Degree competences to which the subject contributes

By the end of the course the student will have to be able to:

1. Apply the scientific method in the resolution of advanced separation processes in the field of chemical engineering
2. Understanding of the theory concepts of the equipment, applications and the effects which the advanced separation processes produce on the quality of the products and its environmental impact.
3. Be able to evaluate current problems, applying the scientific method to solve practical problems
4. Propose and select the mathematical models describing the results, which allow to predict and simulate them
5. Ability to analyse in a critical way some of the current problems which have not yet been resolved in the field of chemical Engineering
### Study load

<table>
<thead>
<tr>
<th></th>
<th>Total learning time: 150h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group:</td>
<td>36h</td>
</tr>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>18h</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
</tr>
<tr>
<td>Self study:</td>
<td>96h</td>
</tr>
</tbody>
</table>

**Total learning time:** 150h

- **Hours large group:** 36h (24.00%)
- **Hours medium group:** 0h (0.00%)
- **Hours small group:** 18h (12.00%)
- **Guided activities:** 0h (0.00%)
- **Self study:** 96h (64.00%)
### 1. Process of membranes separation

**Learning time:** 25h  
- Theory classes: 10h  
- Practical classes: 4h  
- Self study: 11h

**Description:**  

**Related activities:**  
Resolution of problems

**Specific objectives:**  
Learn the basis of the operations with membranes, as well as the calculation methods and the design of the corresponding equipment

### 2. Extraction of solid-solid

**Learning time:** 17h  
- Theory classes: 4h  
- Practical classes: 3h  
- Self study: 10h

**Description:**  
Definition. Applications in the industry. Stages of the process. Extraction speed and characteristics of the solvent. Facts which affect the speed extraction. Ways of operating. Calculation of solid-liquid extraction. Equipment

**Related activities:**  
Resolution of problems

**Specific objectives:**  
Learn the basis of the operation, as well as the calculation methods and the design of the corresponding equipment
### 3. Extraction liquid-solid

**Learning time:** 17h  
- Theory classes: 5h  
- Practical classes: 3h  
- Self study: 9h

**Description:**  

**Related activities:**  
Resolution of problems

**Specific objectives:**  
Learn the basis of the operation, as well as the methods of calculation and the design of the corresponding equipment

### 4. Extraction of supercritical fluids

**Learning time:** 14h 10m  
- Theory classes: 4h  
- Practical classes: 2h  
- Self study: 8h 10m

**Description:**  
Definition and characteristics of the supercritical fluids. Physical-chemical properties of the supercritical fluids. Extraction with supercritical fluids: advantages and disadvantages. Liquid-fluid and solid-fluid balance. Equipment. Applications

**Related activities:**  
Resolution of problems

**Specific objectives:**  
Learn the basis of the operation, as well as the methods of calculation and the design of the corresponding equipment
### 5. Adsorption

**Learning time:** 14h 10m  
- Theory classes: 4h  
- Practical classes: 2h  
- Self study: 8h 10m

**Description:**  

**Related activities:**  
Resolution of problems

**Specific objectives:**  
Learn the basis of the adsorption operation, as well as the calculation methods and the design of the corresponding equipment

### 6. Ionic exchange

**Learning time:** 10h  
- Theory classes: 4h  
- Practical classes: 2h  
- Self study: 4h

**Description:**  
Basis: analogies and differences between the adsorption processes. Applications in the industry. Ion exchange resins: capacity of the resin. Balance between phases. Calculation in extractions of ion exchange by stages and differentials. Equipment

**Related activities:**  
Resolution of problems

**Specific objectives:**  
Learn the basis of the ion exchange, as well as the calculation methods and the design of the corresponding equipment
## 7. Crystallization

<table>
<thead>
<tr>
<th>Description:</th>
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</thead>
<tbody>
<tr>
<td>Basis: Growth and properties of the crystals, saturation, nucleation, speed of crystallisation. Applications in the industry. Effect of the impurities and the temperature. Agglomeration of crystals. Fractional crystallisation. Equipment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Related activities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution of the problems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
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</thead>
<tbody>
<tr>
<td>Learn the basis of the crystallisation operation, as well as the calculation methods and the design of the corresponding equipment.</td>
</tr>
</tbody>
</table>

### Learning time: 9h
- Theory classes: 2h
- Practical classes: 2h
- Self study : 5h

## Hybrid Processes

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>Definition of the hybrid process. Ways of operation. Hybrid process with membranes: reactors with membranes, distillation with pervaporation and other applications. hybrid processes with modified absorbers. Other hybrid processes. Study of the viability of the process</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Related activities:</th>
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</thead>
<tbody>
<tr>
<td>Two monitoring sessions during the semester</td>
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</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning of the project. Resolution of the doubts with the professors</td>
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</tbody>
</table>

### Learning time: 50h
- Theory classes: 7h
- Practical classes: 0h
- Self study : 43h

## Qualification system

<table>
<thead>
<tr>
<th>IE.1. Written exam 50%</th>
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<tbody>
<tr>
<td>IE.3. Questions, tests, problems, small reports 15%</td>
</tr>
<tr>
<td>IE.4. Formal reports 25%</td>
</tr>
<tr>
<td>IE.5. Oral expositions 10%</td>
</tr>
</tbody>
</table>
Bibliography

Basic:

Complementary: