Course guide
240EQ021 - 240EQ021 - Catalysis and Advanced Reactor Design

Last modified: 26/06/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: **Academic year:** 2025 **ECTS Credits:** 4.5
Languages: Spanish

LECTURER

Coordinating lecturer: JORGE BOU SERRA

Others: JORDI LLORCA PIQUE
Calvet Tarragona, Aurelio
Estrany Coda, Francisco

PRIOR SKILLS

Basic knowledge of chemical engineering, chemical reactors and calculus

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Adapting to structural changes in society motivated by phenomena such factors or economic, energy or natural to solve the problems and to provide technological solutions with a high commitment to sustainability.
2. Apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, critical reasoning to establish economically viable solutions to technical problems.

3. Conceptualize engineering models; apply innovative methods in problem solving and applications suitable for the design, simulation, optimization and control of processes and systems.
4. Direct and supervise all types of facilities, processes, systems and services in different industrial areas related to chemical engineering.
5. Design, build and implement methods, processes and equipment for the supply and management of waste solids, liquids and gases in industries, capable of assessing their impacts and risks.
6. Designing products, processes, systems and services for the chemical industry as well as the optimization of other already developed technology based on various areas of chemical engineering, understanding of processes and transport phenomena, separation operations and engineering chemical reactions, nuclear, electrochemical and biochemical.
7. Manage the Research, Development and Technological Innovation, based on the transfer of technology and property rights and patents.
8. Ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, and to correct implementation, evaluating the different solutions Design.

Generical:
9. Ability 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 the material changes its composition, state or energy content, characteristic of chemical industry and other related sectors which include the pharmaceutical, biotechnology, materials, energy, food or environmental.
10. Communicate and discuss proposals and conclusions in forums multilingual, skilled and unskilled, in a clear and unambiguous.
11. Conceive, design, calculate, and design processes, equipment, manufacturing and service facilities in the field of chemical engineering and related industrial sectors in terms of quality, safety, economy, rational and efficient use of natural resources and conservation environment.
12. Possess independent learning skills to maintain and enhance the competencies of chemical engineering to enable the continued development of their profession.
13. Conduct proper research, undertake design and lead the development of engineering solutions in new or unfamiliar environments, linking creativity, originality, innovation and technology transfer.
14. Know how to establish and develop mathematical models using appropriate informatics, scientific and technological basis for the design of new products, processes, systems and services, and for other already developed optimization.
15. Ability to analyze and synthesize to the continued progress of products, processes, systems and services using criteria of safety, affordability, quality and environmental management.

TEACHING METHODOLOGY

Subject in process of extinction. There is no teaching, the students that enroll it do so only with the right to an exam.

LEARNING OBJECTIVES OF THE SUBJECT

i) To develop technical criteria to define a reactor system of an industrial process from chemical data, biological, catalysis, mass and heat transfer and flow of matter and energy.

ii) To provide training to analyze scientifically and technologically any kind of chemical or biological reactor and to express the basis for its optimization and / or modification.

iii) To identify the problems and shortcomings of chemical facilities based on reactors and being able to offer engineering solutions.

iv) To get scientific spirit to investigate new developments in the field of reactors.

STUDY LOAD

Type	Hours	Percentage
Hours large group	40,5	36.00
Self study	72,0	64.00

Total learning time: 112.5 h

CONTENTS

Catalysis

Description:
The catalytic phenomenon. Type of catalysis: homogeneous and heterogeneous. Active centers. Langmuir theory. Catalysts employed in the industry. Evaluation of catalysts: activity, selectivity, stability and cost. Combinatorial methods.
Preparation of catalysts. Design Strategies. Usual methods of synthesis. Additives and promoters. Characterization techniques: physical properties of the support, determination and optimization of active centers.

Specific objectives:
To get scientific bases from catalysis

Related activities:
Nº 1: Design of heterogeneous catalysts

Full-or-part-time: 25h 30m
Theory classes: 5h
Practical classes: 4h
Laboratory classes: 2h
Self study : 14h 30m

Catalytic reactors

Description:
Aspects related to the mass and heat transfer. Effectiveness and Thiele modulus. Design Strategies. Catalytic wall reactors. Microreactors. Catalytic membrane reactors.
Fixed bed catalytic reactors. Fluidized and transported catalyst reactor.

Specific objectives:
To get knowledge of chemical reactors which work containing solid catalysts and to be able to design them

Related activities:
Nº 1: Design of heterogeneous catalysts

Full-or-part-time: 18h
Theory classes: 3h
Practical classes: 3h
Self study : 12h

Multiphase reactors

Description:
Gas-Liquid reactors. Multiphase reactors G / L / S (slurry, trickle bed) reactors multifunction and integration process (catalytic distillation membranes). Reactors with phase change. Agitation and aeration. Supercritical fluid reactors. Reactor safety.

Specific objectives:
To get theoretical and numerical concepts of reactors working in several phases. Acquiring the ability to extrapolate the basis of mass transfer to other chemical engineering systems.

Related activities:
Nº 2: Reactors analyses

Full-or-part-time: 33h
Theory classes: 7h
Practical classes: 4h
Laboratory classes: 2h
Self study : 20h

Enzymatic reactors

Description:
Enzyme kinetics. Inhibition. Effect of the medium and temperature. Enzyme bioreactors: discontinuous stirred tank reactors. Continuous reactors. Enzyme immobilization: strategies and media types. Packed fixed bed reactors

Specific objectives:
To get basic and mathematic concepts of enzymatic bioreactors and their applications.

Related activities:
Nº 3: Analysis of productive system from enzymatic or fermentation processes

Full-or-part-time: 21h
Theory classes: 3h
Practical classes: 3h
Laboratory classes: 2h
Self study : 13h

Fermenters

Description:
Microbial growth: Monod kinetics and others. Biological yields. Aerobic and anaerobic processes. Inhibition. Fermentation Bioreactors: Discontinued stirred tank. Continuous reactors, washing process and dilution rate. Immobilized cell systems. Transfer O2 (OUR) and agitation. Air-lift reactors and bubble size. Scaling

Specific objectives:
To get theoretical and practical knowledge of fermentations and their applications

Related activities:
No 3: Analysis of productive system from enzymatic or fermentation processes

Full-or-part-time: 15h
Theory classes: 4h
Practical classes: 3h
Self study : 8h

GRADING SYSTEM

Subject in process of extinction. There is only one final test that corresponds to 100% of the final grade of the subject.

EXAMINATION RULES.

Indiviual write exams by hand
Duration: depending of time disponibility
Documentation, as books or notes, can be brought. Calculator (accepted by teacher) can be used

BIBLIOGRAPHY

Basic:
- Campbell, Ian M. Catalysis at surfaces. London: Chapman and Hall, cop. 1988. ISBN 0412289709.
- Froment, Gilbert F; De Wilde, Juray; Bischoff, Kenneth B. Chemical reactor analysis and design. 3rd ed. Hoboken, N.J: John Wiley & Sons, cop. 2011. ISBN 9780470565414.
- López Santín-Bellaterra, José; Casas Alvero, Carles; Gòdia i Casablancas, Francesc. Ingeniería bioquímica. Madrid: Síntesis, DL 1998. ISBN 8477386110.
- Doran, Pauline M. Bioprocess engineering principles [on line]. 2nd ed. Amsterdam: Academic Press, cop. 2013Available on: https://www.sciencedirect.com/science/book/9780122208515. ISBN 9780122208515.
- Hagen, Jens. Industrial catalysis : a practical approach [on line]. 2nd. Weinheim, Germany: WILEY-VCH Verlag GmbH, 2006 [Consultation: 22/05/2020]. Available on: http://onlinelibrary.wiley.com/book/10.1002/3527607684. ISBN 3527311440.
- G.F. Froment , Gilbert F.; Bischoff, Kenneth B.; de Wilde, Juray. Chemical reactor analysis and design. 3rd ed. New York, USA: John Wiley and Sons, 2011. ISBN 0470565411.

Complementary:
- Levenspiel, Octave. Ingeniería de las reacciones químicas [on line]. 3a ed. México: Limusa Wiley, 2004 [Consultation: 23/11/2021]. Available on: http://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5758266. ISBN 9681858603.
- Santamaría, Jesús. Ingeniería de reactores. Madrid: Síntesis, DL 1999. ISBN 847738665X.
- Díaz Fernández, Mario. Ingeniería de bioprocesos. Madrid: Paraninfo, 2012. ISBN 9788428381239.

RESOURCES

Other resources:
Teacher notes, problems collection and documents attached at digital campus