UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: ORGANIC CHEMISTRY II
Code: 57314
Type: CORE COURSE
ECTS credits: 6
Degree: 398 - UNDERGRADUATE DEGREE PROGRAMME IN CHEMISTRY
Academic year: 2020-21
Center: 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY
Group(s): 20 23
Year: 2
Duration: C2
Main language: Spanish
Second language:
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **ENRIQUE DIEZ BARRA** - Group(s): **23**

Building/Office	Department	Phone number	Email	Office hours
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Lecturer: **MARIA DEL PILAR PRIETO NUÑEZ-POLO** - Group(s): **20**

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2. Pre-Requisites

It is recommended to have passed the ground level course “Química” and to be enrolled in the course “Química Orgánica I”

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

The course “Química Orgánica II” is included in the module of Fundamentals of Chemistry in the Degree of Chemistry. It is designed to develop the concepts and fundamental data of Organic Chemistry. Lessons also show the experimental evidence that supports the main organic chemistry concepts, and to apply these data and concepts to the resolution of chemical problems. The course also points to the rapid evolution of this area and how it plays as a key role in modern technological developments in very diverse fields, from biology to materials science, influencing in a fundamental way all aspects of daily life.

“Química Orgánica II” is a compulsory, semester-long course, taught in the second year, which introduces the fundamentals of the different areas of chemistry. It consists of 6 theoretical credits. It could be considered as the second part of “Química Orgánica I”, and it is devoted to study the reactivity of the different functional groups, showing the main reaction mechanisms of the main types of organic compounds. At the same time, it tries to generate in the students the capacity to value the importance of Organic Chemistry in their daily life.

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.
E01	Understand and use chemical terminology, nomenclature, conventions and units
E02	Deduce the variation of the properties of the chemical elements according to the Periodic Table
E03	Handle chemicals safely and with respect to the environment
E05	Know the chemical elements and their compounds, their forms of obtaining, structure, properties and reactivity, as well as the main techniques for their analysis
E06	Know the structural properties of chemical compounds, including stereochemistry, as well as the main structural research techniques
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
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)
G01	Know the principles and theories of Chemistry, as well as the methodologies and applications characteristic of analytical chemistry, physical chemistry, inorganic chemistry and organic chemistry, understanding the physical and mathematical bases that require
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
T03	Proper oral and written communication
T06	Ability to approach decision making
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

Acquire an awareness of environmental protection developing the idea that Organic Chemistry should be used to improve the quality of life.

Know the stereochemistry of the compounds

Know the structure of the main organic functional groups

Know the utility of the spectroscopic techniques in Organic Chemistry

Know the main aspects of the terminology and nomenclature in Organic Chemistry

Know the basic principles of Organic Chemistry.

To ensure that the student is able to search and select information in the field of Organic Chemistry and that he / she is capable of processing and presenting it adequately both orally and in writing, developing his / her synthesis capacity, being critical and objective

To develop in the student the capacity of initiative to pose and solve concrete problems of Organic Chemistry, as well as to interpret the obtained results

Develop your ability to teamwork

Recognize the main reactive intermediates and the influence of stereoelectronic effects on their stability and reactivity

Know how to apply the knowledge of Organic Chemistry to the solution of synthetic and structural problems

6. Units / Contents

Unit 1: ALKYL HALIDES. Classification and nomenclature. Physical properties. Preparation by alkane halogenation: mechanism. Regioselectivity. Allylic halogenation. Synthesis from alcohols

Unit 2: REACTIVITY OF ALKYL HALIDES: Influencing factors on SN2 reaction rate. Unimolecular substitution reaction (SN1). Stereochemistry and kinetics. Mechanism. Influencing factors on SN1 reaction rate. Elimination reactions on alkyl halides. E2 and E1 mechanisms: kinetics, approaches, and stereochemistry. Influencing factors on elimination. Substitution-elimination competition.

Unit 3: ARYL HALIDES. Origin, bonds, physical properties. Reactions of aryl halides. Nucleophilic susbstitution on aryl halides: addition-elimination mechanism. Related nucleophilic substitution reactions. Elimination-addition mechanism. Benzyne. Diels-Alder reaction on benzyne.

Unit 4: ORGANOMETALLIC COMPOUNDS. Carbon-Metal bonds in organometallic compounds. Nomenclature. Organolithium compounds. Grignard¿s reagents. Organolithium and organomagnesium compounds as Brønsted¿s bases. Synthesis of aliphatic and acetylenic alcohols. Alkane synthesis by using organocopper compounds. Simmons-Smith reation: Carbenes and carbenoids.

Unit 5: ALCOHOLS, DIOLS Y THIOLS. Nomenclature. Structure ans physical properties. Hydrogen bonds. Spectroscopic features of alcohols. Origin of alcohols. Fuentes de alcoholes. Synthesis of alcohols: Reduction of aldehydes, ketones, carboxilic acids and esters. Alcohols from epoxides. Synthesis of diols. Acidity of alcohols. Alcoxides preparation. Reactivity of alcohols: ether synthesis. Esterification. Oxidation. Oxidative rupture of vicinal diols. Dehydration of alcohol. Alkyl halides from alcohols. Thiols: synthesis, physical and chemical properties.

Unit 6: PHENOLS. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of phenols. Synthetic and natural origin of phenols. Acidity: substitution effects. Phenol reactivity: aromatic electrophilic substitutuion. Acylation of phenols Aspirine: carboxylation of phenols, Kolbe - Schmitt reaction. Preparation of arylethers. Oxidation of phenols: quinones.

Unit 7: ETHERS, EPOXIDES AND SULFURES. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of ethers. Crown-ethers. Synthesis of ethers. Reactivity: acid-catalysed bond rupture. Rupture of aryl ethers by hydracids. Claisen rearrangement of alylaryl ethers. Synthesis of epoxides. Reactions: basic and acid catalysed ring opening. Biological processes involving epoxides. Synthesis of sulfures. Oxidation: sulfoxides and sulfones. Alkylation of sulfures: sulfonium salts.

Unit 8: AMINES AND NITROGEN DERIVATIVES. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of amines. Basicity. Tetraalkylammonium salt as phase transfer catalysis agents. Preparation of amines: ammonia alkylation, Gabriel¿s synthesis, reductions yielding amines, reductive amination. Hofmann¿s rearrangement. Reactivity: N-alkylation, Hofmann¿s elimination, N-acylation, aromatic electrophilic substitution on anilines, nitrosation of alkyl- and arylamines, substitution on diazonium salts, diazonium salts as electrophiles. Nitrocompounds. Nitro-aci tautomerism. Synthesis of nitrocompunds. ¿-H acidity. Nef¿s reaction. Reduction.

Unit 9: ALDEHYDES AND KETONES. NUCLEOPHILIC ADDITION TO CARBONYL GROUP. Nomenclature. Bond and structure: carbonyl group. Physical properties. Spectroscopic features of aldehydes and ketones. Origin and Synthesis of aldehydes and ketones. Reactivity: nucleophilic addition to carbonyl group. Reaction with: water and alcohols. Ketals as protecting groups. Reaction with hydrogen cyanide. Reaction with Grignard¿s reagents. Reaction with primary amines: nuclephilic addition-elimination. Reaction with secondary amine: enamines. Reaction with hydroxylamine: oximes. Beckmann¿s rearrangement. Reaction with hydrazine; hydrazones. Wittig¿s reaction. Oxidation of aldehydes. Baeyer-Villiger¿s oxidation of ketones. Reduction of aldehydes and ketones. Cannizaro¿s reaction.

Unit 10: CARBOXYLIC ACIDS. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of carboxylic acids. Acidity.Dicarboxylic acids. Carbonic acid. Origin and synthesis. Reactivity. Esterification: mechanism. Intramolecular ester formation: lactones. Decarboxylation of malonic acid and related compounds.

Unit 11: CARBOXYLIC ACID DERIVATIVES. NUCLEOPHILIC SUBSTITUION ON ACYL. Clasification. Structure and physical properties. Spectroscopic features. Reactivity (nucleophilic substitution): hydrolysis, alcoholysis, aminolysis, reduction. Reaction with organometallic compounds. Synthesis.

Unit 12: ENOLS AND ENOLATES. Acidity of ¿-hydrogen atoms. Keto-enol tautomerism. HAlogenation of aldehydes and ketones. Haloform¿s reaction. ¿-Halogenation of carboxylic acids: Hell-Volhardt-Zelinsky¿s reaction. Base-catalysed enol formation. Enolate anions, alkylation. Aldol condensation. ¿¿¿-unsaturated carbonyl compouds. 1,2- and 1,4- nucleophylic addition. Michael¿s addition and Robinson¿s annelation.

Unit 13: ENOLATES OF ESTERS AND OTHER ACID DERIVATIVES. Condensation of: Claisen, Thorpe, Knoevenagel and Perkin. Dieckman¿s condensation. Acetoacetic and Malonic synthesis. Depronotanion of carbonyl compund by lithium dialkylamidure.

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		1.16	29	N	-	
Problem solving and/or case studies [ON-SITE]	Guided or supervised work	E01 E07 T03 T07 T09 T11	0.96	24	Y	N	
Study and Exam Preparation [OFF-SITE]	Self-study		2.72	68	N	-	
Progress test [ON-SITE]	Assessment tests	E01 E07 T03 T07 T09 T11	0.08	2	Y	N	

Final test [ON-SITE]	Assessment tests	E01 E07 T03 T07 T09 T11	0.08	2	Y	Y	
Study and Exam Preparation [OFF-SITE]	Self-study		1	25	N	-	
			6	150	Y	N	
		Total:	**12**	**300**			
		Total credits of in-class work: 2.28					**Total class time hours: 57**
		Total credits of out of class work: 3.72					**Total hours of out of class work: 93**

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
Final test	65.00%	100.00%	The final grade of the exam may be increased as a result of the dedication in the criterion "resolution of problems or cases"
Progress Tests	20.00%	0.00%	A first test of 1 hour will be done in the middle of the program (30%) and a second test will be done at the end of the classes. This second test, although focused on the second part of the programme, will incorporate knowledge from the first half of the programme, and will be assessed at 50%. Students that reach 6 points in each one of both tests have not the obligation to attent the final exam. To improve the obtaines calification in this way, students have to be attent the final exam.
Assessment of problem solving and/or case studies	15.00%	0.00%	
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).

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours	**hours**

Unit 1 (de 13): ALKYL HALIDES. Classification and nomenclature. Physical properties. Preparation by alkane halogenation: mechanism. Regioselectivity. Allylic halogenation. Synthesis from alcohols

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1

Unit 2 (de 13): REACTIVITY OF ALKYL HALIDES: Influencing factors on SN2 reaction rate. Unimolecular substitution reaction (SN1). Stereochemistry and kinetics. Mechanism. Influencing factors on SN1 reaction rate. Elimination reactions on alkyl halides. E2 and E1 mechanisms: kinetics, approaches, and stereochemistry. Influencing factors on elimination. Substitution-elimination competition.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	3

Unit 3 (de 13): ARYL HALIDES. Origin, bonds, physical properties. Reactions of aryl halides. Nucleophilic susbstitution on aryl halides: addition-elimination mechanism. Related nucleophilic substitution reactions. Elimination-addition mechanism. Benzyne. Diels-Alder reaction on benzyne.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	1
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2

Unit 4 (de 13): ORGANOMETALLIC COMPOUNDS. Carbon-Metal bonds in organometallic compounds. Nomenclature. Organolithium compounds. Grignard¿s reagents. Organolithium and organomagnesium compounds as Brønsted¿s bases. Synthesis of aliphatic and acetylenic alcohols. Alkane synthesis by using organocopper compounds. Simmons-Smith reation: Carbenes and carbenoids.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1

Unit 5 (de 13): ALCOHOLS, DIOLS Y THIOLS. Nomenclature. Structure ans physical properties. Hydrogen bonds. Spectroscopic features of alcohols. Origin of alcohols. Fuentes de alcoholes. Synthesis of alcohols: Reduction of aldehydes, ketones, carboxilic acids and esters. Alcohols from epoxides. Synthesis of diols. Acidity of alcohols. Alcoxides preparation. Reactivity of alcohols: ether synthesis. Esterification. Oxidation. Oxidative rupture of vicinal diols. Dehydration of alcohol. Alkyl halides from alcohols. Thiols: synthesis, physical and chemical properties.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2

Unit 6 (de 13): PHENOLS. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of phenols. Synthetic and natural origin of phenols. Acidity: substitution effects. Phenol reactivity: aromatic electrophilic substitutuion. Acylation of phenols Aspirine: carboxylation of phenols, Kolbe -Schmitt reaction. Preparation of arylethers. Oxidation of phenols: quinones.

Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	1
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1

Unit 7 (de 13): ETHERS, EPOXIDES AND SULFURES. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of ethers. Crown-ethers. Synthesis of ethers. Reactivity: acid-catalysed bond rupture. Rupture of aryl ethers by hydracids. Claisen rearrangement of alylaryl ethers. Synthesis of epoxides. Reactions: basic and acid catalysed ring opening. Biological processes involving epoxides. Synthesis of sulfures. Oxidation:

sulfoxides and sulfones. Alkylation of sulfures: sulfonium salts.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
Unit 8 (de 13): AMINES AND NITROGEN DERIVATIVES. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of amines. Basicity. Tetraalkylammonium salt as phase transfer catalysis agents. Preparation of amines: ammonia alkylation, Gabriel¿s synthesis, reductions yielding amines, reductive amination. Hofmann¿s rearrangement. Reactivity: N-alkylation, Hofmann¿s elimination, N-acylation, aromatic electrophilic substitution on anilines, nitrosation of alkyl- and arylamines, substitution on diazonium salts, diazonium salts as electrophiles. Nitrocompounds. Nitro-aci tautomerism. Synthesis of nitrocompunds. ¿-H acidity. Nef¿s reaction. Reduction.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	4
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	3
Unit 9 (de 13): ALDEHYDES AND KETONES. NUCLEOPHILIC ADDITION TO CARBONYL GROUP. Nomenclature. Bond and structure: carbonyl group. Physical properties. Spectroscopic features of aldehydes and ketones. Origin and Synthesis of aldehydes and ketones. Reactivity: nucleophilic addition to carbonyl group. Reaction with: water and alcohols. Ketals as protecting groups. Reaction with hydrogen cyanide. Reaction with Grignard¿s reagents. Reaction with primary amines: nuclephilic addition-elimination. Reaction with secondary amine: enamines. Reaction with hydroxylamine: oximes. Beckmann¿s rearrangement. Reaction with hydrazine; hydrazones. Wittig¿s reaction. Oxidation of aldehydes. Baeyer-Villiger¿s oxidation of ketones. Reduction of aldehydes and ketones. Cannizaro¿s reaction.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2
Unit 10 (de 13): CARBOXYLIC ACIDS. Nomenclature. Bond and structure. Physical properties. Spectroscopic features of carboxylic acids. Acidity.Dicarboxylic acids. Carbonic acid. Origin and synthesis. Reactivity. Esterification: mechanism. Intramolecular ester formation: lactones. Decarboxylation of malonic acid and related compounds.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	1
Unit 11 (de 13): CARBOXYLIC ACID DERIVATIVES. NUCLEOPHILIC SUBSTITUION ON ACYL. Clasification. Structure and physical properties. Spectroscopic features. Reactivity (nucleophilic substitution): hydrolysis, alcoholysis, aminolysis, reduction. Reaction with organometallic compounds. Synthesis.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2
Unit 12 (de 13): ENOLS AND ENOLATES. Acidity of ¿-hydrogen atoms. Keto-enol tautomerism. HAlogenation of aldehydes and ketones. Haloform¿s reaction. ¿-Halogenation of carboxylic acids: Hell-Volhardt-Zelinsky¿s reaction. Base-catalysed enol formation. Enolate anions, alkylation. Aldol condensation. ¿¿¿-unsaturated carbonyl compouds. 1,2- and 1,4- nucleophylic addition. Michael¿s addition and Robinson¿s annelation.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	3
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	2
Unit 13 (de 13): ENOLATES OF ESTERS AND OTHER ACID DERIVATIVES. Condensation of: Claisen, Thorpe, Knoevenagel and Perkin. Dieckman¿s condensation. Acetoacetic and Malonic synthesis. Depronotanion of carbonyl compund by lithium dialkylamidure.	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	3
Global activity	
Activities	**hours**
Problem solving and/or case studies [PRESENCIAL][Guided or supervised work]	24
Class Attendance (theory) [PRESENCIAL][Lectures]	29
Total horas:	53

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Bruice, P. Y.	Organic Chemistry	Prentice Hall			1998	
Clayden, J.; Greeves, N.; Warren, S.	Organic Chemistry	Oxford University Press			2012	
	www.oxfordtextbooks.co.uk/orc/clayden2e					
Carey, F.A.	Química Orgánica	McGraw Hill				
Solomons, T. W. G.	Química Orgánica	Wiley, New York,				
Quiñoa, E.	Nomenclatura y representación de los compuestos orgánicos: una guía de estudio y autoevaluación	McGraw Hill				
Vollhardt, K. P.	Química Orgánica	Editorial Omega, Barcelona				
McMurry, J.	Química Orgánica	Thomson				
Morrison, R. T. y Boyd, R. N.,	Química Orgánica	Addison-Wesley				
Wade, L.G.	Química Orgánica	Prentice-Hall				
García Calvo-Flores, F. y Doblado Jiménez, J. A.,	Problemas resueltos de Química Orgánica	Thomson				
Meislich, H.; Nechamkin, H.; Sharefkin, J. y Hademenos G.,	Química Orgánica (1806 problemas resueltos)	McGraw Hill				
Riguera, R. y Quiñoa, E.	Cuestiones y Ejercicios de Química Orgánica	McGraw Hill				