295566 - 295EQ222 - Polymer Transformation Processes

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering
713 - EQ - Department of Chemical Engineering

Academic year: 2019
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: Elaine Armelin Diggroc
Others: María Lluïsa Maspoch
Orlando Santana
Jonathan Cailloux

Opening hours
Timetable: To be specified according to the professors' availabilities.

Prior skills
Fundamental knowledge on chemical structure of polymers, classification, polymerization methods and polymer physics.

Requirements
Previous knowledge on other subjects related to polymer science (chemical of polymerization, polymer physics, properties).

Degree competences to which the subject contributes

General:
CGMUEQ-01. Ability to apply the scientific method and the principles of engineering and economics, to formulate and solve complex problems in processes, equipment, facilities and services, in which the matter undergoes changes in its composition, state or energy content, characteristic of the chemical industry and other related sectors among which are the pharmaceutical, biotechnological, materials, energy, food or environmental
CGMUEQ-02. To conceive, project, calculate and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and environment conservation

Transversal:
03 TLG. 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.

Learning objectives of the subject

b.
### Study Load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 36h</th>
<th>24.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>6h</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>6h</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>102h</td>
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</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Topic 1: Plastics for general purpose (commodity plastics)</th>
<th>Learning time: 23h 45m</th>
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<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 9h</td>
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<tr>
<td></td>
<td>Guided activities: 2h</td>
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<tr>
<td></td>
<td>Self study: 12h 45m</td>
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<tr>
<td>1. Knowledge on plastics for general purpose: Polyethylene (PE), Polipropylene (PP), Polyvinyl chloride (PVC) and Polystyrene (PS).</td>
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<tr>
<td>2. Chemical structures, properties, processing and recycling methods</td>
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<tr>
<td>3. Main applications and processing techniques</td>
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<tr>
<td>Related activities:</td>
<td>Work in the exercises proposed at classroom related to the plastic properties and polymer characterization</td>
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<thead>
<tr>
<th>Topic 2: Engineering plastics</th>
<th>Learning time: 20h 45m</th>
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<tbody>
<tr>
<td>Description:</td>
<td>Theory classes: 6h</td>
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<tr>
<td></td>
<td>Guided activities: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 12h 45m</td>
</tr>
<tr>
<td>1. Knowledge in main family of engineering plastics:</td>
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<tr>
<td>- Polycarbonates (PC)</td>
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<tr>
<td>- Polyesters: Polyethylenetereftalate (PET), Polybutylentereftalate (PBT).</td>
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<td>- Polyamides: Nylon 6, Nylon 6,6</td>
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<td>- Styrene copolymers: Acrylonitrile-butadiene-styrene (ABS), Styrene-acrylonitrile (SAN)</td>
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<td>- Acrylic plastics: Polymethacrylate (PMMA)</td>
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<td>- Polymers: Polyoxymethylene (POM)</td>
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<tr>
<td>2. Chemical structure, properties, recycling processes.</td>
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<tr>
<td>3. Main applications</td>
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</tr>
<tr>
<td>Related activities:</td>
<td></td>
</tr>
<tr>
<td>Work in the exercises proposed at classroom related to the plastic properties and polymer characterization.</td>
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</tr>
</tbody>
</table>
**Topic 3: Termosets and elastomers**

**Learning time:** 17h 45m  
Theory classes: 4h  
Guided activities: 1h  
Self study: 12h 45m

**Description:**
1. Knowledge on termoset materials: epoxy resins, polyuretanes (PUR), unsaturated polyesters, silicones; and elastomers: natural rubber (latex) and synthetic rubber (SBR, NBR, Neoprene, among others).
2. Chemical structure, properties, processing and recycling.
3. Main applications

**Related activities:**
Work in the exercises proposed at classroom related to thermosets and elastomers.

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**Topic 4: High performance polymers**

**Learning time:** 15h 45m  
Theory classes: 2h  
Guided activities: 1h  
Self study: 12h 45m

**Description:**
1. Knowledge on main family of high performance plastics: Polyimides (PI), Polyaryletercetones (PAEK), polytetrafluoroetilene (PTFE), polyesters aromatics (APE, PCT, PEN), polysulfones and polysiloxanes.
2. Estructuras, propiedades físico-químicas, procesado y reciclado.
3. Principales aplicaciones

**Related activities:**
Work in the exercises proposed at classroom related to the plastic properties and polymer characterization.

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**Topic 5: Polymer rheology**

**Learning time:** 17h 15m  
Theory classes: 3h  
Laboratory classes: 1h 30m  
Self study: 12h 45m

**Description:**
Knowledge on the fundamental of polymer rheology and the main assays carried out for viscosity measurements. Introduction to the fundamentals of plastic transformation.

**Related activities:**
Laboratory for practice on the measurement of melt flow index.
### Topic 6: Extrusion

**Learning time:** 17h 15m  
- Theory classes: 3h  
- Laboratory classes: 1h 30m  
- Self study: 12h 45m

**Description:**  
Main equipments and spindles used for the extrusion of plastics. Extrusion nozzles for the manufacture of different profiles as well as the corresponding calibrators. Analysis of the process and the influence of the different variables on the quality of the pieces. Knowledge on the techniques related to extrusion (Coextrusion, multilayer extrusion, extrusion blow, among others)  

**Related activities:**  
Extrusion process of thermoplastics.

### Topic 7: Injection

**Learning time:** 21h 45m  
- Theory classes: 6h  
- Laboratory classes: 3h  
- Self study: 12h 45m

**Description:**  
Knowledge of thermoplastic injection machines. Analysis of the process and the influence of the different variables on the quality of the pieces. Introduction to the design of molds, parts of a mold. Analysis of defects of injected parts, we will work with real pieces in class, and the causes and possible solutions to these defects will be analyzed. Injection by blowing.  

**Related activities:**  
Injection process of plastics.

### Topic 8: Other transformation techniques used in plastic processing

**Learning time:** 18h 45m  
- Theory classes: 3h  
- Laboratory classes: 3h  
- Self study: 12h 45m

**Description:**  
Description of the process of thermoforming and rotational molding. Advanced processing techniques: bicomponent injection, coinjection, gas assisted injection and water injection. Foaming and micro-foaming processes.
Final marks from formative evaluations:
Non-presencial and presencial activities (AD1+AD2) = 30%
Reports on laboratory practices (AP) = 10%
Practices exam (EPr) = 10%
Middle-term exam (EP) = 25%
Final exam (EF) = 25%
Final marks (Nf): 0.3*AD + 0.10*AP + 0.10*EPr + 0.25*EP + 0.25*EF

Regulations for carrying out activities

1. There will be supervised activities (type AD), with deliverables corresponding to the theory or problems approached at class, and the students will report the activities of laboratory practices (type AP). Furthermore, there will be another exam (EPr) with few questions related to the laboratory practices (over a total of 2-3 practices).
2. There will be a middle-term exam (EP) at the first part of our subject and a final exam (EF), with 2h of duration, to evaluate the individual progress of each student in this subject.
There is not any additional exam, related to recover the abovementioned marks (called "re-avaluació").

Bibliography

Basic:


Complementary:


Others resources:

Material to follow the theoretical and experimental classes will be available in Atenea digital platform.