240EQ231 - Polymer Technology I

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2017
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Optional) MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2012). (Teaching unit Optional)
ECTS credits: 6  Teaching languages: English

Teaching staff
Coordinator: SEBASTIAN MUÑOZ GUERRA
Others: Sebastián Muñoz Guerra, Jordi Puiggali Bellalta

Prior skills
Basic knowledge in organic chemistry and polymers

Requirements
"Polymers and Biopolymers" course

Degree competences to which the subject contributes

Transversal:
1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
2. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Teaching methodology
MD1, MD2, MD3.

Learning objectives of the subject
1) Know the chemical and physicochemical methods used for polymerization and copolymerization, the molecular mechanisms underlying these processes, their designing possibilities according to properties of the product, and the technologies used for its application on the manufacturing of polymers on both industrial and laboratory scales.
2) Know the available procedures for the chemical modification of polymers and biopolymers addressed to the modification of their properties, the chemical, thermal and environmental degradation processes, and to examine how these processes are followed and controlled by the appropriate chemical and physical analysis and tests.
3) Understand the theoretical principles governing the structure and performance of polymers both in solution and in the solid state and know the techniques used in the structural analysis of amorphous and crystalline polymers.
4) Understand the thermal and mechanical properties of polymers, their relation to the chemical and crystallographic structure, the techniques used for the calorimetric study and to monitor the crystallization phenomenon and the tests applied to evaluate the mechanical performance.
5) Know in a general way the specific properties of the polymers justifying its use as optical and electrical conducting materials or membranes, and introduce the study of multicomponent materials for its interest in improving the properties.
### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 0h 0.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h 0.00%</td>
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<tr>
<td></td>
<td>Hours small group: 54h 36.00%</td>
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<tr>
<td></td>
<td>Guided activities: 0h 0.00%</td>
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<tr>
<td></td>
<td>Self study: 96h 64.00%</td>
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</table>
# 240EQ231 - Polymer Technology I

## Content

<table>
<thead>
<tr>
<th>POLYMERIZATION I</th>
<th>Learning time: 18h</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 6h</td>
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<tr>
<td></td>
<td>Laboratory classes: 3h</td>
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<tr>
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<td>Self study: 9h</td>
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</table>

**Related activities:**
Troubleshooting exercises of practical and theoretical nature to deepen in the application of the concepts introduced in this topic.

**Specific objectives:**
Know the chemical and physicochemical methods of polymerization going through polycondensation and polyaddition mechanisms, and how they are applied to the preparation of polymers both in industry and laboratory.

<table>
<thead>
<tr>
<th>POLYMERIZATION II</th>
<th>Learning time: 10h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 1h 30m</td>
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<tr>
<td></td>
<td>Guided activities: 5h 30m</td>
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</table>

**Related activities:**
Troubleshooting of practical and theoretical exercises to deepen the implementation of the introduced concepts in this topic.

**Specific objectives:**
Determine the chemical and physicochemical methods of polymerization used in the polymers' synthesis of organometallic catalysts and by means of special mechanisms as these are applied to the preparation of polymers on an industrial scale or laboratory.
### COPOLYMERIZATION

**Learning time:** 10h  
Theory classes: 3h  
Laboratory classes: 1h 30m  
Self study: 5h 30m

**Description:**  

**Related activities:**  
Troubleshooting of practical and theoretical exercises to deepen the implementation of the introduced concepts in this topic.

**Specific objectives:**  
Know the chemical and physicochemical methods used in the synthesis of copolymers through different possible mechanisms, and as they are applied to the preparation and design of copolymers on both industrial and laboratory scales according to the properties to be achieved for these materials.

### POLYMERIZATION TECHNOLOGY

**Learning time:** 12h  
Theory classes: 3h  
Laboratory classes: 1h 30m  
Self study: 7h 30m

**Description:**  

**Related activities:**  
Troubleshooting of practical and theoretical exercises to deepen the implementation of the concepts introduced in this issue. Elaboration of a report on illustrative processing cases.

**Specific objectives:**  
Know the technologies used in industrial production of polymers according to the polymerization mechanism involved, the comparative advantages and disadvantages, and the systems and equipment needed. Acquire the basic criteria for the selection of the technology process that is suitable for the preparation of a given polymer.
### MODIFICATION AND DEGRADATION OF POLYMERS

**Learning time:** 10h  
- Theory classes: 3h  
- Laboratory classes: 1h 30m  
- Self study: 5h 30m

**Description:**  

**Related activities:**  
Troubleshooting to deepen the implementation of the concepts introduced in this issue and study illustrative cases.

**Specific objectives:**  
Know the available procedures for the chemical modification of polymers and biopolymers, how these reactions modify the properties of materials and the limitations of their practical application. Interpret the parameters defining the occurrence of chemical, thermal and environmental degradation, to elucidate the chemical mechanisms involved in the degradation processes and how these processes are studied and are followed by chemical and physical analysis.

### PHYSICAL CHEMISTRY OF POLYMERS

**Learning time:** 16h  
- Theory classes: 4h 30m  
- Laboratory classes: 3h  
- Self study: 8h 30m

**Description:**  

**Related activities:**  
Resolution of a collection of practical and theoretical exercises to deepen the implementation of the concepts introduced in this section.

**Specific objectives:**  
Determine the theoretical principles governing the performance of polymers in both dilute and concentrated solutions. Relate the theoretical concepts with practical application in both separation and fractionation processes, as in the characterization of blends or alloys, as well as in the basic characterization of polymeric materials.
### THE SOLID STATE. STRUCTURAL CHARACTERIZATION TECHNIQUES

**Learning time:** 13h  
Theory classes: 4h 30m  
Laboratory classes: 1h 30m  
Guided activities: 7h

**Description:**  

**Related activities:**  
Resolution of exercises designed to facilitate the understanding of the molecular organization in the crystalline state and deduction of the most characteristic structural parameters.

**Specific objectives:**  
Have a basic understanding of inter-and intramolecular interactions that determine the molecular organization in both the amorphous and crystalline states. Understand the crystallization process and learn to justify the morphologies derived therefrom. Introduce the main techniques used in structural analysis and be able to select the most suitable in order to solve a specific problem.

### THERMAL PROPERTIES OF POLYMERS: ANALYTICAL TECHNIQUES

**Learning time:** 10h 30m  
Theory classes: 3h  
Laboratory classes: 1h 30m  
Self study: 6h

**Description:**  

**Related activities:**  
Interpretation of a set of calorimetric data representative of different classes of polymers. Perform exercises that introduce the analysis of crystallization kinetics.

**Specific objectives:**  
Relate the chemical and crystallographic structure of a polymer with the thermal properties of both the amorphous and the crystalline states. Introduce the main techniques used in the calorimetric analysis of a polymer.
240EQ231 - Polymer Technology I

<table>
<thead>
<tr>
<th>MECHANICAL PROPERTIES OF POLYMERS: ANALYTICAL TECHNIQUES</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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<td></td>
<td>Laboratory classes: 1h 30m</td>
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<td>Self study (distance learning): 6h</td>
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**Description:**

**Related activities:**
Resolution of representative exercises paying special attention to the viscoelastic performance and rheological properties in general.

**Specific objectives:**
Gain knowledge of the different mechanical performance of materials and how they relate to their structure and the test temperature. Understand the effect of the variable time and relaxation mechanisms. Acquire knowledge about the diverse mechanical testing techniques.

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<tr>
<th>SPECIFIC PROPERTIES: MULTICOMPONENT SYSTEMS</th>
<th>Learning time: 10h</th>
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<tr>
<td></td>
<td>Theory classes: 3h</td>
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<td></td>
<td>Laboratory classes: 1h 30m</td>
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<tr>
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<td>Self study (distance learning): 5h 30m</td>
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</table>

**Description:**

**Related activities:**
Individual work on the properties of a given material, correlating them with the acquired knowledge about its structure.

**Specific objectives:**
Gain generic knowledge on the specific properties of the polymers justifying its use as optical materials, electrically conducting materials or membranes. Introduce the study of multicomponent materials and understand the interest in improving specific properties.

### Qualification system
IE1, IE3, IE4.
2 Partial exams (written exercises) and 1 Final exam (written exercise).
Reevaluation exercise (written exercise covering the non-passed subject part)
240EQ231 - Polymer Technology I

Bibliography

Basic:


Complementary: