



Universitat de Lleida

DEGREE CURRICULUM  
**UNIT OPERATIONS OF  
CHEMICAL PROCESSES**

Coordination: GARVIN ARNES, ALFONSO

Academic year 2022-23

## Subject's general information

<b>Subject name</b>	UNIT OPERATIONS OF CHEMICAL PROCESSES			
<b>Code</b>	14523			
<b>Semester</b>	1st Q(SEMESTER) CONTINUED EVALUATION			
<b>Typology</b>	<b>Degree</b>	<b>Course</b>	<b>Character</b>	<b>Modality</b>
	Master's Degree in Industrial Engineering	1	COMPULSORY	Attendance-based
	Master's Degree in Industrial Engineering	2	COMPULSORY	Attendance-based
<b>Course number of credits (ECTS)</b>	6			
<b>Type of activity, credits, and groups</b>	<b>Activity type</b>	PRAULA		TEORIA
	<b>Number of credits</b>	3		3
	<b>Number of groups</b>	1		1
<b>Coordination</b>	GARVIN ARNES, ALFONSO			
<b>Department</b>	FOOD TECHNOLOGY			
<b>Teaching load distribution between lectures and independent student work</b>	Classrom Work: 60h Independent student work: 90h			
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.			
<b>Language</b>	Catalan: 80 % Spanish: 20 %			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
GARVIN ARNES, ALFONSO	alfonso.garvin@udl.cat	6	

## Subject's extra information

A unit operation is each one of the steps that can be found in any industrial process (wheter chemical or not).

This subject studies the most usual and important unit operations in the chemical industrial proceses. So, it will consist of applying the Process Engineering to Chemical processes. All the concept that will be studied will be able to be used in any industrial process: food, biotechnology, chemist, etc.

The unit operations studied are the following:

- Distillation
- Solit/Liquid Extraction
- Humidification / Dehumidification / Drying
- Dessign of reactors

Prerequisites: To follow this subject properly, some previous knowledge on chemistry and mathematics are recommended.

## Learning objectives

The main aim of this subjtect is to know the classification of all the unit operations along with the fisical-chemical fundamentals and the mathematical models for the most important unit operations involved in the chemical industry.

1. To know the classificacion of all the unit operations as a function of the property transferred: mass, energy, mass-energy, momentum and other complementary unit operations.
2. To know how the following unit operations work:
  1. Distillation
  2. Solid-liquid extraction
  3. Drying
  4. Chemical reaction
3. To know the fundamentals of each unit operation.
4. To know the magnitudes, nomenclature and units for each unit operation.
5. To know how to obtain and work with the mathematical models for both each unit operation and each operation mode.
6. To know how to use the mathematical models so as to solve numerical problems related to the dessign and operation of the equipment needed for each unit operation.

## Competences

Basic competences:

- **CG6.** To have suitable knowledge of the scientific and technological issues of: mathematical, analytical and numerical methods in engineering, electrical engineering, energetic engineering, chemical engineering, mechanical engineering, mechanics of continuous means, industrial electronics, automation, manufacture,

material, quantitative methods of management, industrial computing, urbanism, infrastructures, etc.

- **CB3.** To be able to integrate knowledge and face complexity in order to make judgements from an information that, being incomplete or limited, it would include issues of social and ethical responsibilities directly related to the application of this knowledge and judgements.
- **CG7.** To project, calculate and design products, processes, installations and plants.
- **CG9.** To do research, development and innovation in products, processes and methods.

General Competences EPS:

- **CG2.** Capacity to consider the socioeconomic context as well as the sustainability criteria in the engineering solutions.

Specific competences set in ORDEN CIN/311/2009:

- **CE4.** Capacity for the analysis and design of chemical processes.
- **CE7.** Capacity to design electronic and industrial instrumentation systems.

Cross-disciplinary UdL competences:

**CT1.** Appropriate skills in oral and written language.

## Subject contents

0.- Introduction. Classification of unit operations.

### 1. Distillation

1. Introduction
2. Liquid-vapour equilibrium
  1. Partial pressure. Dalton, Raoult and Henry Laws.
  2. Relative volatility.
3. Distillation of binary solutions
  1. Simple distillation
  2. Flash distillation
4. Continuous rectification of binary solutions
  1. Number of plates
  2. reflux ratio
  3. In and out multiple streams
  4. Plate and column yield

### 2. Solid-liquid extraction

1. Introduction
2. Solid-liquid equilibrium
  1. Solution and solvent retention
  2. Triangular diagram
  3. Extraction operation methods
    1. One simple contact
    2. Repeated simple contact
    3. Multiple countercurrent contact

### 3. Drying

1. Introduction
2. Air-water interaction
3. Mass and energy balances
4. Drying mechanisms
  1. Period of constant drying rate
  2. Period of decreasing drying rate
5. Drying time
  1. Particle drying
  2. Tray drying
  3. Vibrating bed drying

4. Reactors designs *Disseño de reactores*
  1. Batch reactor
  2. Plug flow reactor
  3. Stirred tank reactor
  4. Real reactor

## Methodology

- Master classes: the concepts are introduced by the professor without the active participation of the students, although, obviously the students can ask as many questions as they need so as the exposed concepts sink in.
- Problems resolution: the professor introduce a complex question with the aim that all the students ans the very professor can solve it together in the same classroom.

## Development plan

Week	Method	Subject	Class Time	Student Time	Professor
1	Master Class	0.Introduction	2	3	A. Garvín
1 & 2	Master Class	T1	6	9,5	A. Garvín
3	Practical Cases	T1	4	6	A. Garvín
4 & 5	Master Class	T2	8	12	A. Garvín
6 & 7	Practical Cases	T2	8	12	A. Garvín
8	Master Class	T3. Introd.	2	3	A. Garvín
8	Master Class	T3.R.I.	2	3	A. Garvín
9	Written Test				A. Garvín
10	Practical Cases	T3.R.I.	4	6	A. Garvín
11	Master Class	T3.T.A.	1	1,5	A. Garvín
11	Practical Cases	T3.T.A.	3	4,5	A. Garvín
12	Master Class	T3.R.R.	3	4,5	A. Garvín
12 & 13	Practical Cases	T3.R.R.	5	7,5	A. Garvín
14 & 15	Master Class	T4	6	9	A. Garvín
15, 16 & 17	Practical Cases	T4	8	12	A. Garvín

18	Written Test			A. Garvín
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## Evaluation

Evaluation	Items	Evaluation activity	%	Week
1 <sup>st</sup> Part	1-2	Written test	50	9
2 <sup>on</sup> Part	3-4	Written test	50	17
Remedial exam	1-4	Written test	100	19

There will be a first call consisting of a continuous evaluation. If the first call is not approved, there will be a remedial exam. In order to pass the course, the mark has to be bigger or equal to 5.0.

The continuous evaluation will consist of two exams. The first one will take place in Novembre and will consist of two problems, one about item 1 and another about item 2. The second exam will take place in January and will also consist of two problems, one about item 3 and another about item 4. The mark of the first call will be the average of the 4 partial marks.

If the mark is less than 5.0, there will be another exam at the late January or at the early February. The student will be able to decide the items to be examined. The final mark will be the average between all the final partial marks for each item. Every student will also be able to try to increase the final mark by attending this exam and trying to solve the problem proposed for any specific item. In the case the problem is finally filed at the end of this exam, the mark for this specific item will be the new one, regardless of which mark is higher.

The students have to bring a calculator with ability to linear regressions. They can also bring all the documents attached in the virtual campus.

## Bibliography

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**IBARZ, A. y BARBOSA-CÁNOVAS, G.V. (2002).** “*Unit Operations in Food Engineering*”. CRC Press, Boca Ratón, FL.

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