Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
Teaching unit: 713 - EQ - Department of Chemical Engineering  
Academic year: 2019  
Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)  
ECTS credits: 6  
Teaching languages: Catalan

Teaching staff

Coordinator: Josep Maria Guadayol Cunill  
Others: Josep Maria Guadayol Cunill

Prior skills

Knowledge of technical English. Students will be expected to have passed the subjects on physical chemistry, fluid transport and heat transfer. Students lacking knowledge of these topics should not take this subject.

Degree competences to which the subject contributes

Specific:
1. CHE: Knowledge of material and energy balances, biotechnology, the transfer of materials, separation operations, chemical reaction engineering, the design of reactors, and the reuse and transformation of raw materials and energy resources.

Teaching methodology

- Face-to-face lecture sessions.  
- Face-to-face practical work sessions.  
- Independent learning and exercises.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.

Practical class work will be covered in three types of sessions:  
a) Sessions in which the lecturer will provide students with guidelines to analyse data for solving problems by applying methods, concepts and theoretical results (85%).  
d) Sessions in which students give presentations of group work (9%).  
d) Examination sessions (6%).

Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.
Group work will consist of longer, more complex exercises that require the application of the concepts covered in class. All group members (maximum three students) will be expected to work together to complete the exercises, especially in applications that require knowledge of many different concepts.

Students may come to office hours to resolve any doubts that may arise from the theoretical or applied content presented in class.

Learning objectives of the subject
3200671 - OB1 - Basic Operations I

In this subject, students will learn the fundamentals of the unit operations of chemical engineering. After a general overview, we will delve into the particulars of each operation. We will adapt, for the purposes of chemical engineering, operations that are not strictly chemical in nature but are applied in chemistry, and whose fundamentals are well understood (for example, dimensional analysis, heat transfer and fluid transport).

In addition, we will develop applications that provide a practical overview of the subject's theoretical content—a fundamental objective for any chemical engineer.

Groups of students will work on both theoretical and applied content.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>30h</th>
<th>20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>30h</td>
<td>20.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
# Content

## TOPIC 1: INTRODUCTION TO UNIT OPERATIONS

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Continuous and batch operations.</td>
</tr>
<tr>
<td>- Systems of units.</td>
</tr>
<tr>
<td>- Dimensional analysis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Mastery of the basic concepts used throughout the subject.</td>
</tr>
<tr>
<td>- Mastery of the SI system of units and knowledge of commonly used English units.</td>
</tr>
<tr>
<td>- An understanding of and ability to apply the principles of dimensional analysis, which is necessary in order to work with the dimensionless quantities that occur in laboratory data related to fluid-transport phenomena and unit operations.</td>
</tr>
<tr>
<td>- The ability to document, plan and conduct an open-ended experiment in a group under supervision.</td>
</tr>
<tr>
<td>- The ability to use techniques and computer tools to calculate, process and interpret data and present results.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study: 6h</td>
</tr>
</tbody>
</table>

## TRANSPORT OF FLUIDS

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Calculation and design of operations controlled by momentum transport and mechanical energy.</td>
</tr>
<tr>
<td>- Transport of incompressible fluids in chemical engineering</td>
</tr>
<tr>
<td>- Transport of compressible fluids in chemical engineering</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuing with the content introduced in Fluid Mechanics (third semester), we use examples from chemical engineering to review the concepts necessary to follow the subject:</td>
</tr>
<tr>
<td>- Application of the concepts of incompressible fluid mechanics to fluid statics and transport in chemical engineering</td>
</tr>
<tr>
<td>- Application of the concepts of compressible fluid mechanics to fluid transport in chemical engineering</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning time: 20h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td>Self study: 12h</td>
</tr>
</tbody>
</table>
### TOPIC 3: HEAT TRANSFER

**Description:**
- Fundamental considerations. Steady and transient states
- Heat transfer by means of conduction, convection and radiation
- Correlation for the calculation of convective heat transfer coefficients with and without phase change
- Overall heat transfer coefficient
- Introduction to heat exchangers
- Shell-and-tube heat exchangers
- Heat exchanger design
- Design combustion power-generation equipment (furnaces and boilers)

**Specific objectives:**
Continuing with the content introduced in Applied Thermodynamics and Heat Transfer (third semester), we use examples from chemical engineering to review the concepts necessary to follow the subject:
- Understand and differentiate between the concepts of steady-state and transient processes
- Understand and differentiate between the concepts of conduction, convection and radiation
In addition, the following new content will be presented:
- Convective heat transfer coefficients and identification of the applicable coefficient for a given situation
- Calculation of the overall heat transfer coefficient in any situation
- Selection and calculation of heat exchangers, taking into account the requirements of each situation
- Design of heat exchangers using the Kern method
- Calculation of single- and multiple-effect evaporators
- Calculation, design and selection of heat-transfer equipment and installations
- Design of combustion power-generation equipment
- Energy saving and efficiency applied to industrial processes

### OPERATIONS OF SEPARATION

**Description:**
- Evaporation
- Introduction to mass transfer
- Operations related with equilibrium
- Liquid-liquid extraction

**Specific objectives:**
- Familiarity with the theoretical basis of the calculation, design and selection of separation equipment.
- Familiarity with the basis of mass transfer
- An understanding of the concept operations based on equilibrium
- Knowledge and calculations about the evaporation operation
- Knowledge and calculations about the liquid-liquid extraction operation
Qualification system

- First examination: 25%
- Second examination: 25%
- Third examination: 25%
- Fourth examination: 25%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept. If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

Important note: To maintain a good friendly in the classroom and to achieve better benefit, remember that any system of electronic type (mobile phones, computers when not authorized, tablets, etc.) are strictly forbidden; if this rule is not followed, the doubts of the students during the course will not be answered, either in the classroom or personal consultations.

Regulations for carrying out activities

It is essential that students have knowledge of technical English, as it enables them to access a broader range of information on this subject. Therefore, the notes, PowerPoint slides and examinations for this subject will be in English.

Bibliography

Basic:


Complementary:


