UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: CATALYTIC PROCESSES
Code: 57332
Type: ELECTIVE
ECTS credits: 6
Degree: 409 - CHEMISTRY
Academic year: 2023-24
Center: 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY
Group(s): 20
Year: 4
Duration: C2
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **GEMA DURA GRACIA** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
Edificio San Alberto Magno (primer piso)	QUÍMICA INORG., ORG., Y BIOQ.		Gema.Dura@uclm.es	Monday, Tuesday and Wednesday 16:00-18:00

Lecturer: **FELIX ANGEL JALON SOTES** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
San Alberto Magno/Planta primera	QUÍMICA INORG., ORG., Y BIOQ.	926052184	felix.jalon@uclm.es	Monday, Tuesday and Wednesday 17:00-19:00

2. Pre-Requisites

The student must have passed Module 1 of Basic Training

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

The training that Catalytic Processes students receive is essential for the understanding, design and development of the most important industrial chemical processes. Most processes in the chemical industry are catalytic processes, both homogeneous catalysis and heterogeneous catalysis, such as the metathesis of olefins, hydrogenation processes of unsaturated substrates, the polymerization of different monomers, the carbonylation of olefins or alcohols, synthesis of ammonia, synthesis of methanol .... So that the understanding of these industrial processes supposes a preparation for the future professional activity of the graduates in Chemistry.

The course of Catalytic Processes is a completely transversal and essential subject for the formation of a Graduate in Chemistry and is practically related to all the subjects of the Degree, although we can mention:

Fundamentals of Chemistry and Basic Laboratory Operations,

Physical Chemistry I: Chemical Thermodynamics

Physical Chemistry IV: Chemical Kinetics

Inorganic Chemistry I

Inorganic Chemistry II

Molecular Inorganic Chemistry

Inorganic Chemistry of the Solid State

Organic Chemistry I

Organic Chemistry II

Organic Chemistry III

Extension of Organic Chemistry

Structural Determination

Chemical engineering

Materials science

4. Degree competences achieved in this course

Course competences

Code	Description
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.
CB04	Transmit information, ideas, problems and solutions for both specialist and non-specialist audiences.
E07	Relate macroscopic properties with those of atoms, molecules and non-molecular chemical compounds
E09	Know the kinetics of chemical change, including catalysis and reaction mechanisms
E11	Know the basic operations and the unitary processes of the chemical industry
E15	Know how to handle the standard chemical instrumentation and be able to elaborate and manage standardized procedures of work in the laboratory and chemical industry
E16	Plan, design and develop projects and experiments
E17	Develop the ability to relate to each other the different specialties of Chemistry, as well as this one with other disciplines (interdisciplinary character)
G02	Be able to gather and interpret data, information and relevant results, obtain conclusions and issue reasoned reports on scientific, technological or other problems that require the use of chemical tools
G03	Know how to apply the theoretical-practical knowledge acquired in the different professional contexts of Chemistry
G04	Know how to communicate, orally and in writing, the knowledge, procedures and results of chemistry, both specialized and non-specialized
G05	Acquire and adapt new knowledge and techniques of any scientific-technical discipline with incidence in the chemical field
T05	Organization and planning capacity
T07	Ability to work as a team and, where appropriate, exercise leadership functions, fostering the entrepreneurial character
T09	Motivation for quality, job security and awareness of environmental issues, with knowledge of internationally recognized systems for the correct management of these aspects
T10	Ability to use specific software for chemistry at user level
T11	Ability to obtain bibliographic information, including Internet resources

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Knowing fundamental aspects of the process of Industrial Interest Processes in Homogeneous and Heterogeneous Catalysis

Know the most important processes in Homogeneous and Heterogeneous Catalysis of Industrial Interest

Know the fundamental concepts of Catalysis

Train the student for autonomous work and learning, as well as for personal initiative.

Train the student to search for information, its analysis, interpretation and use for analytical purposes

Train the student to search for information, its analysis, interpretation and use for practical purposes.

6. Units / Contents

Unit 1: Fundamental Concepts of Catalysis. Basic principles. General concepts in catalysis. Catalysis in the chemical industry. Classification of catalytic systems. Comparison between Homogeneous and Heterogeneous Catalysis

Unit 2: Catalytic processes of olefin isomerization. General concepts. Isomerization mechanisms. Applications

Unit 3: Metathesis catalytic processes I. Complexes with carbene (alkylidene) ligands: Fischer type and Schrock type. Reactivity. Applications.

Unit 4: Metathesis catalytic processes II. General concepts. Mechanisms of metathesis. Applications.

Unit 5: Catalytic processes of olefin hydrogenation. Introduction. Types of catalysts. Hydrogenation mechanisms. Representative catalytic processes. Catalytic processes of asymmetric hydrogenation.

Unit 6: Catalytic processes of carbonylation. Introduction. Fischer-Tropsch processes. Carbonylation of alkenes. Carbonylation of alcohols. Hydroformylation. Processes of industrial interest.

Unit 7: Catalytic processes of oxidation. Type of processes. Epoxidation of olefins; asymmetric epoxidations. Oxidation of olefins.

Unit 8: Fundamentals of heterogeneous catalysis. Individual steps. Mechanisms.

Unit 9: Types of heterogeneous catalysts. Redox and acid-base catalysts. Metals. Semiconductors. Isolators.

Unit 10: Catalysts performance. Supported catalysts. Promotors and inhibitors. Deactivation and regeneration.

Unit 11: Synthesis of heterogeneous catalysts. Immobilization of homogeneous catalysts. Zeolites.

Unit 12: Characterization of heterogeneous catalysts.

Unit 13: Heterogeneously Catalyzed Processes in Industry. Refinery. Hydrogen and syngas. Ammonia. Methanol. Fisher-Tropsch process. Ethylene and propylene oxidation. Polyolefins.

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	CB02 CB04 E07 E09 E11 G02 G03 G05	1.4	35	N	-	Presentation of theoretical contents with the support of informatic presentations
Problem solving and/or case studies [ON-SITE]	Workshops and Seminars	CB02 CB04 G02 G03 T05 T07 T09 T10 T11	0.44	11	Y	Y	Problem solving in the classroom.
Group tutoring sessions [ON-SITE]	Group tutoring sessions	CB02 CB04 E07 E09 G02 G03 G04	0.1	2.5	N	-	Approach and resolution of doubts in the classroom
Progress test [ON-SITE]	Assessment tests	CB02 CB04 E07 E11 E15 G02 G03 G04	0.2	5	Y	N	Carrying out partial tests to monitor the continuous evaluation
Study and Exam Preparation [OFF-SITE]	Self-study	CB02 CB04 E07 E09 E11 E15 E16 G02 G03 G05 T10 T11	3.86	96.5	N	-	Autonomous study of the student

Total:	**6**	**150**	
Total credits of in-class work: 2.14			**Total class time hours: 53.5**
Total credits of out of class work: 3.86			**Total hours of out of class work: 96.5**

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
Assessment of problem solving and/or case studies	25.00%	0.00%	The resolution of the problems by the student will be valued positively, as well as the completion of test-type seminars and their active participation in class. On the other hand, the student will be able to increase his/her continuous evaluation grade by submitting seminars and questions at the teacher's proposal
Progress Tests	75.00%	0.00%	Two evaluation tests will be carried out that will allow passing the subject by passing the two partial exams. The first evaluation will have a value of 25% of the final grade. Those who pass this exam will carry out a second evaluation that will coincide in date with the final exam. The evaluation of the second evaluation will be 50% of the total grade. The two partials will account for 75% of the final grade
Final test	0.00%	100.00%	For students who have not passed the partial evaluation (continuous evaluation) they will take a final test whose assessment will be 100%.
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:

The subject has two parts: Homogeneous Catalysis and Heterogeneous Catalysis, which participate with 60 and 40% of the grade, respectively, and which are evaluated as follows:

1. Exam with theoretical and practical questions about the contents taught in the subject (75% of the grade)

2. Participatory resolution, in the classroom, of seminars on problems and work carried out by the student (25% of the grade)

A partial examination of the Homogeneous Catalysis part will be performed. If it is passed, an examination of the part dedicated to the Heterogeneous Catalysis will be made the day of the ordinary examination.

Non-continuous evaluation:

Examination of the total of the course

Specifications for the resit/retake exam:

Examination of the total of the course

Specifications for the second resit / retake exam:

Examination of the total of the course

9. Assignments, course calendar and important dates

Not related to the syllabus/contents	
Hours	**hours**
Group tutoring sessions [PRESENCIAL][Group tutoring sessions]	2.5
Progress test [PRESENCIAL][Assessment tests]	5
Study and Exam Preparation [AUTÓNOMA][Self-study]	96.5
Unit 1 (de 13): Fundamental Concepts of Catalysis. Basic principles. General concepts in catalysis. Catalysis in the chemical industry. Classification of catalytic systems. Comparison between Homogeneous and Heterogeneous Catalysis	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Unit 2 (de 13): Catalytic processes of olefin isomerization. General concepts. Isomerization mechanisms. Applications	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	1
Unit 3 (de 13): Metathesis catalytic processes I. Complexes with carbene (alkylidene) ligands: Fischer type and Schrock type. Reactivity. Applications.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	1
Unit 4 (de 13): Metathesis catalytic processes II. General concepts. Mechanisms of metathesis. Applications.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	1
Unit 5 (de 13): Catalytic processes of olefin hydrogenation. Introduction. Types of catalysts. Hydrogenation mechanisms. Representative catalytic processes. Catalytic processes of asymmetric hydrogenation.	

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	1

Unit 6 (de 13): Catalytic processes of carbonylation. Introduction. Fischer-Tropsch processes. Carbonylation of alkenes. Carbonylation of alcohols. Hydroformylation. Processes of industrial interest.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	1

Unit 7 (de 13): Catalytic processes of oxidation. Type of processes. Epoxidation of olefins; asymmetric epoxidations. Oxidation of olefins.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	1

Unit 8 (de 13): Fundamentals of heterogeneous catalysis. Individual steps. Mechanisms.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	3

Unit 9 (de 13): Types of heterogeneous catalysts. Redox and acid-base catalysts. Metals. Semiconductors. Isolators.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2

Unit 10 (de 13): Catalysts performance. Supported catalysts. Promotors and inhibitors. Deactivation and regeneration.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2

Unit 11 (de 13): Synthesis of heterogeneous catalysts. Immobilization of homogeneous catalysts. Zeolites.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	2

Unit 12 (de 13): Characterization of heterogeneous catalysts.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2

Unit 13 (de 13): Heterogeneously Catalyzed Processes in Industry. Refinery. Hydrogen and syngas. Ammonia. Methanol. Fisher-Tropsch process. Ethylene and propylene oxidation. Polyolefins.

Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	3

Global activity

Activities	hours
Class Attendance (theory) [PRESENCIAL][Lectures]	35
Group tutoring sessions [PRESENCIAL][Group tutoring sessions]	2.5
Study and Exam Preparation [AUTÓNOMA][Self-study]	96.5
Problem solving and/or case studies [PRESENCIAL][Workshops and Seminars]	11
Progress test [PRESENCIAL][Assessment tests]	5
	Total horas: 150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
BOND, G. C.	Heterogeneous catalysis : principles and applications					
Bhaduri, Sumit	Homogeneous catalysis . Mechanisms and industrial applications					
Farrauto, Robert J.	Fundamentals of industrial catalytic processes					
Parshall, George W.	Homogeneous catalysis : the applications and chemistry of ca					
L. A. Oro, E. Sola	Fundamentos y aplicaciones de la catálisis homogénea					
Rothenberg, Gadi	Catalysis : concepts and green applications					
GATES, Bruce C.	Catalytic chemistry					
Hagen, Jens	Industrial catalysis : a practical approach					
Leeuwen, Piet W. N. M. van	Homogeneous catalysis : understanding the art					