COURSE DATA

Data Subject	
Code	33996
Name	Bases for Chemical Engineering
Cycle	Grade
ECTS Credits	6.0
Academic year	2024 - 2025

Study (s)

Degree	Center	Acad. year	Period
1103 - Degree in Food Science and Technology	Faculty of Pharmacy and Food Sciences	1	Second term

Subject-matter

Degree	Subject-matter	Character
1103 - Degree in Food Science and Technology	14 - Chemical engineering	Obligatory

Coordination

Name	Department
FERNANDEZ DOMENE, RAMON MANUEL	245 - Chemical Engineering
SANCHEZ TOVAR, RITA	245 - Chemical Engineering

SUMMARY

The subject Bases of Chemical Engineering is an obligatory subject that is given in the first year of the Degree in Science and Food Technology. In the curriculum of the University of Valencia has a total of 6 ECTS. This course aims to give students an overview of chemical engineering, and training in the management of the key tools for analysis and design of any process unit, the balances of properties and the rate equations. These skills are the bases necessary for the study of the basic operations of the food industry and know the fundamentals of the operations taking place in processing and preserving food.

Being the subject in the Degree in Science and Food Technology, teachers consider the study of the chemical process must be directed focused at areas of greatest interest and value to the food industry.

The subject is eminently applied, so that to the theoretical components must be added the practical, both numerical resolution of questions and problems that simulate real situations in which they apply theoretical concepts introduced, in order to familiarize the students with the operation mode of the processes of the food industry.

In particular, they want the students being able to apply and solve mass and energy balances in the units that are part of the typical processes of the food industry, to know the mechanisms and equations governing the transportation of property, especially in making reference to heat transfer due to its special importance in processing and preserving food and to begin the knowledge and design of chemical reactors.

The general **objectives** of the course are:

- Understand the scope of chemical engineering and its relationship with the food industry.
- Understand, apply and solve mass and energy balances.
- Understand the mechanisms and rate equations of property transport: diffusive flow and convective flow.
- Understand the mechanisms of heat transfer: conduction, convection and radiation.
- Understand, describe and size chemical reactors.
- Interpret correctly the information about a problem and translate it into process variables and / or operating equipment.
- Be able to develop a problem correctly, understandable and organized.
- Be able to analyze the results of a problem.

The course **contents** are: Chemical process. Unit Operation. Operation modes of the food industry. Conservation Equations: Material and Energy Balances. Transport mechanism. Rate equations. Heat Transfer: Conduction, Convection and Radiation. Chemical Reactors: classification and design equations.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

To successfully complete the subject is essential that the student possesses a previous knowledge of mathematics and chemistry.
Among such background knowledge is included:
- Thermodynamics: heat of reaction and equilibrium
- Reaction rate and chemical kinetics
- Management of logarithms and exponentials
- Solving systems of linear equations
- Solving linear and non linear equations
- Immediate resolution integral

- Solving simple differential equations

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1103 - Degree in Food Science and Technology

- Develop skills to undertake further study.
- Capacidad de interpretar datos relevantes.
- Control and optimise processes and products in the food industry.
- Develop new processes and products in the food industry.
- Poseer y comprender los conocimientos en el área de Ciencia y Tecnología de los Alimentos.
- Manufacture and preserve food.
- Saber aplicar esos conocimientos al mundo profesional, contribuyendo al desarrollo de los Derechos Humanos, de los principios democráticos, de los principios de igualdad entre mujeres y hombres, de solidaridad, de protección del medio ambiente y de fomento de la cultura de la paz.
- Know the modes of operation of the food industry.
- Know, apply and solve mass and energy balances to calculate flows, compositions, temperatures and energy needs of processes in the food industry.
- Know the mechanisms and equations of property transfer rate: convective flow and diffusive flow.
- Know the mechanisms of heat transfer.
- Apply the equations for conductive heat flow to calculate the thickness of insulation.
- Apply the equations for convective heat flow to calculate the size of concentric-tube heat exchangers.
- Apply the equations for reaction rate and mass and energy balances to design chemical reactors.
- Interpret information regarding a problem and translate it into process variables or variables of operation of equipment.
- Ser capaz de analizar los resultados de un problema.
- Ser capaz de integrarse y participar activamente en tareas de grupo.
- Ser capaz de distribuir el tiempo adecuadamente para el desarrollo de tareas individuales o de grupo.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

The student should be able to:

- List and describe the operation methods of the food industry, and their advantages and disadvantages.
- Perform and interpret the flow chart of a process.
- Interpret and translate correctly into equations or data the variables of a problem.
- Set up and solve the macroscopic material balances in systems without chemical reaction in steady state, to calculate flow rates and compositions of the streams involved in the process of the food industry.

- Set up and solve the macroscopic material balances in systems without chemical reaction and non-steady state to determine the variation in composition and / or mass of the system.
- Set up and solve energy balances, in systems without chemical reaction at steady state, to calculate the temperatures of the streams involved in the process of the food industry and / or the energy needs of a process of the food industry.
- Set up and solve energy balances in systems without chemical reaction in non-steady state to determine the temperature variation of a system.
- Set up and solve the mechanical energy balance to calculate the energy consumption of pumps driving fluids.
- Identify the mechanisms and rate equations of heat transfer.
- Apply and solve the equations for conductive heat flow at steady state to determine the temperature distribution in a material.
- Apply and solve the equations for conductive heat flow at steady state to calculate the thicknesses of insulation.
- Apply and solve the equations for conductive heat flow in non-steady state to determinate the temperature distribution in a material.
- Apply the equations for the convective flow of heat to the sizing of double pipe heat exchangers.
- Apply the reaction rate equations and material and energy balances to the sizing of chemical reactors.

Also the development of several generic skills will be encouraged, among which are included:

- Capacity for analysis and synthesis.
- Ability to interpret relevant data.
- Ability to communicate ideas, problems and solutions.
- Ability to argue from rational and logical criteria.
- Ability to speak properly and organized.
- Ability to develop a problem in a systematic and organized order.
- Ability to critically analyze the results of a problem.
- Ability to work independently.
- Ability to integrate and actively participate in group tasks.
- Ability to properly distribute the time to develop individual and group tasks.

DESCRIPTION OF CONTENTS

1. INTRODUCTION TO CHEMICAL ENGINEERING

Industrial activity.- Food Industry and Chemical Engineering.- Chemical Process.- Unit Operations. Definition.- Forms of operation of the chemical industry. Discontinuos and continuous operation. Steady state and unsteady state. Election of the type of process.- Transport Phenomena. Transport mechanisms. Reynolds Experiment.- General approach to systems analysis and design.

2. MATERIAL BALANCES

Property balances around an environment.- Material balance. Total balance. Material balance applied to a component.- Application of material balance in systems without chemical reactions. Steady-state systems. Unsteady state systems.

3. ENERGY BALANCES

Introduction.- Total energy balance. General expression. Expression of the various terms.- Application of energy balance. Steady-state systems. Unsteady state systems.- Thermal energy balance.- Balance of mechanical energy

4. RATE EQUATIONS

Introduction.- General equation for molecular transport. Molecular transport of heat energy: Fourier's law of conduction. Molecular transport of momentum: Newton's law of viscosity. Molecular material transport: Fick's law of diffusion.- Rate equations for turbulent transport. Individual transport coefficients. Estimation. Global transport coefficients

5. HEAT TRANSFER

Mechanisms of heat transfer.- Heat conduction in steady state. Simple transport of heat. Driving on a material plane geometry. Driving in a material of cylindrical geometry. Driving in a material of spherical geometry. Driving through various materials in series .- Heat conduction in unsteady state. Approach the equations of variation. Analytical solution of the differential equation of energy conservation. Graphical solution. Application to bodies of finite dimensions .- Introduction to the design of heat exchangers. Classification of heat exchangers. Double pipe heat exchangers. Nomenclature. Design equations. Integration of the design equations.

6. INTRODUCTION TO CHEMICAL REACTORS DESIGN

Generalities.- Thermodynamics: Heat of reaction and chemical equilibrium reaction.- Reaction rate and chemical kinetic.- Classification of reactors.- Study of ideal reactors. Stirred tank batch reactor. Continuous stirred tank reactor. Continuous tubular reactor- Heterogeneous reactors.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	53,00	100
Tutorials	2,00	100
Seminars	2,00	100
Development of group work	12,00	0
Development of individual work	2,00	0
Study and independent work	30,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	5,00	0
Preparation of practical classes and problem	5,00	0
Resolution of case studies	15,00	0
Resolution of online questionnaires	1,00	0
TOTAL	**147,00**	

TEACHING METHODOLOGY

The development of the course is structured around five topics: theoretical classes, practical classes of problems, seminars, proposed work and tutoring. In the theoretical classes the model of lecture will be used. The teacher will present and explain the relevant contents of each theme. Practical classes of problems will be developed following two different models. In one of them the teacher will solve a series of sample problems to show how to identify the essential elements of solving the problems of the subject. In other type of problems the students, individually or arranged in groups, will solve similar problems under the supervision of the teacher. Whenever possible, the Sustainable Development Goals will be used to contextualize the problems raised and solved in class. The SDG related to environmental sustainability (SDG 12: Responsible Consumption and Production) will be used more specifically.

In seminars students will present to the group a topic proposed by the teachers of the subject, to be developed with the guidance and supervision of them. The proposed work the student will be divided into three types: problems of similar complexity to those of the exams, numerical questions and questionnaires and self-correcting tests performed on the Virtual Classroom to assess the learning level of the most important concepts of each topic. All proposed works will have a timetable for completion and delivery. And for the tutorials, students will attend to them in small groups. It will be programmed activities aimed to prepare the most important concepts of each topic. Also, the teacher will discuss and clarify general aspects of the subject and individual questions. In these sessions the work submitted by students will be returned duly corrected, and the issues and errors arisen in its resolution will be clarified.

EVALUATION

The assessment of student learning will take place following two models:

A) From the notes of the activities of students, the note of the seminar and the exam.

B) From the notes of the seminar and the exam.

Attendance at seminars and tutorial sessions is obligatory in both models of evaluation. Not attending without justifiable cause coordinated seminars sesions, involve a zero mark corresponding to the seminar evaluation.

To choose the mode of assessment A) the student must have done at least 80% of the activities submitted. Beyond this requirement to qualify for this type of evaluation, the final grade is obtained as the greater of:

- The weighting between the average grade of the exam (70%), the average score of the activities submitted multiplied by the factor number of activities submitted / number of activities proposed (20%) and the rating of the seminar (10%).

- The weighting of the average grade of the examination (90%) and the rating of the seminar (10%).

In mode B) the final grade is obtained from the weighting of the average grade of the examination (90%) and the rating of the seminar (10%).

The examination includes both theoretical and practical issues and problems. To pass the course an average (weighted, if necessary) of the different parts of the exam higher than 45 (of 100) is required.

To pass the course it will be necessary to obtain a grade equal or higher than 50 points (out of 100).

REFERENCES

Basic

- Ingeniería de la Industria Alimentaria (Volumen I)
  J. Aguado, J. A. Calles, P. Cañizares, B. López, F. Rodríguez, A. Santos, D. Serrano (Ed. Síntesis, 2002)

Additional

- Introducció a lEnginyeria Química
  A. Aucejo y colaboradores (Barcelona: Portic, 1999)
- Introducción a la Ingeniería Química
  G. Calleja (Ed. Síntesis, 2008)
- Curso de Ingeniería Química
  J. Costa López y colaboradores (Ed. Reverté, 2000)

- Ingeniería Química
  E. Costa Novella y colaboradores (Ed. Alhambra, 1986)
- Principios elementales de los procesos químicos
  R. M. Felder, R. W. Rousseau (3a ed. Limusa, 2008)
- Cálculo de Balances de Materia y Energía
  E. J. Henley, E. M. Rosen (Ed. Reverté, 2002)
- Ingeniería de las Reacciones Químicas
  O. Levenspiel (3a ed. Limusa, 2010)
- Material and Energy Balances
  G. V. Reklaitis (Ed. Wiley, 1983)