COURSE DATA

Data Subject	
Code	44431
Name	Advanced reactors
Cycle	Master's degree
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)			
Degree	**Center**	**Acad. year**	**Period**
2209 - M.D. in Chemical Engineering	School of Engineering	1	First term

Subject-matter		
Degree	**Subject-matter**	**Character**
2209 - M.D. in Chemical Engineering	4 - Advanced reactors	Obligatory

Coordination	
Name	**Department**
CHAFER ORTEGA, AMPARO	245 - Chemical Engineering
LLOPIS ALONSO, FRANCISCO	245 - Chemical Engineering
MIGUEL DOLZ, PABLO JOAQUIN	245 - Chemical Engineering

SUMMARY

The Advanced Reactors course is a compulsory subject of 6 ECTS that develops in the first semester of the Master of Chemical Engineering and taught in Spanish.

Matter of Chemical Reaction Engineering is one of the fundamental pillars of Chemical Engineering.

During the formation of Grade students, they have acquired knowledge about the kinetics of chemical reactions combined with the basic principles of Chemical Engineering. This knowledge, has allowed them develop the design and analysis of elementary operation in chemical reactors.

This course of Advanced Reactors aims to provide students with the necessary skills to design and analyze more real and complex reactors as catalytic, bioreactors, and nuclear reactors.

This is a subject with a practical component in which, after the introduction of the concepts, students will undertake numerous practical exercises.

The subject to be developed are:

Catalysis. Catalytic reactors: fixed, moving, fluidized and entrained (transport) bed. Multiphase reactors. Design and analysis of bioreactors and enzyme reactors. Electrochemical reactors. Nuclear reactors.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It is recommended to have the right skills for Numerical Methods, Transport Phenomena and Chemical Reaction Engineering.

OUTCOMES

2209 - M.D. in Chemical Engineering

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Be able to apply the scientific method and the principles of engineering and economics to formulate and solve complex problems in processes, equipment, facilities and services in which matter changes its composition, state or energy content, these changes being characteristic of the chemical industry and of other related sectors such as pharmacology, biotechnology, materials science, energy, food or the environment.
- Conceive, plan, calculate and design processes, equipment, industrial facilities and services in the field of chemical engineering and other related industrial sectors in terms of quality, safety, economics, rational and efficient use of natural resources and environmental conservation.
- Know how to establish and develop mathematical models by using appropriate software in order to provide the scientific and technological basis for the design of new products, processes, systems and services and for the optimisation of others already developed.

- Integrate knowledge and handle the complexity of formulating judgments and decisions, based on incomplete or limited information, which take account of the social and ethical responsibilities of professional practice.
- Adapt to changes and be able to apply new and advanced technologies and other relevant developments with initiative and entrepreneurship.
- Have skills for independent learning in order to maintain and enhance the specific competences of chemical engineering which enable continuous professional development.
- Be able to access information tools in different areas of knowledge and use them properly.
- Be able to take responsibility for their own professional development and specialisation in one or more fields of study.
- Design products, processes, systems and services for the chemical industry and optimise others already developed, on the basis of the technologies of various areas of chemical engineering including transport processes and phenomena, separation operations and engineering of chemical, nuclear, electrochemical and biochemical reactions.
- Apply critical reasoning to their knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience and practice, in order to establish economically viable solutions to technical problems.
- Conceptualize engineering models; apply innovative methods in problema solving and applications suitable for the design, simulation, optimization and control of processes and systems.
- Be able to solve unfamiliar and ill-defined problems that have specifications in competition by considering all possible methods of solution, including the most innovative ones, and selecting the most appropriate, and correct implementation by evaluating the different design solutions.

LEARNING OUTCOMES

- Gain knowledge on the scientific basis of catalysis and catalytic systems used in industry.
- Be able to assess the efficiency of the catalysts.
- Be able to evaluate transport phenomena related to heat and mass transfer in the catalyst.
- Know how to determine the effectiveness of a catalytic particle.
- Be able to model and design catalytic reactors with a fluid phase in the presence of solid catalysts.
- Be able to model and design reactors operating with various stages present (multiphase reactors).
- Be able to model and design enzymatic reactors.
- Be able to model and design bioreactors.
- Be able to model and design electrochemical reactors.
- Be able to model and design nuclear reactors.

DESCRIPTION OF CONTENTS

1. Catalysis

Introduction. Catalysis in solutions. Catalysis by enzymes. Catalysis by polymers. Catalysis in molecular scale-cavities. Catalysis on surfaces. Properties, preparation and characterization techniques of catalysts.

2. Heterogeneous catalytic reactors: General characteristics

Introduction. Catalyst. Internal diffusiion. Diffusion coefficient estimation. Influence of the external mass transfer. Use of heterogeneous catalysts. Fixed bed reactors. Moving bed reactors. Reactors with suspended catalyst.

3. Reactors employing a fluid phase and a catalytic solid phase: fixed bed, moving bed, fluidized bed

Introduction. Design and analysis. Fixed bed reactors. Moving bed reactors. Fluidized bed reactors. Pneumatic transport reactors.

4. Three-phase reactors: gas, liquid, and catalytic solid

Introduction. Characteristics of triphasic reactors. Bubble columns (Slurry reactors). Mechanically stirred reactors. Fixed beds with biphasic flow (Trickle beds). Moving bed reactors. Fluidized triphasic beds (Ebullated beds). Characteristics-uses of triphasic reactors. Comparison of three-phase reactors.

5. Design and analysis of bioreactors and enzyme reactors

Introduction. Microbial and Enzyme kinetics. Design of enzymatic and bioreactors working in batch or continuous way. Comparison between batch and continuous bioreactors. Bioreactors design alternatives.

6. An introduction to electrochemical reactors

Introduction. Electrochemical thermodynamics and kinetics. Electron transfer and mass trasnport in electrochemical systems. Mass and energy balances. Electrochemical reactor design. Influence of limiting diffusion current. Influence of electrode geometry. Industrial electrochemical processes.

7. An Introducction to nuclear reactors

Basic Concepts. Nuclear atomic structure. Chemical elements. Nuclear stability. Nuclear reactions with neutrons. Nuclear Reactors. Reactor core components. Control of nuclear reactors. Types of nuclear reactors. Operation of Nuclear Power Plants. Central Pressurized Water Reactor (PWR). Central Boiling Water Reactor (BWR). New generations of reactors. Global research and innovation on future reactors.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	35,00	100
Classroom practices	20,00	100
Tutorials	5,00	100
Attendance at events and external activities	2,00	0
Development of group work	5,00	0
Study and independent work	21,50	0
Preparation of evaluation activities	15,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	20,00	0
Resolution of case studies	10,00	0
Resolution of online questionnaires	1,50	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

Theoretical activities

In the theoretical classes, the topics will be providing a comprehensive and integrated vision, analyzing in detail the key aspects and more complex too. This work will be developed taking into account encouraging the student participation.

Practical activities

These activities complement the theoretical classes in order to apply the basics and expand the knowledge of students in the matter. They can include any of the following types of classroom activities:

• Classes of problems in classroom

• Discussion sessions and solving exercises which previously have worked the students

• Making group projects

• Lab and / or computer sessions.

Transversal activities

Visit to industrial facilities, attending courses, conferences, round tables and other types of organized activities proposed by the CEC of the Master.

Evaluation

Completion of questionnaires or/and individual written tests in the classroom with the teacher's presence.

Tutoring

Tutoring activities by the responsible teacher.

EVALUATION

The assessment of student learning will be conducted by performing one or more tests that include both, theoretical questions and resolution of a practical case. These tests will a weigh of 50% on the final grade, being mandatory to obtain in the average of tests a grade equal or greater than 4 (out of 10). The rest of the grade will be obtained from the evaluation of practical activities, the production of works, reports and / or oral presentations (45%) and the continuing evolution of each student based on regular attendance at classes, participation and degree of involvement of students in the teaching-learning process (5%).

The subject is considered passed when the grade obtained is equal to or greater than 5 (over 10).

The assessment system is independent of the call (1st or 2nd).

In any case, the evaluation system will be governed by the Reglament d’Avaluació i Qualificació de la Universitat de València per a Títols de Grau i Màster (http://links.uv.es/j0Im3ec).

REFERENCES

Basic

- "Catalytic Chemistry" B.C. Gates (Wiley, 1992)
- "Cinética Química Aplicada" J.R. González et al. (Editorial Síntesis, 1999)
- "Ingeniería de Reactores" J.M. Santamaria et al. (Editorial Síntesis, 1999)
- "Basic Bioreactor Design" K. Vant Riet, J. Tramper (Marcel Dekker, 1991)

- "Principios de ingeniería de los bioprocesos" P.M. Doran (Ed. Acribia, 1998)
- "Introducción a la Ingeniería Electroquímica" F. Coeuret (Ed. Reverté, 1992)
- "Reactores Nucleares" J.M. Martínez-Val, M. Piera (Ed. UPM Publicaciones ETSII, 1997)

Additional

- "Chemical Reactor Analysis and Design" G.B. Froment, K.B. Bischoff (Wiley, 1990)
- "Biochemical Engineering" S. Aiba, A.E. Humphrey, N.F. Millis (Academic Press, 1973)
- "Biochemical Engineering Fundamentals" J.E. Balley, D.F.G. Ollis (McGraw-Hill, 1986)
- "Electrochemical Engineering Principles" G. Prentice (Ed. Prentice Hall, 1991)
- "Nuclear Reactor Engineering: Reactor Design Basics" S. Glasstone, A. Sesonske (Ed. Springer Science, 2013)