

## Course guide

### 320062 - FEQ - Foundations of Chemical Engineering

Last modified: 19/04/2023

**Unit in charge:** Terrassa School of Industrial, Aerospace and Audiovisual Engineering  
**Teaching unit:** 713 - EQ - Department of Chemical Engineering.

**Degree:** BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** Catalan

#### LECTURER

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**Coordinating lecturer:** Manuel-Jose Lis Arias

**Others:**

#### PRIOR SKILLS

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Students will be expected to have passed Chemistry and Experimentation in Chemical Engineering.

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

2. 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

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- Face-to-face lecture sessions.
- Face-to-face practical work sessions.
- Independent learning and the resolution of case studies.
- Group study and resolution of a simple case of a chemical process.

In the lectures, the lecturer will introduce the theoretical fundamentals of the subject, concepts, methods and results, which will be illustrated with relevant examples to facilitate their understanding.

Practical class work will be covered in three types of sessions:

- a) Sessions in which the lecturer will provide students with guidelines on how to analyse processes and solve problems using simple calculus and problem solving software. (80%)
- b) Sessions in which the flowcharts students have compiled in groups will be discussed. (8%)
- d) Examination sessions (12%).

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.

#### LEARNING OBJECTIVES OF THE SUBJECT

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The introductory courses to Chemical Engineering have two clear goals:

- 1) To give students a better idea of how chemical processes turn raw materials into finished products for use by society.
- 2) To make students understand how chemical engineers take decisions and assess limitations in the design of new products and products.

By the time they have completed the subject, students should be able to draw the flowchart of a chemical process that is an approximation of real processes. This will include the selection of the separation or mixing technologies required, the determination of reasonable operating conditions, the integration of energy needs and the calculation of material and energy flows.



## STUDY LOAD

| Type               | Hours | Percentage |
|--------------------|-------|------------|
| Hours medium group | 30,0  | 20.00      |
| Hours large group  | 30,0  | 20.00      |
| Self study         | 90,0  | 60.00      |

**Total learning time:** 150 h

## CONTENTS

### TOPIC 1: THE TRANSFORMATION OF THE EARTH'S RESOURCES INTO USEFUL PRODUCTS

#### Description:

- Raw materials
- Balance equations
- Chemical reactions, chemical equilibrium
- Stoichiometry
- Generation-consumption: analysis

#### Specific objectives:

For students to:

- Define concepts such as raw products and finished products.
- Represent industrial processes and assess range.
- Determine in which units chemical processes occur.
- Study different chemical reactions based on examples.
- Assess reactive balance systems and their control variables.
- Use stoichiometry to assess balanced and unbalanced chemical reactions.
- Construct the stoichiometric matrices of an industrial process.
- Introduce the concept of balance in the component parts of a process.
- Draw block flow diagrams and process flow diagrams.

#### Related activities:

Related activity 1

#### Full-or-part-time: 24h

Theory classes: 5h

Practical classes: 4h

Self study : 15h

## TOPIC 2: PROCESS FLOWS: VARIABLES, FLOW DIAGRAMS AND BALANCES

### Description:

- Study of process flow diagrams
- Determination the variables of each current
- Block flow diagrams and equipment
- Material balance equations
- Degrees of freedom

### Specific objectives:

For students to:

- Identify the parts of an industrial chemical process.
- Differentiate mixing, separation and reaction zones.
- Identify the variables that must be considered in any given current.
- Define the degrees of freedom based on a flow diagram.
- Define the degrees of freedom in each processing unit.

### Related activities:

Related activity 1

**Full-or-part-time:** 17h

Theory classes: 3h

Practical classes: 4h

Self study : 10h

## TOPIC 3: MATHEMATICAL ANALYSIS OF MASS BALANCE EQUATIONS IN PROCESSES

### Description:

- Reaction advancement. Balanced and unbalanced. Chemical
- Linear equations
- Fractional conversion
- Balances in multiple-reaction systems
- Mixing and separation operations

### Specific objectives:

For students to:

- Understand the relationship between mass balances and the conservation law.
- Work with transitory components in equations.
- Know how to approach balances in multiple-reaction systems.
- Define useful specifications for the operation of a process under study.
- Develop well defined linear equation systems that define chemical processes.

### Related activities:

Related activity 1

Related activity 2

**Full-or-part-time:** 23h

Theory classes: 4h

Practical classes: 4h

Self study : 15h

#### TOPIC 4: SYNTHESIS OF REACTOR FLOW DIAGRAMS AND PROCESS CONDITIONS

**Description:**

- Major industrial chemical reactions
- Balance equations in chemical reactors
- Current composition specifications in reactors
- Fractional conversion and recycle
- Chemical balance and chemical kinetics

**Specific objectives:**

For students to:

- Calculate output current compositions in reactors from balances.
- Apply the principles of stoichiometry to input currents in reactors.
- Understand the concepts of selectivity and performance in chemical reactions.
- Understand balance equations and calculations from balance constants.
- Understand the influence of reaction kinetics in the calculation of balances in reactors.

**Related activities:**

Related activity 1

**Full-or-part-time:** 23h

Theory classes: 4h

Practical classes: 4h

Self study : 15h

#### TOPIC 5: SELECTION OF SEPARATION TECHNIQUES AND THEIR INCLUSION IN FLOW DIAGRAMS

**Description:**

- Differences in physical properties
- Classification of separation units
- Material balance equations in separations
- Recirculation in separation systems
- Separations based on balance
- Evaporation, condensation and distillation in balance
- Absorption, adsorption and extraction
- Separations for multiple stages

**Specific objectives:**

For students to:

- Define the properties that are decisive in the selection of separation operations.
- Define the different unit operations used in separation.
- Establish the criteria for detecting the presence of balances in order to choose the most suitable operation.
- Use specific case studies to select the optimum separation system.

**Related activities:**

Related activity 1

**Full-or-part-time:** 23h

Theory classes: 4h

Practical classes: 4h

Self study : 15h



## TOPIC 6: CALCULATION OF THE ENERGY IN PROCESSES AND ENERGY FLOW DIAGRAMS

### Description:

- Calculations of the energy in processes: basic notions
- Quantification of energy, data and equations
- Energy balances in processes
- Energy conversion processes
- Energy optimisation in processes: examples

### Specific objectives:

For students to:

- Ascertain the energy needs in a chemical process.
- Define the most suitable sources of energy to be used in a process.
- Use thermodynamic parameters in processes.
- Apply energy balances to cover the needs of a process.
- Optimise energy in chemical processes.

### Related activities:

Related activity 1

Related activity 2

Related activity 3

### Full-or-part-time: 40h

Theory classes: 10h

Practical classes: 10h

Self study : 20h

## ACTIVITIES

### RELATED ACTIVITY 1:

#### Description:

Evaluation of a global process diagram group

### RELATED ACTIVITY 2:

#### Description:

Delivery of 10 solved problems.

### RELATED ACTIVITY 3:

#### Description:

Oral Presentation Activity 1

## GRADING SYSTEM

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- 1st exam: 35%
- 2nd exam: 45%
- Presented workclass and activities: 20%

All those students who suspend, want to improve note or can not attend the partial exam, will have the opportunity to examine the same day of the final exam. If the circumstances do not make it feasible that it is the same day as the final exam, the teacher responsible for the subject will propose, via the Atenea platform, that the aforementioned recovery test will be carried out another day, during class hours .

The new note of the recovery exam will replace the old one only in case it is higher.

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.

## BIBLIOGRAPHY

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### Basic:

- Murphy, Regina M. Introducción a los procesos químicos: principios, análisis y síntesis. México D. F: McGraw-Hill, 2007. ISBN 9789701061992.
- Himmelblau, D.M. Principios básicos y cálculos en ingeniería química. 6ª ed. México D.F: Prentice-Hall Hispanoamericana, 1997. ISBN 9688808024.

### Complementary:

- Martínez de la Cuesta, P. J.; Rus Martínez, E. Operaciones de separación en ingeniería química. Madrid: Prentice Hall, 2004. ISBN 8420542504.
- McCabe, W. L.; Smith, J. C.; Harriott, P. Operaciones unitarias en ingeniería química. 7ª ed. Madrid: McGraw-Hill, 2007. ISBN 9789701061749.
- Chohey, N. P. Handbook of chemical engineering calculations [on line]. 3rd ed. New York: McGraw-Hill, 2004 [Consultation: 19/09/2022]. Available on : <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=4656321>. ISBN 9780071433266.