295113 - 295II133 - Sustainable Materials

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 702 - CMEM - Department of Materials Science and Metallurgy
Academic year: 2018
Degree: ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: Maria Lluïsa Maspoch Ruldua
Others: Jonathan Cailloux
Orlando Santana

Opening hours
Timetable: The student must specify and fix the consultation with the professor via e-mail.

Prior skills
Scientific and technical education in materials science and engineering. Specifically, in the production, the transformation, the processing, the recycling and the storage of all type of materials which take into account sustainability concepts.

Requirements
No one is required

Teaching methodology
PM1: Traditional lecture with master classes (practical resources will be available on the UPC intranet Atenea)
PM2: Active learning in small groups with real case projects. Industrial seminars and/or visits are equally considered.
PM3: Collaborative learning with teamwork and teamwork presentation
PM4: Tutoring
PM5: Skills evaluation

It should be noted that this course is mainly based on self-learning (project based learning methodology), with a close tutoring accorded by the professor.

PM: pedagogical method

Learning objectives of the subject
- Raise student’s awareness of reduce, reuse and recycle materials
- Develop student knowledge of circular economy
- Enhancement of analytical and presentational skills
- Improvement of team working abilities and interpersonal communications
- Improvement of decision making attitude and personal initiatives to resolve real-life scientific problems
## Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td>22h</td>
<td>0h</td>
<td>4h</td>
<td>102h</td>
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<tr>
<td></td>
<td>14.67%</td>
<td>0.00%</td>
<td>14.67%</td>
<td>2.67%</td>
<td>68.00%</td>
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## Content

<table>
<thead>
<tr>
<th><strong>Material waste</strong></th>
<th><strong>Learning time:</strong> 25h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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<tr>
<td></td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 22h</td>
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**Description:**
Type of plastic wastes and the different alternatives for reusing them.

**Specific objectives:**
The seminar will provide general knowledge about waste reduction, circular economy and Ecodesign

<table>
<thead>
<tr>
<th><strong>Recycling materials</strong></th>
<th><strong>Learning time:</strong> 25h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 22h</td>
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**Description:**
What challenges face manufacturers who recycle material waste.
Explain the recycling hierarchy indicated by the terms primary, secondary, tertiary and quaternary recycling.
What materials are most commonly recycled from post-consumer sources and why?

**Specific objectives:**
Introduction of new concepts regarding material recycling together with the real-life issues who face manufactures during recycling process (i.e. separation, degradation, etc.)

<table>
<thead>
<tr>
<th><strong>Life cycle Assessment</strong></th>
<th><strong>Learning time:</strong> 25h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td></td>
<td>Self study: 22h</td>
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**Description:**
Introduction to the concept of life cycle assessment concept in order to assess the environmental impact associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance and recycling.

**Related activities:**
CES EduPack
## Bio-based polymers

**Learning time:** 25h  
Theory classes: 3h  
Laboratory classes: 0h  
Self study: 22h

**Description:**  
Bio-based polymers: a sustainable way to minimize plastic pollution?

**Specific objectives:**  
Introduction to bio-based polymers with a complete description of the different types, their productions and their applications.

## Circular economy seminar

**Learning time:** 5h 30m  
Theory classes: 1h 30m  
Laboratory classes: 0h  
Self study: 4h

**Description:**  
A circular economy seminar will be launched and expert presentations will take place.

## 1st project: Plastic waste collection, separation and recycling

**Learning time:** 15h  
Theory classes: 0h  
Laboratory classes: 15h  
Self study: 0h

**Description:**  
This first project is based in the initial collection of plastic taps followed by their separation according to the plastic type. In a second step, plastic wastes will be grounded, extruded and/or injection-moulded in order to manufacture new plastic items. The 3D printing of a recycled plastic filament may be also largely considered.

**Related activities:**  
Experimental work  
Team working  
Tutoring  
Deliverable reports  
Oral presentation and discussion of the obtained results.
2nd project: characterization of the previously manufactured plastic item

**Learning time:** 15h
- Theory classes: 0h
- Laboratory classes: 15h
- Self study: 0h

**Description:**
In this second project, each group will determine the physico-chemical, thermal, mechanical and morphological properties of its recycled plastic item.

**Related activities:**
- Experimental work
- Team working
- Tutoring
- Deliverable reports
- Oral presentation and discussion of the obtained results.

**Qualification system**

40 % End-of-course evaluation* and 60 % continuous assessment**

* End-of-course evaluation referred to as a written test
**Continuous assessment included collaborative work and oral presentations (25%), delivery of project reports (25%) and attendance to laboratories and industrial seminars (10%).

The re-evaluation grade replaces the final exam grade. In order to take the re-evaluation exam, laboratory reports as well as oral presentations must have been submitted.

**Regulations for carrying out activities**

It will be indicated for each activity

**Bibliography**

**Basic:**
- Circular economy in Europe: Developing the knowledge base, European Environment Agency.
- Recycling of Polymers: A review.