250209 - QUIMMATER - Chemistry of Materials

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 PUBLIC WORKS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 7,5
Teaching languages: Catalan, Spanish

Degree competences to which the subject contributes

Specific:
3071. 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.

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.

Teaching methodology

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.

1. Identify and determine the composition and structure of construction materials using different 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

Settling and consolidating the fundamental concepts of chemistry acquired in the high school. In case this knowledge does not have themselves, to provide the students tools so that they can attain them and they allow them the correct follow-up of the subject.

Providing basic knowledge of the structure of the matter that allows the interpretation of the chemical, physical properties and mechanics of the materials from the atomic interactions, as well as the establishment of relations between its microscopic structure and its macroscopic properties.

Studying the main types of chemical processes, the factors that influence and the consequences that they entail.

Providing the basic knowledge that will allow to understand the chemistry of the most usual building materials, as well as of the processes of degradation that these can suffer.

Introducing the students into the study of the building materials used by the technical engineer of public works in his professional exercise, from the study of the conglomerants materials.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group:</th>
<th>55h</th>
<th>29.33%</th>
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<tbody>
<tr>
<td>Hours medium group:</td>
<td>14h</td>
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<td>7.47%</td>
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<tr>
<td>Hours small group:</td>
<td>6h</td>
<td></td>
<td>3.20%</td>
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<tr>
<td>Guided activities:</td>
<td>7h 30m</td>
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<td>4.00%</td>
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<tr>
<td>Self study:</td>
<td>105h</td>
<td></td>
<td>56.00%</td>
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Last update: 04-12-2018
| Topic 01. Introduction: Fundamental concepts and atomic structure | **Learning time:** 12h  
Theory classes: 5h  
Self study: 7h |
|---|---|
| **Description:**  

| Item 02. Phase Diagrams | **Learning time:** 9h 36m  
Theory classes: 2h  
Practical classes: 2h  
Self study: 5h 36m |
|---|---|
| **Description:**  
Definition of concepts: components, phases, solid solution, miscibility. Binaries and the lever rule  
Quantification of phases and compositions, use of the lever rule |

| Item 03. Metallic materials and durability | **Learning time:** 36h  
Theory classes: 9h  
Practical classes: 6h  
Self study: 21h |
|---|---|
| **Description:**  
Ferrous metals and their properties. Fe-C diagram. Non-ferrous metals  
Interpretació 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.  
Oxidació- reduction: Corrosion  
Piles eletroquímiques. redox |

| Topic 04. binders | **Learning time:** 9h 36m  
Theory classes: 4h  
Self study: 5h 36m |
|---|---|
| **Description:**  
Clays: mineralogical, chemical properties. Applications in construction  
Gypsum: mineralogy, chemistry and applications in construction. regulations  
Aerial and hydraulic lime |
### Topic 05. Formation and fabrication of the cement Portland clinker

**Learning time:** 14h 23m  
Theory classes: 4h  
Practical classes: 2h  
Self study: 8h 23m

**Description:**  
Phase diagrams. Bogue calculations

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### Topic 06. Portland cement and Microstructure of hydrated cement paste

**Learning time:** 12h  
Theory classes: 5h  
Self study: 7h

**Description:**  
Caracteristiques and properties of portland cement and nomenclature  
Hydration reactions. Determining the heat of hydration. Stages in the development of the microstructure.  
Components and structure of phases of the hydrated cement paste. Technical monitoring of hydration.  
Microstructure characterization techniques. Determination of Ca / Si.

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### Topic 07. Other cements: additions, special cement and CACtura and CAC

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

**Description:**  
Ciments characteristics. Cements with additions.  
Aluminous cement characteristics CAC  
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<table>
<thead>
<tr>
<th>Topic 08. Durability and degradation phenomena (solubility,...)</th>
<th>Learning time: 33h 36m</th>
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<tbody>
<tr>
<td><strong>Description:</strong> Processes attack in the cement paste and its consequences: Attack of sulfates, chlorides, carbonation, dissolution / leaching, cation exchange reaction and alkali-granulate</td>
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<tr>
<td>Concept of balance and chemical reactions</td>
<td></td>
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<tr>
<td>Concept review solubility and concentration (molarity, molality, % ...)</td>
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<tr>
<td>Exercises calculate concentrations, solubility and precipitates, product ion.</td>
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<tr>
<td>The concept of acid-base reactions</td>
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<tr>
<td>Ionization</td>
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<tr>
<td>pH</td>
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<tr>
<td>Salts</td>
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<td>Calculation of pH, introduction of salts in an aqueous solution and the pH variation</td>
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<tr>
<th>Topic 09. General properties of building materials</th>
<th>Learning time: 14h 23m</th>
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<td><strong>Description:</strong> Overview of the properties of construction materials. Physical properties: density, porosity, permeability, absorption capacity, thermal, electrical …</td>
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<td>General Properties: mechanics</td>
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<td>Solving exercises</td>
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<tr>
<th>Laboratory Practices</th>
<th>Learning time: 9h 36m</th>
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<td><strong>Description:</strong> Practice in the computer lab - instrumental techniques for identifying materials - Interpretation of various structures by XRD</td>
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</table>
| A session in the laboratory to perform two practices: - consistency of cement, Vicat needle - manufacturing mortars - and calculating the resistant class

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

2 exams will be:

EX1 30%
Topics:
1- atomic structure (bond, solid state)
2- phase diagrams
3- Metals and their durability (Fe-C diagram, properties and corrosion)

EX2: 50%
4- Binders and their regulations
5- Durability and attack processes in binders
6- Chemical Equilibrium, Acid-Base Reactions, Solubility
7- General Properties

20% of the grade will be: Laboratory grade (10%) + (10%) problems solved individually and / or in group sessions in class (attendance and class work)

The final grade will therefore be obtained from the following expression:

Final grade = 0.30 * EX1 + 0.50 * EX2 + 0.20 * (Laboratory score (10%) + solved problems individually and / or in class sessions (attendance and class work) (10%))

Practices will be evaluated on the basis of mandatory and personal reports to be submitted after each of the laboratory practices.

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 laboratoris (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:


Pardo, P. Apunts específics de l'assignatura. Apunts Campus digital,


Complementary:


