# UNIVERSIDAD DE CASTILLA - LA MANCHA

# GUÍA DOCENTE

## 1. General information

**Course:** DESIGN AND OPERATION OF HETEROGENEOUS REACTORS
**Code:** 310745
**Type:** CORE COURSE
**ECTS credits:** 6
**Degree:** 2336 - MASTER DEGREE PROGRAM IN CHEMICAL ENGINEERING
**Academic year:** 2023-24
**Center:** 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY
**Group(s):** 20
**Year:** 1
**Duration:** C2
**Main language:** Spanish
**Second language:** English
**Use of additional languages:**
**English Friendly:** Y
**Web site:**
**Bilingual:** N

Lecturer: **FERNANDO DORADO FERNANDEZ** - Group(s): **20**

| Building/Office | Department | Phone number | Email | Office hours |
|---|---|---|---|---|
| Enrique Costa. Despacho 2 | INGENIERÍA QUÍMICA | 3516 | fernando.dorado@uclm.es | M-Th from 13 to 14 h. |

Lecturer: **ANA RAQUEL DE LA OSA PUEBLA** - Group(s): **20**

| Building/Office | Department | Phone number | Email | Office hours |
|---|---|---|---|---|
| Enrique Costa. Despacho 16 | INGENIERÍA QUÍMICA | +34926051963 | anaraquel.osa@uclm.es | Monday to Thursday, from 13:00 to 14:00 Wednesday and Thursday from 9:00 to 10:00 |

## 2. Pre-Requisites

Not established

## 3. Justification in the curriculum, relation to other subjects and to the profession

Heterogeneous reactors are of great importance in Chemical Engineering since a large number of reactions of industrial interest are carried out in this type of reactors. Therefore, their study is transcendental for the Chemical Industry. Thus, a Chemical Engineer must have a perfect knowledge of the fundamentals of design and operation of this type of reactors.

## 4. Degree competences achieved in this course

**Course competences**

| Code | Description |
|---|---|
| CB07 | To be able to apply acquired knowledge and problem-solving skills in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study |
| CB10 | To possess the learning skills to continue studying in a largely self-directed or autonomous manner. |
| E01 | To apply knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience, and practice, with critical reasoning to establish economically viable solutions to technical problems. |
| E02 | To design products, processes, systems and services of the chemical industry, as well as the optimization of others already developed, taking as technological base the diverse areas of the chemical engineering, comprehensive of processes and transport phenomena, separation processes and engineering of the chemical, nuclear, electrochemical and biochemical reactions. |
| E05 | To direct and supervise all types of installations, processes, systems and services of the different industrial areas related to chemical engineering. |
| G01 | To have adequate knowledge 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 undergoes changes in its composition, state or energy content, characteristic of the chemical industry and other related sectors including the pharmaceutical, biotechnological, materials, energy, food or environmental sectors. |
| G02 | To conceive, project, calculate and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and environmental conservation. |
| G05 | To know how to establish mathematical models and develop them by means of appropriate computing, as a scientific and technological basis for the design of new products, processes, systems and services, and for the optimization of others already developed. |
| G06 | To have the capacity of analysis and synthesis for the continuous progress of products, processes, systems and services using criteria of safety, economic viability, quality and environmental management. |
| G09 | To communicate and discuss proposals and conclusions in multilingual forums, specialized and non-specialized, in a clear and unambiguous way |
| G11 | To possess the skills of autonomous learning in order to maintain and improve the competences of chemical engineering that allow the continuous development of the profession |
| MC1 | To have acquired advanced knowledge and demonstrated an understanding of the theoretical and practical aspects and of the working methodology in the field of Chemical Engineering with a depth that reaches the forefront of knowledge |
| MC2 | To be able, through arguments or procedures developed and supported by themselves, to apply their knowledge, understanding and problem-solving skills in complex or professional and specialized work environments that require the use of creative or innovative ideas |
| MC3 | To have the ability to collect and interpret data and information on which to base their conclusions including, where necessary and relevant, reflection on social, scientific or ethical issues in the field of chemical engineering |
| MC4 | To be able to deal with complex situations or those that require the development of new solutions in the academic, work or professional field of study of Chemical Engineering |
| | To know how to communicate to all types of audiences (specialized or not) in a clear and precise way, knowledge, methodologies, |

| | |
|---|---|
| MC5 | ideas, problems and solutions in the field of the study of Chemical Engineering |
| MC6 | To be able to identify their own training needs in the field of study of Chemical Engineering and work or professional environment and to organize their own learning with a high degree of autonomy in all kinds of contexts (structured or unstructured). |

## 5. Objectives or Learning Outcomes

**Course learning outcomes**

Description

To integrate all the elements studied, allowing the student to approach the complete calculation of the chemical, electrochemical, biochemical and nuclear reactor.

To be able to develop the corresponding mass and energy balances for the different types of reactors.

To be able to analyze the modifications of the kinetic equation by the appearance of transport phenomena of mass and energy in a reactor when there are two or more phases, or when there are deactivation processes.

To acquire knowledge to calculate and design heterogeneous reactors

To acquire knowledge related to the safety and supervision of the reactor, allowing the complete design of the reactor.

## 6. Units / Contents

**Unit 1: Kinetics of Heterogeneous Reactors**
**Unit 2: Fixed-Bed Catalytic Reactors**
**Unit 3: Fluidized-Bed Catalytic Reactors**
**Unit 4: Reactors for Non-Catalytic Gas-Solid Reactions**
**Unit 5: Reactors for Fluid-Fluid Reactions**
**Unit 6: Three-Phase Reactors**
**Unit 7: Biochemical Reactors**
**Unit 8: Electrochemical Reactors**
**Unit 9: Nuclear Reactors**
**Unit 10: Thermal Stability in Chemical Reactors**
**Unit 11: Reactor Safety**

## 7. Activities, Units/Modules and Methodology

| Training Activity | Methodology | Related Competences (only degrees before RD 822/2021) | ECTS | Hours | As | Com | Description |
|---|---|---|---|---|---|---|---|
| Class Attendance (theory) [ON-SITE] | Lectures | E02 E05 G01 G02 G05 G06 MC1 MC6 | 1 | 25 | N | - | |
| Problem solving and/or case studies [ON-SITE] | Project/Problem Based Learning (PBL) | CB07 E01 E02 G01 MC2 MC4 | 1 | 25 | Y | N | |
| Group tutoring sessions [ON-SITE] | Guided or supervised work | CB10 G02 G06 G09 G11 MC3 MC5 | 0.2 | 5 | Y | N | |
| Study and Exam Preparation [OFF-SITE] | Self-study | CB07 CB10 E01 G01 G02 G09 G11 MC2 MC4 | 3.6 | 90 | N | - | |
| Final test [ON-SITE] | Assessment tests | CB07 E01 G01 MC1 MC2 | 0.2 | 5 | Y | Y | |
| | | **Total:** | **6** | **150** | | | |
| | | **Total credits of in-class work: 2.4** | | | | | **Total class time hours: 60** |
| | | **Total credits of out of class work: 3.6** | | | | | **Total hours of out of class work: 90** |

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

## 8. Evaluation criteria and Grading System

| Evaluation System | Continuous assessment | Non-continuous evaluation* | Description |
|---|---|---|---|
| Oral presentations assessment | 15.00% | 15.00% | |
| Assessment of problem solving and/or case studies | 30.00% | 15.00% | |
| Final test | 55.00% | 70.00% | |
| **Total:** | **100.00%** | **100.00%** | |

*According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).*

**Evaluation criteria for the final exam:**

**Continuous assessment:**

In order to obtain the weighted average described in the Evaluation System, it is necessary to have a minimum mark of 4.0 in each part (final exam, presentation of topics and problem solving). The average must be equal to or higher than 5.0 out of 10 to pass the course.

**Non-continuous evaluation:**

In order to obtain the weighted average described in the Evaluation System, it is necessary to have a minimum mark of 4.0 in each part (final exam, presentation of topics and problem solving). The average must be equal to or higher than 5.0 out of 10 to pass the course.

**Specifications for the resit/retake exam:**

In order to obtain the weighted average described in the Evaluation System, it is necessary to have a minimum mark of 4.0 in each part (final exam, presentation of topics and problem solving). The average must be equal to or higher than 5.0 out of 10.

**Specifications for the second resit / retake exam:**

In order to obtain the weighted average described in the Evaluation System, it is necessary to have a minimum mark of 5.0 in each part (final exam, presentation

of topics and problem solving).

| 9. Assignments, course calendar and important dates | |
|---|---|
| **Not related to the syllabus/contents** | |
| **Hours** | **hours** |

## 10. Bibliography and Sources

| Author(s) | Title/Link | Publishing house | Citv | ISBN | Year | Description |
|---|---|---|---|---|---|---|
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| Doraiswamy, L.K. y Sharma, M.M. | Heterogeneous Reactions: Analysis, Examples and Reactor Design | J. Wiley & Sons | Nueva York | | 1984 | |
| Fogler, H.S. | Elements of Chemical Reaction Engineering, 5th edition | Pearson | | 9780133887822 | 2016 | |
| Froment, G.F.;Bischoff, K.B.; De Wilde, J. | Chemical Reactor Analysis and Design, 3rd Edition | Wiley | Nueva York | 978-0-470-56541-4 | 2010 | |
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| Kunii, D.; Levenspiel, O. | Fluidization Engineering | Krieger | Malabar | | 1969 | |
| Atkinson, B. | Reactores Bioquímicos | Reverté | Barcelona | | 1986 | |
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| Smith, J.M. | Chemical Engineering Kinetics | McGraw-Hill | Nueva York | | 1981 | |
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| Westerperp, K.R. | Chemical Reactor Design and Operation | John Wiley | Nueva York | | 1984 | |