



Universitat de Lleida

# DEGREE CURRICULUM

# **UNIT OPERATIONS OF CHEMICAL PROCESSES**

Coordination: GARVIN ARNES, ALFONSO

Academic year 2017-18

## 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>	Degree	Course	Typology	Modality
	Master's Degree in Industrial Engineering	1	COMPULSORY	Attendance-based
<b>ECTS credits</b>	6			
<b>Groups</b>	1GG			
<b>Theoretical credits</b>	6			
<b>Practical credits</b>	0			
<b>Coordination</b>	GARVIN ARNES, ALFONSO			
<b>Department</b>	TECNOLOGIA D'ALIMENTS			
<b>Teaching load distribution between lectures and independent student work</b>	Classroom 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 %			
<b>Office and hour of attention</b>	Office E2.2.15 Campus ETSEA Date set by mutual agreement with the teacher Phone: 973 70 29 07			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
GARVIN ARNES, ALFONSO	garvin@tecal.udl.cat	6	Open. Better ask for the professor's availability. Campus ETSEA. Office E2.2.15.

## Subject's extra information

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

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

The unit operations studied are the following:

- Distillation
- Solid/Liquid Extraction
- Humidification / Dehumidification / Drying
- Design of reactors

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

## Learning objectives

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

1. To know the classification 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 design 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 designsDisseño 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	Methodolgy	Items	Classroom hours	Student hours	Professor
1	Master class	0. Introduction	2	5	A. Garvín
1 i 2	Master class	1. Distillation	6	9	A. Garvín
3 i 4	Problems resolution	1. Distillation	6	9	A. Garvín
4 i 5	Master class	2. S-L Ext	4	6	A. Garvín
6	Problems resolution	2. S-L Ext	4	6	A. Garvín
7	Master class	3. Drying	4	6	A. Garvín
9	Evaluation. Written test.				A. Garvín
10	Problems resolution	3. Drying	2	3	A. Garvín
10 i 11	Master class	3. Drying	4	6	A. Garvín
11	Problems resolution	3. Drying	2	3	A. Garvín
12	Master class	4.1. Batch R.	2	3	A. Garvín
12	Problems resolution	4.1. Batch R.	2	3	A. Garvín
13	Master class	4.2. P.F.R.	1	1.5	A. Garvín
13	Problems resolution	4.2. P.F.R.	1	1.5	A. Garvín
14	Master class	4.3. S.T.R.	1	1.5	A. Garvín

14	Problems resolution	4.3. S.T.R.	3	4.5	A. Garvín
15	Master class	4.4. Real R.	4	6	A. Garvín
16	Problems resolution	4.4. Real R.	4	6	A. Garvín
17	Evaluation. Written test.				A. Garvín

## Evaluation

Evaluation	Items	Evaluation activity	%	Week
1 <sup>st</sup> Part	0-2	Written test	50	9
2 <sup>on</sup> Part	3-4	Written test	50	17
Remedial exam	0-4	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.

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

**IBARZ, A. y BARBOSA-CÁNOVAS, G.V. (1999).** “*Operaciones Unitarias en la Ingeniería de Alimentos*”. Technomic Publishing, Lancaster, PA.

**IBARZ, A. y BARBOSA-CÁNOVAS, G.V. (2005).** “*Operaciones Unitarias en la Ingeniería de Alimentos*”. Ed. Mundiprensa, Madrid.

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

BIRD, R.B.; STEWARD, W.E. y LIGHTFOOT, E.N. (1964). “*Fenómenos de Transporte*”. Ed. Reverté. Barcelona.

COSTA, J.; CERVERA, S.; CUNILL, F.; ESPLUGAS, S.; MANS, C. y MATA, J. (1984). “*Curso de Química Técnica*”. Ed. Reverté. Barcelona

COSTA, E.; SOTELO, J.L.; CALLEJA, G.; OVEJERO, G.; DE LUCAS, A.; AGUADO, J. y UGUINA, M.A. (1983,...). “*Ingeniería Química*”. Vol. I a VII. Ed. Alhambra. Madrid.

COULSON, J.M. y RICHARDSON, J.F. (1979...). "*Ingeniería Química*". Tomo I a VI. Ed. Reverté. Barcelona.

FOUST, A.S.; WENZEL, L.A.; CLUMP, C.W.; MAUS, L. y ANDERSEN, L. (1979). "*Principios de Operaciones Unitarias*". Ed. Cecs. México.

Geankoplis, C.J. (1983). "*Transport Processes and Unit Operations*", Allyn and Bacon, Boston. Versión en castellano de editorial C.E.C.S.A., México (1992).

McCABE, W.L. y SMITH, J. C. (1968). "*Operaciones Básicas de Ingeniería Química*". Ed. Reverté. Barcelona.

PERRY, R.H. y CHILTON, C.H. (1982). "*Manual del Ingeniero Químico*". Ed. McGraw-Hill.