295705 - RMP - Recycling and Raw Materials

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 702 - CMEM - Department of Materials Science Science and Metallurgy
Academic year: 2019
Degree: BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Ruperez De Gracia, Elisa
Others: Maspoch Ruldua, Maria Lluïsa
Cailloux, Jonathan
Klotz, Magali
García Masabet, Violeta Del Valle

Opening hours

Timetable: It will be agreed with each of the teachers.

Prior skills

Basic knowledge of chemistry, formulation and thermodynamics of chemical reactions are required, as well as the main characteristics of the different families of materials.

Degree competences to which the subject contributes

Specific:
CEI-16. Understand the basic applications of environmental technologies and sustainability principles.
CEMT-22. Knowledge and application of materials technology in the production, transformation, processing, selection, control, maintenance, recycling and storage of all types of materials.

Transversal:
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

Teaching methodology

· The face-to-face activities consist of:
  · Theoretical classes in which the contents related to the different blocks of the syllabus are presented
  · Laboratory sessions in which practices related to the theoretical contents are carried out
  · Visits to companies: in order to know in more detail some of the theoretical concepts explained in class
  · Exhibition in the classroom of supervised works.

· Non-contact activity: Students work in a group on a monographic work on the extraction of metals, recycling of materials or waste treatment.

Learning objectives of the subject

The main objective of the subject is that the student has the ability to assess the environmental impact associated with
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the extraction of materials from natural resources and the advantages of recycling in order to achieve a sustainable ecosystem with a rational use of Non-renewable natural resources.

At the end of the course the student must:
- Adequately know the life cycle analysis as an environmental management tool to assess the environmental impact associated with a product during its entire life cycle.
- Keep in mind the optimization and innovation in the processes of extraction and recycling of materials in order to reduce the environmental impact.
- Be aware of the importance of optimal waste management and the recovery of non-recoverable waste in the environmental impact.

<table>
<thead>
<tr>
<th>Study load</th>
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<tbody>
<tr>
<td><strong>Total learning time:</strong> 150h</td>
<td></td>
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<tr>
<td>Hours large group:</td>
<td>45h</td>
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<tr>
<td>Hours small group:</td>
<td>15h</td>
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<tr>
<td>Self study:</td>
<td>90h</td>
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</table>
# 295705 - RMP - Recycling and Raw Materials

## Content

<table>
<thead>
<tr>
<th>Unit</th>
<th>Introduction to recycling</th>
<th>Learning time: 4h 30m</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Theory classes: 1h 30m</td>
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<td></td>
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<td>Self study: 3h</td>
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</table>

**Description:**
1. The materials throughout history. Annual production in the world.
2. Life cycle of a material.
3. History of recycling. The 3 R: reduce, reuse and recycle.
4. Types and waste management
5. Circular economy

<table>
<thead>
<tr>
<th>Unit</th>
<th>Life Cycle Analysis (LCA)</th>
<th>Learning time: 4h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory classes: 1h 30m</td>
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<td></td>
<td>Self study: 2h 30m</td>
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**Description:**
Life

<table>
<thead>
<tr>
<th>Unit</th>
<th>Polymers: Raw materials and recycling</th>
<th>Learning time: 45h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory classes: 1h 30m</td>
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<tr>
<td></td>
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<td>Practical classes: 4h</td>
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<td></td>
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<td>Self study: 27h 30m</td>
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</table>

**Description:**
Polímeros

<table>
<thead>
<tr>
<th>Unit</th>
<th>Recycling of urban solid waste. Technology and processes.</th>
<th>Learning time: 6h 30m</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory classes: 1h 30m</td>
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<tr>
<td></td>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
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<td>Self study: 3h</td>
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</tbody>
</table>

**Description:**
- Classification of waste
- Technology of waste treatment and recycling.

**Related activities:**
Visit to the public company TERSA dedicated to managing environmental services related to the circular economy, the valuation of municipal waste, the generation and commercialization of renewable energies.
## Unit 5. Introduction to extractive metallurgy: pyrometallurgy

**Learning time:** 15h 30m  
- Theory classes: 4h 30m  
- Practical classes: 2h  
- Self study: 9h

**Description:**  
- Extractive metallurgy: Pyrometallurgy and hydrometallurgy  
- Pyrometallurgy calcination, roasting of sulfuros and reduction of oxides. Ellingham diagrams  
- Pyrometallurgy: metallothermy and igneous electrolysis

**Related activities:**  
- Exercises related to Ellingham Diagrams  
- Practice 3. Recovery of noble metals: copellation

## Unit 6. Extraction and recycling of steel. Example of pyrometallurgical process.

**Learning time:** 11h  
- Theory classes: 3h  
- Practical classes: 2h  
- Self study: 6h

**Description:**  
- Primary metallurgy: extraction of steel from ore. Environmental impact analysis.  
- Continuous casting

## Unit 7. Introduction to extractive metallurgy: hydrometallurgy

**Learning time:** 4h 30m  
- Theory classes: 1h 30m  
- Self study: 3h

**Description:**  
- Leaching processes: static and dynamic  
- Extraction processes:  
  - Precipitation of a compound  
  - Extraction with organic solvents  
  - Ionic exchange  
  - Adsorption with activated carbon
## Unit 8. Extraction and recycling of aluminum

**Learning time:** 9h  
- Theory classes: 3h  
- Self study: 6h

**Description:**  
- Extraction of aluminum from bauxite:  
  - Bayer Process: Obtaining alumina from bauxite  
  - Hall-Heroult process: igneous electrolysis of alumina  
- Recycling of aluminum  
- Environmental impact

**Related activities:**  
Analysis of research articles on alternative processes to the extraction of aluminum to reduce the environmental impact

## Unit 9: Extraction of other metals: titanium, magnesium and copper

**Learning time:** 18h  
- Theory classes: 6h  
- Self study: 12h

**Description:**  
- Obtaining titanium: Kroll process and alternative methods  
- Obtaining magnesium:  
  - By electrolysis: Dow method and SOM process  
  - By thermal reduction: Pidgeon process  
- Obtaining copper: pyrometallurgical and hydrometallurgical processes  
- Environmental impact

**Related activities:**  
Analysis of research articles about alternative processes to the extraction of titanium and magnesium.

## Unit 10. Recycling of ceramic materials and glass

**Learning time:** 4h 30m  
- Theory classes: 1h 30m  
- Self study: 3h

**Description:**  
Unit 10. Recycling of ceramic materials and glass

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**Qualification system**

First partial: 20%  
Segon partial: 40%  
Practices + reports visits: 20%  
Monographic work: 20%
Bibliography

Basic:


Complementary:


Others resources:

Software CES Edupack 2018