests of cement.

**Learning time:** 14h 23m
- Theory classes: 6h
- Self study: 8h 23m

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**durability**

**Description:**
- Processes attack in the cement paste and its consequences: Attack of sulfates, chlorides, carbonation, dissolution / leaching, cation exchange reaction and alkali-granulate.
- The concept of chemical equilibrium and reactions.
- Concept solubility.
- Exercises solubility.
- The concept of acid-base reactions.
- Ionization.
- $pH$-meter.
- Salts.
- Acid-base exercises.

**Learning time:** 26h 24m
- Theory classes: 6h
- Practical classes: 5h
- Self study: 15h 24m
# Introduction to the study of the properties of building materials

<table>
<thead>
<tr>
<th>Learning time: 14h 23m</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Practical classes: 2h</td>
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<tr>
<td>Self study: 8h 23m</td>
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**Description:**
- Physical properties of materials
- Problems general properties: Physical

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# Laboratory Practices

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<th>Learning time: 9h 36m</th>
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<tbody>
<tr>
<td>Laboratory classes: 4h</td>
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<tr>
<td>Self study: 5h 36m</td>
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**Description:**
- Practice in the computer lab:
  - Instrumental technical to the identification of materials
  - Interpretation of various structures by XRD
- A session in the laboratory to perform two practices:
  - Consistency of cement, Vicat needle
  - Manufacturing mortars
  - And calculating the resistant class

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# Exams

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<th>Learning time: 14h 23m</th>
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<tr>
<td>Laboratory classes: 6h</td>
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<td>Self study: 8h 23m</td>
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Qualification system

Exercises to take (bi-weekly periodicity; 30% of the final grade)
• Partial exams (3; no eliminatory of subject matter; Each 20% of the final grade)
• Laboratory (10% of the total)
• Bonus (up to 10%)

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 laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.
It is an indispensable requirement to approve of the subject to have carried out the practices of laboratori (presencial session and non presencial session) and to have given the corresponding report and to have carried out activity 0 that will be proposed in the classroom.
Bibliography

Basic:


Callister, William D. Introducción a la Ciencia e Ingeniería de los Materiales. 3a. Reverté, 1995. ISBN 842917253X.


Complementary:


