Universidad Zaragoza

Academic Year/course: 2022/23

27216 - Fundamentals of Chemical Engineering

Syllabus Information

Academic Year: 2022/23
Subject: 27216 - Fundamentals of Chemical Engineering
Faculty / School: 100 - Facultad de Ciencias
Degree: 452 - Degree in Chemistry
ECTS: 6.0
Year: 3
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The course Fundamentals of Chemical Engineering is compulsory and is part of the Fundamental module of the Degree. It has a teaching load of 6 ECTS and is taught in the first semester of the third year of the Degree.

It is a basic and introductory course on Chemical Engineering concepts that help to understand how chemical processes are carried out at industrial scale.

The subject is structured in two sections:
Section I: Introduction. Mass and Energy Balances in Steady State

Section II: Transport Phenomena, Application to Equipment Design and Introduction to Separation Unit Operations and Reactor Design

1.2. Context and importance of this course in the degree

The general objective of this subject is to acquire a practical vision of the discipline of Chemical Engineering and its relationship with Chemistry and the current Chemical Industry.

Like all the subjects of the Fundamental block of this undergraduate degree, this subject contributes to achieving the competencies and skills of this module, which constitutes the core of the Chemistry training that the future graduate receives. The objective of this module is to provide the student with the core of essential knowledge, experimental skills and attitudes in the different branches of Chemistry, complemented with specific transversal training. Therefore, the course aims to introduce students to the tools and basic knowledge of chemical engineering, to be able to face with a broad criterion the various problems that will arise in their profession.

The student will acquire the basis to carry out simple calculations associated with chemical processes, they will learn how to solve mass and energy balances, transport phenomena, and how to design basic separation unit operations and chemical reactors.

1.3. Recommendations to take this course

In this subject, it is advisable to have acquired several of the competencies disclosed in the basic module of the degree during the first and second years. Those acquired in the subjects of General Chemistry, Physics, Mathematics, Statistics, and Computer Science are considered especially necessary for the correct follow-up of the course; Introduction to the Chemical Laboratory and Chemical Laboratory are both also necessary.

The student is strongly encouraged to attend the classes, carrying out the exercises proposed as personal work, preparing, and solving the laboratory practice-related questions. Continuous study and active participation in the classroom are also recommended.

2. Learning goals

2.1. Competences

The student should:

1. Manage the terminology and basic nomenclature in Chemical Engineering.
2. Raise, develop and solve macroscopic mass and energy balances in different processes of the Chemical Industry.
3. Know the mechanisms of mass and heat transport phenomena and the mathematical equations that govern them.
4. Know and apply the transport equations between different phases in the design of mass transfer equipment.
5. Apply simple calculation methods in the analysis and sizing of equipment for heat and mass transfer and also to design chemical reactors (discontinuous plug flow and continuous stirred tank reactors).
6. Gather and interpret relevant data (normally within the study area of ??Chemistry) to make judgments that include a reflection on social, scientific, or ethical issues.
7. Understand and transmit information, ideas, problems, and solutions to both a specialized and non-specialized audience. Be able to express clearly orally and in writing, mastering the specialized language of the course.
8. Work in a team, organize, plan and make decisions.

2.2. Learning goals

The general objective of this subject is to acquire a practical vision of the discipline of Chemical Engineering and its relationship with Chemistry and with the current Chemical Industry.

Like all the subjects of the Fundamental core of the degree in Chemistry, this subject contributes to achieving the competencies and skills of this module, which constitutes part of the core of the training that the future graduate receives. The objective of this module is to provide the student with the core of essential knowledge, experimental skills, and attitudes in the different branches of Chemistry, complemented with specific transversal training. Therefore, the course aims to introduce students to the tools and basic knowledge of chemical engineering, to be able to face with a broad criterion the various problems that will arise in their profession. The bases of the calculations associated with chemical processes must be established, fundamentally resolution of mass and energy balances will be included as well as transport phenomena, basic separation unit operations and the design of chemical reactors.

2.3. Importance of learning goals

The course of Fundamentals of Chemical Engineering will allow students to acquire the knowledge and the basic tools essential for chemical engineering calculations needed in Chemistry and in the Chemical Industry. The laboratory practices carried out by the student in the framework of this subject will reinforce the contents, and at the same time, they will provide a practical vision of the subject.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The subject is evaluated continuously, by two independent sections according to its structure. The instruments for the evaluation of each section are diverse:
1. Written tests: two exams, one at the end of Section I and the other at the end of Section II.
2. Participation in class.
3. Laboratory practices.

To pass the subject it is necessary to pass Sections I and II independently. To pass each section it will be necessary to have reached a minimum score of 5 points (out of 10) in the individual written tests and in the laboratory practice questionnaires. Passing a section exam implies a grade ? 5, and exempts the student from taking the said section in the global written assessment test. However, in the global assessment test, the grade obtained in the laboratory and that of each passed section for the two calls will be saved, until September as long as the grade is equal to or greater than 5 points.

Section I: the total score will be the one obtained in the exam and the score could be upgraded thanks to the participation of the student in class up to 10%.

Section II: the total score will be as follows: 80% would be devoted to the written exam and 20% to the laboratory practices questionnaire. The score could also be upgraded thanks to the participation of the student in class up to 10%.

Students who do not choose ??for continuous assessment or who do not pass any section of the subject by this procedure or who want to improve the grade of any of the approved sections will have the right to take the global assessment test that will take place in the calls on February and September (you can only upload a grade for any of the section approved in the February call) and that will represent 100% of the grade. The global assessment test both in the first and second call will consist of a written exam and a laboratory practice session (for those students who have not passed or have not carried out the corresponding laboratory practices during the academic year). The written exam will include problems and theoretical-practical questions on the contents of Section I (50% of the final grade) and Section II (50% of the final grade).

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The course consists of 60 hours of which 48 hours will be devoted to lectures and problems and the remaining 12 hours will be used to carry out laboratory practices. The activities of laboratory practices will be carried out in Laboratory 1 of Building D of the Faculty according to the calendar that it was previously published. These practices will be carried out in teams of 2-3 students, according to the number of students enrolled. The questionnaires of the laboratory practices with the questions related to the development of the same and the data obtained will be delivered at the end of the corresponding practice. The

score obtained is the same for the whole team. The two written exams during the continuous or global evaluation will be focused on the contents reviewed during the course and those exams will be announced in the classroom, in the bulletin board of the Department of Chemical Engineering and Environmental Technologies and in moodle with the less two weeks in advance. The location and timetable for office hours (advisory meetings) will be established by each teacher and will be made public at the beginning of the course in the classroom, on the bulletin board of the Department of Chemical Engineering and Environmental Technologies and in moodle. The dates for the global evaluation test in first and second calls will be in accordance with the academic calendar of the Faculty of Sciences and will be available on its website : http://ciencias.unizar.es/web/horarios.do. This link will be updated at the beginning of each academic year.

4.2. Learning tasks

The course includes the following learning tasks:

- Section I. Introduction. Balances of Matter and Energy in Steady State 9 h Lectures (theoretical classes and problem solving and cases) 10 hours Classes of problem solving of Balances of Matter and Energy The 9 hours of lectures will be devoted:
    - Introduction to Chemical Engineering.
    - Basic nomenclature and calculation methods. Unit systems. Dimensional analysis. Conversion of units.
    - Macroscopic balances of matter and energy in processes of the chemical industry.
    - Systematic procedure for the realization of balances of matter in steady state with and without chemical reaction.
    - Balances of steady state energy with and without chemical reaction
    - Simultaneous balances of matter and energy in steady state. 2.
- Section II. Transport Phenomena, Application to Equipment Design and Introduction to Separation Operations and Reactor Design 21 hours Lectures (theoretical classes and problem solving and cases) 8 hours Class of problem solving 12 h Laboratory practices in small groups (teams of 2-3 students) The 21 h of lectures that will be devoted to:
    - Introduction to transport phenomena.
    - Transport mechanisms. Transport equations within a fluid in molecular regime. Boundary layer theory.
    - Transportation between phases. Individual and global transport coefficients.
    - Application to the design of heat exchangers.
    - Basics of separation operations. Equipment for contact between phases.
    - Introduction to the design of absorption columns.
    - Introduction to reactor design. Applied Chemical Kinetics.
    - Isothermal and Adiabatic Discontinuous stirred tank Reactor.
    - Isothermal and Adiabatic Continuous stirred tank Reactor.
    - Continuous Isothermal and Adiabatic plug flow Reactor.

The 12 h of laboratory practices will be distributed as follows: Each laboratory team consisting of 2-3 students will perform three of the five proposed practices according to the planning carried out by the teachers responsible for the course. The laboratory sessions will be 4 hours long (including the time to solve the questionnaire) and will be done towards the end of the semester. The practices corresponding to this Section are:

- Practice 1: Transfer of matter between phases: Absorption-Desorption G-L. Determination of individual coefficients of matter transfer.
- Practice 2. Transfer of matter between phases: Absorption with chemical reaction.
- Practice 3. Transfer of matter between phases: Extraction S-L. Contact mode, number of stages and separation factor.
- Practice 4. Transfer of matter between phases: Discontinuous distillation.
- Practice 5: Ideal Piston Flow Reactor. Influence of the operating conditions on the conversion. and Ideal Perfect Mixing Reactor. Association in Series of Ideal Reactors.

Thus, the total 60 hours taught in the course include 30 hours of lectures in the classroom with the entire group, 18 hours of problem solving and 12 hours of laboratory practices. The work of the student is distributed among the hours of study, problem solving, preparation of the practices, and written evaluation tests.

4.3. Syllabus

The course is divided in two sections. The following syllabus is intended to help the student the consecution of his/her formative training throughout the following activities:

Section 1: Introduction. Mass and energy balances in steady state.

	Hours present	**Activity**
	9 h	Master class (theoretical classes and exercises)

1.9 ECTS	10 h	Exercises

The 9 h of master classes will include:

- Chemical Engineering Introduction
- Nomenclature and unit systems; dimensional analysis; units conversion.
- Mass and energy balances in steady state in chemical processes.
- Mass balances in steady state with and without chemical reaction.
- Simultaneous resolution of mass and energy balances in steady state.

Section 2: Transport phenomena. Unit Operations and Processes. Reactor Design.

	Hours present	**Activity**
4.1 ECTS	21 h	Lectures
	8 h	Exercises
	12 h	Lab practices (2 people groups)

The 21 h of master classes will include:

- Introduction to Transport Phenomena
- Transport mechanisms. Transport equations in laminar flow regime. The boundary layer.
- Individual and global transport coefficients.
- Heat exchanger design
- Fundamentals of separation processes. Distillation
- Design of absorption and stripping towers.
- Reactor design. Chemical reaction kinetics.
- Discontinuous reactors
- The continuous plug flow reactor model
- The continuous flow stirred-tank reactor

12 h of laboratory practices will be distributed as follows:

Each couple will carry out 3 laboratory practices, two related to Section 1 (laboratory practices 1a to 4a) and one related to section 2 (laboratory practices 5).

Each laboratory practice will last 2,5h. Each couple will carry out 2 practices from the 4 included in Section 1:

- Practice 1a: Gas/liquid absorption/desorption. Determination of individual mass transport coefficients.
- Practice 2a: Ion exchange. Determination of the breakthrough curve.
- Practice 3a: Extraction solid/liquid. Analysis of the contact mode, temperature and number of stages.
- Practice 4a: Discontinuous distillation.
- Practice 5a: continuous plug flow reactor model. Influence of the reaction conditions on the conversion. The continuous flow stirred-tank reactor. Reactors in series.
- Practice 6: Resolution of problems of Block II interactively with students (3h) and exposure of the questionnaires of practices (1h).

4.4. Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Facultad de Ciencias web (https://ciencias.unizar.es/grado-en-quimica-0).

Specific dates of the different activities will be announced during the classes, bulletin boards or by ADD (Moodle2 Platform).

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=27216