COURSE DATA

Data Subject	
Code	34756
Name	Basis of chemical engineering II
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1401 - Degree in Chemical Engineering	School of Engineering	2	First term

Subject-matter

Degree	Subject-matter	Character
1401 - Degree in Chemical Engineering	14 - Foundations of chemical engineering	Obligatory

Coordination

Name	Department
ALVAREZ HORNOS, FRANCISCO JAVIER	245 - Chemical Engineering
DEJOZ GARCIA, ANA MARIA	245 - Chemical Engineering

SUMMARY

The subject *Basis of Chemical Engineering II* is part of the same name subject-matter whose overall objective is that students acquire and apply the basic principles of chemical engineering for subsequent application to the design and analysis of the operation of chemical reactors and unit operations of the process industry. It is a compulsory subject that is taught in the second year of the Degree in Chemical Engineering during the first four-month period. The curriculum consists of a total of 6 ECTS.

This course aims to provide the knowledge of the fundamentals of momentum, heat and mass transfer processes, by introducing two fundamental tools for analysis and design the chemical or physical process: microscopic balances and rate equations, establishing the necessary basis for the study of design equipment in the process industries.

This is a subject with a practical component in which, after the introduction of the concepts, it will be conducted numerous exercises and experimentation in the laboratory.

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

- To acquire and to properly use the basic terminology and nomenclature of chemical engineering.
- To know the laws governing the momentum, heat and mass transfer in any physical or chemical process, to tackle then the equipment design of the chemical process industry.
- To use databases, empirical equations or estimation methods in order to calculate the physical, thermodynamic or transport parameters for the equipment design.
- To develop the skills to solve numerical problems in transport phenomena, and to interpret the results.
- To enhance skills in reasoning and systematic work.
- To develop skills for working in the laboratory and for data collection, processing and reporting results, focusing on the experimentation in the field of chemical engineering.

The course **contents** are: Fundamentals of Transport Phenomena. Unit Operations. Introduction to Chemical Engineering Laboratory.

Observations: The theory classes will be taught in Spanish and practical and laboratory classes as stated in the course sheet available on the website of the degree.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

Solving systems of algebraic and differential equations
Rectangular, cylindrical and spherical coordinates systems
Chemical reaction kinetics and elemental stoichiometric calculations
Conservation laws
Balance approach

OUTCOMES

1401 - Degree in Chemical Engineering

- G3 - Knowledge of basic and technological subjects that allows students to learn new methods and theories and provides them with versatility to adapt to new situations.
- G4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering.

- G5 - Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and analogous work.
- TE1 - Knowledge of material and energy balances, biotechnology, matter transfer, separation operations, chemical reaction engineering, reactor design, and valorisation and transformation of raw materials and energy resources.
- TE3 - Ability to design and manage applied experimental procedures, especially for determining thermodynamic and transport properties, and modelling of phenomena and systems in the field of chemical engineering, systems with fluid flows, heat transfer, matter transfer operations, kinetics of chemical reactions and reactors.

LEARNING OUTCOMES

Learning outcomes

- To know and distinguish the different transport mechanisms in chemical engineering (G3, G5 and TE1 competencies).
- To know the rate equations governing the transport phenomena (G3, G5 and TE1 competencies).
- To know the most common unit operations, distinguishing the property transferred (G3 and TE1 competencies).
- To interpret and extract the information needed to solve problems (G3, G4, G5, TE1 and TE3 competencies).
- To select and apply appropriate mathematical methods to solve problems (G3, G4, G5, TE1 and TE3 competencies).
- To can handle apparatus and devices of industrial application (G4, G5 and TE3 competencies).
- To make measurements with accuracy and precision (G4, G5 and TE3 competencies).
- To critically analyze the results obtained by solving the problems or making lab practices (G3, G4, G5, TE1 and TE3 competencies).
- To write clearly, understandably and organized reports of work done in the laboratory (G4, G5 and TE3 competencies).
- To find, select and understand the information in specialized literature sources (G3, G4 and G5 competencies).
- Acquire ability to work in groups.

Skills to acquire

The student should be able to:

- Identify and describe the rate equations for molecular transport processes.
- Explain the differences between balance equations and rate equations.
- Find, calculate or estimate the values of the transport properties and predict their variation with pressure and temperature.
- Explain the differences of laminar and turbulent flow, as well as the causes of the turbulence origin.
- Define the concepts of individual and overall transport coefficients, and set out the rate equations for transport between phases.
- Estimate the individual transport coefficients and their dependence on the physical properties of fluids and flow characteristics.
- Write the definitions of the dimensionless modules of Reynolds, Prandtl, Schmidt, Nusselt and

Sherwood, calculate its values and interpreting its physical sense.
- Extracting information from the statement of a problem and the flow chart of a process.
- Interpret and translate as variables the data of a problem.
- Correctly interpret other data, definitions and relationships of the process and take the form of equations.
- Set out the appropriate boundary conditions for the integration and resolution of transport problems.
- Set out problems of laminar fluid motion.
- Set out problems of molecular transport of energy.
- Set out problems of molecular transport of matter.
- Set out problems of mass transfer between phases.
- Set out problems of heat transfer between phases.
- Solve process transfer problems by applying appropriate mathematical tools.
- Interpret and reason out the results of a problem.
- Conduct experiments of property transfer.
- Interpret and report experimental results.

In addition to the specific objectives mentioned above, the subject will encourage the development of several **social and technical competencies**, including the following:

- Capacity for analysis and synthesis.
- Ability to interpret relevant data.
- Ability to communicate in a properly and organized way.
- Ability to argue from rational and logical criteria.
- Ability to communicate ideas, problems and solutions.
- Ability to develop a problem in a systematic and organized way.
- Ability to critically analyze the results of a problem.
- 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 TRANSPORT PHENOMENA

Transport Phenomena in Chemical Engineering. Transport mechanisms. Concept of unit operation. Classification of unit operations.

2. RATE EQUATIONS IN MOLECULAR TRANSPORT

Concept of rate equation. Momentum transport. Newton's law of viscosity. Heat Transfer. Fourier law of conduction. Mass transfer. Fick's law of diffusion. General unidirectional rate equation. Estimate of transport properties.

3. INTRODUCTION TO DESIGN EQUATIONS IN MOLECULAR TRANSPORT

Combining the property balances and the velocity laws: Equation of Motion, Equation of Energy and Diffusion equation.

4. UNIDIRECTIONAL STEADY STATE MOLECULAR TRANSPORT

Applying the design equations to the resolution of unidirectional molecular transport at steady state problems.

5. UNSTEADY STATE MOLECULAR TRANSPORT

Unidirectional transport in finite media. Simplified solution. Application to finite-dimensional bodies.

6. INTRODUCTION TO INTERPHASE TRANSPORT. TRANSPORT COEFFICIENTS

Definitions of individual transport coefficient. Interphase transport. Overall transport coefficients. Estimation of transport coefficients: semi-empirical equations and analogies between transport phenomena.

7. DESIGN EQUATIONS IN TURBULENT TRANSPORT

Property balances. Representation on the phase or equilibrium diagrams. Rate equations. Combination of the balances with the rate equations: design equations. Applying the equations to the design of basic operations.

8. LABORATORY OF BASIS OF CHEMICAL ENGINEERING II

Reynolds experiment. Determination of the viscosity of mixtures and their variation with temperature. Calculations and reporting. Sessions of autonomous resolution of complex problems.

WORKLOAD

ACTIVITY	Hours	% To be attended
Classroom practices	33,00	100
Theory classes	15,00	100
Laboratory practices	12,00	100
Development of group work	20,00	0
Development of individual work	20,00	0
Preparation of evaluation activities	25,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the subject is structured around the theoretical and problem classes, laboratory practices and performing work.

In the theoretical classes model of lecture will be used. The teacher will present and / or explain the main contents of each issue to highlight those key aspects for subject understanding. (G3, G5 and TE1 competencies).

Practical sessions of problems will be developed following two models. In some of the classes, the teacher will solve a series of sample problems in order to teach students to identify the essential elements of the problem approach and resolution. In other practical sessions the students will solve similar problems. After the work has been completed, the problems will be collected, analyzed and corrected. (G3, G4, G5 and TE1 competencies).

The proposed work to the student during the theoretical and practical classes will be carried out individually and it will consist of: Theoretical Questions (G3, G5 and TE1 competences), Numerical Questions (G3, G4, G5 and TE1 competencies) and Problems (G3, G4, G5 and TE1 competencies). After correction, the students will be informed of their results and a summary of the most consolidated and more frequent failures.

Laboratory practice sessions, they will be developed following three models. An experimental laboratory session where some activities will be programmed to introduce the practice to be carried out and the experimental activities to acquire the laboratory data, which will be carried out entirely by the students under the supervision of the teacher; a session of analysis and treatment of the obtained data from the laboratory experiments; and two sessions of autonomous resolutions of problems.

The proposed work to the student during the laboratory practice sessions will be carried out in-group and it will consist of: Laboratory report (G3, G4, G5, TE1 and TE3 competencies) and Complex Problems (G3, G4, G5 and TE1 competencies).

EVALUATION

Attendance to the laboratory sessions is a **mandatory** activity to overcome the subject. In addition, the experimental laboratory session is a **non-recoverable activity**.

FIRST AND SECOND CALL

Assessment in the **first and second call** will be conducted through the evaluation of a final exam, of the theoretical questionnaire, of the activities carried out throughout the course (problems, in-person questionnaires) and of the laboratory activities (report and complex problems).

The final grade of the subject, as long as the minimum marks and the conditions explained below have been met, will be obtained as the greater of:

Final Mark= 0.4·(NE) + 0.2·(NCT) + 0.1·(NPR) + 0.1·(NC) + 0.2·(NL)

Final Mark = 0.6·(NE) + 0.2·(NCT) + 0.2·(NL)

<u>Exam (NE)</u>: The note corresponding to this section will be obtained from the mark obtained in a **Final Exam of the whole subject** that will consist of a part of practical questions and of a part of problems. The minimum mark of the exam will be 5.0 out of 10.

<u>Theoretical Questionnaires (NCT):</u> In the first call, the note corresponding to this section will be obtained from the weighted average of the marks obtained in two questionnaires solved individually by the student throughout the course. In the second call, the note corresponding to this section will be obtained from the mark obtained in a questionnaire solved on the official date. It will be had to obtain a minimum score of 3.5 out of 10.

<u>Problems (NPR):</u> The note corresponding to this section will be obtained from the marks obtained in the problems solved individually delivered throughout the course.

<u>Questionnaires in-person (NC):</u> The note corresponding to this section will be obtained from the marks obtained in the in-person questionnaires solved individually by the student throughout the course.

<u>Laboratory (NL):</u> The note corresponding to this section will be obtained from the mark obtained in the report of the experimental practice (50%) and the delivered complex problems (50%). The minimum mark in the experimental practice report is 5.0 out of 10.

In order to pass the subject, the **Final Mark** obtained must be equal to or greater than 5 out of 10. The final mark of students who have not passed the course for having obtained in the Final Exam, in the Theoretical Questionnaires or in the experimental practice report marks less than the minimum required, will be the lowest of them.

If the subject is not exceeded, in the first call, by having obtained a grade lower than 5.0 in the report of the experimental practice, it must be submitted again the report on the second call on the date established.

The Not Presented grade will only be assigned if the final exam (NE) is not carried out.

In any case, the evaluation system will be governed by the established in the Reglament d'Avaluació i Qualificació de la Universitat de València per a Títols de Grau i Màster (http://links.uv.es/7S40pjF).

According to the Regulation of the advanced call to complete the studies of Degree (ACGUV 30/2015), the Academic Grade Commission establishes that in this subject it is not possible to request the advanced call if it has not been exceeded, prior to the request, the laboratory practices.

Competences evaluation:

- Activities (scoring and non-scoring): G3, G4, G5 and TE1 competencies
- Exams: G3, G4, G5 and TE1 competencies
- Laboratory practice assistance: G3, G4, G5, TE1 and TE3 competencies
- Reports: G3, G4, G5 and TE3 competencies

REFERENCES

Basic

- Fenómenos de Transporte
R. B. Bird, W. E. Stewart, E. N. Lightfoot
Reverté, 1964
- Ingeniería Química. Tomo 2. Fenómenos de Transporte
E. Costa Novella y otros
Alhambra, 1984

Additional

- Introductory Transport Phenomena
R. B. Bird, W. E. Stewart, E. N. Lightfoot, D. J. Klingenberg
Wiley, 2015
- Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition
J. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer
Wiley, 2001.
- Transport Phenomena in Newtonian Fluids A Concise Primer
P. Olsson
Springer, 2014
http://links.uv.es/xyCJDs0
- Incropera's principles of heat and mass transfer
Frank P. Icropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine
Wiley, 2017