Course Guide

ORGANIC CHEMISTRY II

FACULTY OF CHEMISTRY
COMPLUTENSE UNIVERSITY OF MADRID
ACADEMIC YEAR 2022-2023

I.- COURSE IDENTIFICATION

COURSE NAME:	**Organic Chemistry II**
NUMBER OF CREDITS:	**12**
CHARACTER:	**Mandatory**
SUBJECT:	**Organic Chemistry**
MODULE:	**Fundamental**
DEGREE:	**Degree in Chemistry**
SEMESTER/COURSE:	**Annual (3rd year)**
DEPARTMENT:	**Organic Chemistry**

PROFESSORS IN CHARGE:

Course Coordinator	**Professor:** **Department:** **Office:** **e-mail:**	**Mª del Mar Gómez Gallego** Organic Chemistry QB-4103 margg@ucm.es
Laboratory Coordinator	**Professor:** **Department:** **Office:** **e-mail:**	**Paloma Martínez Ruiz** Organic Chemistry QB-415 palmarti@ucm.es

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Group B		
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II.- OBJECTIVES

■ GENERAL OBJECTIVES

OG1. To continue with the study of the reactivity of the functional groups initiated on the previous course, Organic Chemistry I.

OG2. To familiarize the student with the basis of organic synthesis.

OG3. To introduce the student in the fundamental aspects of the structure and reactivity of the most relevant types of natural products.

OG4. To introduce the student in the structural analysis of organic compounds.

OG5. To acquire a series of manual and intellectual skills that will allow the students to carry out the synthesis of simple organic compounds in the laboratory, as well as their subsequent isolation and purification.

■ SPECIFIC OBJECTIVES

OE1. To acquire abilities to apply the general knowledge of the reactivity of organic compounds to the synthesis of simple organic molecules.

OE2. To apply the basic concepts of organic reaction mechanisms to the study and understanding of synthetic strategies.

OE3. To relate the structure of the main functional groups of organic compounds with their fundamental spectroscopic features.

OE4. To interpret experimental data of organic compounds (physical, spectroscopic and spectrometric) and apply then to the structural analysis.

OE5. To recognize the importance of Organic Chemistry within science, and its impact on today's society (industry, environment, medicine...).

OE6. To apply experimental protocols of synthesis, isolation, purification and structural elucidation to new organic compounds.

OE7. To search and use the suggested literature for the development of the course.

III.- BACKGROUND KNOWLEDGE AND RECOMMENDATIONS

■ PRIOR KNOWLEDGE:

Knowledge of the fundamental organic reaction mechanisms, stereochemistry and conformational analysis and of the basic experimental techniques used on an organic chemistry laboratory.

■ RECOMENDATIONS:

It is recommended that students enrolling in this course have previously taken and passed the *Organic Chemistry I* course.

IV.- CONTENTS

■ BRIEF DESCRIPTION OF THE CONTENTS:

Theory contents:

Structural determination of organic compounds by spectroscopic and spectrometric methods. Chemistry of enols and enolates. Introduction to the structure and reactivity of natural products.

Laboratory contents:

Organic syntheses selected by the biological, technological or industrial interest of the products and/or by the synthetic methodology employed (use of organometallic reagents, catalysis…). Use of spectroscopical techniques for the characterization of products and synthetic intermediates.

■ PROGRAM:

THEORY:

- ***1. Structural analysis of organic compounds.***
- 1.1. ^{1}H and ^{13}C Nuclear Magnetic Resonance Spectroscopy
- 1.1.1. Chemical equivalence.
- 1.1.2. Coupling constants.
- 1.1.3. Magnetic equivalence.
- 1.2. Mass Spectrometry. Basic fragmentations of organic compounds.
- 1.3. Application to solve structures by using a combination of spectroscopical and spectrometrical techniques.
- ***2.Chemistry of enols and enolates.***
- 2.1. Structure and reactivity.
- 2.2. Reactions of enols and enolates: alkylation and condensation. Synthetic equivalents of enolates.
- 2.3. α,ß-Unsaturated carbonylic compounds: conjugated addition, Michael addition and Robinson annelation.
- ***3. Introduction to organic synthesis***

- 3.1. Basic concepts. Objectives of the organic synthesis.
- 3.2. Functional groups transformations.
- 3.3. Activation and protection of functional groups.
- 3.4. Retrosynthetic analysis.
- ***4. Introduction to the structure and reactivity of natural products.***
- 4.1. Introduction to the chemistry of heterocyclic compounds.
- 4.2. Carbohydrates.
- 4.3. Aminoacids and peptides.

LABORATORY:

Laboratory sessions (12 sessions, first semester)

1. Chemistry of enolates I (2 sessions)
2. Chemistry of enolates II (2 sessions)
3. Coupling reactions (1 session)
4. Chemistry of enolates III (1 session)
5. Luminescence of organic compounds (0,5 sessions)
6. Natural products chemistry (3,5 sessions)
7. Chemistry of enolates IV (2 sessions)
8. Characterization of organic compounds by spectroscopical techniques (transversal content to be developed in all sessions).

V.- TARGET COMPETENCES

■ GENERAL:

CG1-MF1	Recognize chemical processes in daily life.
CG2-MF1	Relate chemistry to other disciplines.
CG3-MF1	Continue his/her studies in multidisciplinary areas.
CG5-MF1	Demonstrate knowledge and understanding of the essential facts, concepts, principles, and theories related to Chemistry domains.
CG6-MF1	Analyze and solve qualitative and quantitative problems.
CG7-MF1	Recognize and analyze new problems and plan strategies to solve them.
CG8-MF1	Consult and use scientific information in an effective way.

CG9-MF1	Demonstrate knowledge of laboratory materials and practical skills.
CG10-MF1	Handle chemical equipment and materials safely.
CG10-MF2	Recognize and assess hazards in the use of chemicals and laboratory procedures.
CG11-MF1	Handle standard chemical instrumentation.
CG11-MF2	Develop the ability to apply techniques for the characterization of chemical species.
CG12-MF1	Interpret data from observations and laboratory measurements.
CG13-MF1	Recognize and implement good scientific practices in measurement and experimentation.

■ SPECIFIC:

CE1-MFQO1	Master the basic language of Organic Chemistry (also in the English language for bilingual groups).
CE14-MFQO1	Relate and recognize the structure and reactivity of functional groups of organic compounds.
CE14-MFQO2	Interpret experimental data of organic compounds (spectroscopic and spectrometric) and apply them to structural analysis.
CE15-MFQO1	Interpret experimental data on the reactivity of organic compounds and the selectivity of organic reactions
CE15-MFQO2	Design strategies and apply different methods for the synthesis of simple organic structures.
CE16-MFQO1	Apply experimental protocols for the synthesis, isolation, purification, and structural elucidation of novel organic compounds.

■ TRANSVERSAL:

CT1-MF1	Prepare and write reports of scientific and technical nature.
CT2-MF1	Cooperate with other students through teamwork.
CT3-MF1	Apply critical and self-critical reasoning.
CT5-MF1	Use chemical information and bibliography.
CT6-MF1	Identify the importance of chemistry in the industrial, environmental and social context.
CT7-MF1	Use computer tools and programs.
CT11-MF1	Develop autonomous learning.
CT12-MF2	Develop sensitivity to environmental issues.

VI. – LEARNING OUTCOMES

Once the student has passed this course, he/she should be able to:

1. Know the structure and reactivity of enols and enolates in alkylation and condensation reactions and their synthetic equivalents.
2. Know the structure and reactivity of α,ß-unsaturated carbonylic compounds toward nucleophiles and their annelation reactions.
3. Design simple synthetic methodologies to form C-C bonds, using organic functional groups transformations and the main strategies of activation and protection.
4. Know and apply the basic Retrosynthetic Analysis methodologies to make simple molecules.
5. Know the structure and reactivity of carbohydrates, aminoacid, peptides and proteins.
6. Know the basic concepts on the structure and reactivity of heterocyclic compounds.
7. Correlate the basic information obtained from the different spectroscopical techniques and apply it to the structural determination of organic molecules.

VII. – WORKING HOURS AND DISTRIBUTION BY ACTIVITY

Activity	Face-to-face (hours)	Personal Work (hours)	Credits (hours)
Theory Classes	56	54	4,4 (110)
Seminars	20	45	2,6 (65)
Tutorials/guided work	8	17	1,0 (25)
Laboratory	42	31	2,92 (73)
Preparation of exams	6	21	1,08 (27)
Total	**132**	**168**	**12 (300)**

VIII.- METHODOLOGY

A mixed methodology based on cooperative learning, collaborative learning and self-learning will be followed. The face-to-face activities of the course are structured in lectures or master classes of the principles, seminar classes, tutorials and guided activities, and practical classes (practicum).

Theory lectures
These lectures will be held in the classroom and within them the headings indicated in the course syllabus as "lectures" will be developed by the teacher. They will allow the student to obtain a global and comprehensive view of the subject. Blackboard and computer presentations will be used. At the end of each topic, new proposals may be made to

interrelate contents already studied with those of the rest of the topic or with other topics. Prior to the presentation, all the teaching materials necessary for the classes, which do not appear in the course textbook, will be available to the students in the UCM Virtual Campus.

Seminar sessions
The aim will be to apply the student acquired knowledge to solve a set of questions/exercises. For this purpose, students will be given a set of questions/exercises related to each topic of the course. The teacher will explain, if necessary, some exercises and the rest will be solved by the students as personal work. Some of the questions will be related to aspects not described in the theory lectures, so that students can use the acquired knowledge in the answer to the questions.

Face-to-face tutorials/guided activities:
Face-to-face tutoring sessions will be held through the course on exercises related to the subject matter. In these tutoring sessions the teacher will review and correct, if necessary, the solutions proposed by the students, will solve the doubts and difficulties that have arisen in the resolution of the proposed exercises, and will guide the students to the correct solution of those exercises that were poorly proposed or solved.

Laboratory sessions:
laboratory sessions (12 sessions of 3,5 h/session) will be distributed during the first semester. Their contents will be directly related to those of the theory classes and the experiments will be explained in the laboratory manual. Prior to the execution of each experience, the students will prepare the experiments under the guidance of the professor. During each session, the student will perform the hands-on experiment(s) and will produce a laboratory notebook about their actual work, reflecting in detail each of the operations and reactions carried out. The laboratory notebook will be handed in to the teacher at the end of the practical sessions period.

IX.- BIBLIOGRAPHY

At the beginning of the course, the recommended bibliography will be commented, indicating the most relevant aspects of each text to the course.

■ THEORY

- **Reference Manual**: Clayden, J; Greeves, N. y Warren, S.: *"Organic Chemistry"*, 2nd ed., Oxford University Press, 2012 (ISBN 978-0199270293).
- **Specific Manuals**
- McMurry, J.: "*Química Orgánica*", 9ª ed., Cencage Learning, 2018 (ISBN 978-6075265582).
- Starkey, L.S.: "*Introduction to strategies for organic synthesis*", Wiley, 2012 (ISBN 978-0470484098).
- Hesse, M.; Meier, H. y Zeeh, B.: "*Métodos espectroscópicos en Química Orgánica"*, 2ª ed., Síntesis, Madrid, 2005 (ISBN 978-8477385226).

- Field, L. D.; Sternhell, S.; Kalman, J. R.: "*Organic Structure s from Spectra*" Wiley, 5th Ed. 2013, (ISBN 9781118325452).

■ LABORATORY

- Martínez Grau, M. A. y García Csákÿ, A.: "*Técnicas experimentales en síntesis orgánica*". Síntesis, Segunda edición, 2012.

X.- EVALUATION

For the final evaluation it is mandatory for the student to participate in the proposed activities. Attendance to all the laboratory sessions is also mandatory. In order to get the final evaluation, the student must have participated in at least 70% of the face-to-face activities. The student's academic performance and the final grade will be computed according to the weights shown in each of the items listed below. It will be mandatory for the student to pass the laboratory activities to obtain the final course grading. These sessions account for 15% of the overall grade. All grades will be based on the absolute 10-points score and according to the scale established in the law (RD1125/2003). This criterion will be maintained in all the partial exams and the final ones.
The grades of the activities foreseen for the evaluation of the course (periodic controls, partial exams, laboratory sessions...) will be communicated to the students with sufficient time before the final exam, so that they can adequately plan the study of this and other courses. In particular, the grades of the mid-term exams will be communicated within a maximum of 20 days, except in the case of the third partial exam, in which the period may be shorter in order to adapt to the final exam date. In any case, a minimum period of seven days between the publication of the grades and the date of the final exam of the course will be respected.

■ WRITTEN EXAMS: 70%

The course content is divided into two independent parts. The knowledge acquired by the student will be evaluated by means of several exams:

Spectroscopical Techniques (Topic 1). *Exam 1* (25%). The students having at least a 5.0 grade do not have to repeat this part in the final exam.

Synthesis and Reactivity (Topics 2-4). *Exam 2* (Topic 2, 15%). *Exam 3* (Topics 3 and 4, 30%). The students having at least a 5.0 grade *on each of* the exams (on both, *Exam 2* and *Exam 3*), do not have to repeat this part in the final exam.

Those students who take the final exam will need to obtain a minimum grade of 5.0 in that exam to have access to the overall grade of the course.

Competences assessed: CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE1-MFQO1, CE14-MFQO1, CE14-MFQO2, CE15-MFQO1, CE15-MFQO2, CE16-MFQO1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT12-MF2. The competence CE1-MFQO1 (to dominate the basic language of Organic Chemistry) is compulsory to pass the course. There will be several tests along the year to evaluate this competence.

■ PERSONAL WORK AND GUIDED ACTIVITIES: 15%

Tutorials, personal work, participation in classroom activities, seminars: The student's skills in solving the proposed problems and exercises will be valued. The active participation of the student in all the teaching activities will be valued positively in the final grade.
Competences assessed: CG1-MF1, CG2-MF1, CG7-MF1, CG8-MF1, CE1-MFQO1, CE14-MFQO1, CE14-MFQO2, CE15-MFQO1, CE15-MFQO2, CE16-MFQO1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2

■ LABORATORY 15%

Attendance at all scheduled sessions is mandatory. To pass the course it is also mandatory to obtain at least 5.0 points in the laboratory activities. The laboratory sessions will be continuously evaluated. Once finished the experimental sessions there will be a written exam. Qualification of the laboratory sessions will comprise a weighted grading of the work carried out in the laboratory plus the laboratory notebook contents (70%), and the grade obtained in the written exam (30%). The grades obtained either in the exam or in the laboratory work must have a minimum value of 4.5 points to make the final weighted grading. The students who failed to pass the written exam (but have passed the rest of activities, that is, theory and experimentation) could have an extraordinary written exam. The students who had passed the laboratory in the three years previous to the course, are not required to repeat it.
Competences assessed: CG1-MF1, CG2-MF1, CG7-MF1, CG8-MF1, CG9-MF1, CG10-MF1, CG11-MF1, CG11-MF2, CG12-MF1, CG13-MF1, All the transversals and specific competences.

■ EXTRAORDINARY GRADING

Extraordinary Exam:	**70%**
The continuous evaluation of the course (tutorials and active participation in classes) will be taken into account in the extraordinary grading (15%). The extraordinary exam, given to those students that failed the regular one, will have a 70% weight.	
Laboratory:	**15%**
There will be a written exam for those students who failed the corresponding laboratory exam in the regular call and a written exam plus a practical exam in case the laboratory was not passed in the regular exam and lab sessions. It is mandatory to obtain the grade 5.0 in the laboratory written exam to do the practical exam.	

ACTIVITY PLANNING– CHRONOGRAM

SUBJECT	ACTIVITY	HOURS	STARTS	ENDS
1. Structural analysis of organic compounds	Theory and problems classes	18	1st week	7th week
	Tutorials/Personal work*	2		
	Written exam	1	8th week	
2. Chemistry of enols and enolates	Theory and problems classes	25	8th week	16th week
	Tutorials/Personal work*	2	8th week	16th week
	Written exam	1	17th week	
3. Introduction to organic synthesis	Theory and problems classes	23	16th week	24th week
	Tutorials/Personal work*	2	16th week	24th week
4. Introduction to the structure and reactivity of natural products	Theory and problems classes	10	24th week	28th week
	Tutorials/Personal work*	2	24th week	28th week
	Written exam	1	28th week	

*Dates can be modified.

SUMMARY OF ACTIVITIES

Teaching Activity	Associated Competences	Teacher Activity	Student Activity	Evaluation Procedure	IP	NIP	Total	C (%)
Theory classes	CG2-MF1, CG7-MF1, CG8-MF1 CE1-MFQO1, CE14-MFQO1, CE14-MFQO2, CE15-MFQO1, CE15-MFQO2, CE16-MFQO1 CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT12-MF2	- Preparation of the materials. - Presentation of theoretical concepts.	- Previous preparation of the classes - Note taking.	- Marking of the written answers to questions related to the theoretical concepts explained	56	54	110	15
Seminars	CG1-MF1, CG8-MF1, CG10-MF2, CG12-MF1 CE1-MFQO1, CE14-MFQO1, CE14-MFQO2, CE15-MFQO1, CE15-MFQO2, CE16-MFQO1 CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2	- Previous Preparation of the classes. - Application of the theorethical contents to the resolution of exercices and problems.	- Previous preparation of the classes - Note taking - Completion of exercises - Formulation of questions and doubts.	- Marking of the answers (approach and result) made in writing for the resolution of the given practical exercises.	20	45	65	
Tutorials	CG1-MF1, CG8-MF1, CG10-MF2, CG12-MF1 CE1-MFQO1, CE14-MFQO1, CE14-MFQO2, CE15-MFQO1, CE15-MFQO2, CE16-MFQO1 CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF2	- Discussion of the programmed exercices.	- Consult the teacher about the conceptual and methodological difficulties encountered when studying the subject matter.	- Marking of the answers (approach and result) made in writing for the resolution of the given practical exercises.	8	17	25	

Teaching Activity	Associated Competences	Teacher Activity	Student Activity	Evaluation Procedure	IP	NIP	Total	C (%)
Exams	All general, specific and crosscutting competencies	- Proposal, proctoring and correction of the examinations. - Student marking.	- Preparation and completion of exams and other tests.	- Assessment of written exams.	6	21	27	70
Laboratory	All general, specific and crosscutting competencies	- Explanation and supervision of the experimental procedures - Teach how to interpret and discuss the experiments carried out	- Conducting and analyzing experiments.	- Continuous evaluation of the student's attitude and aptitude (skills) in the laboratory.	42	31	73	15
Laboratory Exams	All general, specific and crosscutting competencies	- Proposal, proctoring and correction of the exams. - Student marking	- Preparation for and completion of the exams.	- Evaluation of exams				
IP: In-person; NIP: non in-person (autonomous work); C: rating								