FACULTAD DE
CIENCIAS QUÍMICAS

ORGANIC CHEMISTRY II

COURSE GUIDE

BSc Chemistry

Academic Year 2026-2027

UNIVERSIDAD
COMPLUTENSE
MADRID

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-403 margg@ucm.es
Laboratory Coordinator	**Professor:** **Department:** **Office:** **e-mail:**	**Paloma Martínez Ruiz** Organic Chemistry QB-415 palmarti@ucm.es

Group A		
Theory Seminars Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	**Mª del Mar Gómez Gallego** Organic Chemistry QB-403 margg@ucm.es
Group B		
Theory Seminars Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	**Silvia Roscales García** Organic Chemistry QA-338A silviaroscales@quim.ucm.es
Group C		
Theory Seminaris Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	**Paloma Martínez Ruiz** Organic Chemistry QB-415 palmarti@ucm.es
Group D		
Theory Seminars Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	**Israel Fernández López** Organic Chemistry QA-328-A israel@ucm.es

Group E (English)	
Theory **Seminars** **Tutorials**	**Professor:** **Beatriz Lora Maroto** **Department:** Organic Chemistry **Office:** QA-332D **e-mail:** belora@ucm.es

Laboratory QA-340

Group	Term	Professor	e-mail	Office	Dept.
A1-A4	1st	Mª del Mar Gómez Gallego	margg@ucm.es	QB-403	QO
	1st	José Luis Segura Castedo	segura@ucm.es	QB-344	QO
	1st	Beatriz Illescas Martínez	beti@ucm.es	QB-301B	QO
	1st	Andreas Gouloumis	andreas.gouloumis@quim.ucm.es	QA-332B	QO
B1-B4	1st	M. Ángeles Herranz	maherran@ucm.es	QB-331A	QO
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	1st	Andreas Gouloumis	andreas.gouloumis@quim.ucm.es	QA-332B	QO
	1st	Laura Rodríguez	laura.rodriguez.perez@quim.ucm.es	QA-338	QO
C1-C4	1st	José Luis Segura Castedo	segura@ucm.es	QB-344	QO
	1st	Paloma Martínez Ruiz	palmarti@ucm.es	QB-415	QO
	1st	Beatriz Illescas Martínez	beti@ucm.es	QB-301B	QO
	1st	Ángel Martín Domenech	angmar@ucm.es	QB-402A	QO
D1-D4	1st	Beatriz Illescas Martínez	beti@ucm.es	QB-301B	QO
	1st	Israel Fernández López	israel@ucm.es	QA-328A	QO
	1st	Andreas Gouloumis	andreas.gouloumis@quim.ucm.es	QA-332B	QO
	1st	José Santos Barahona	jsantosb@ucm.es	QB-348A	QO
E1-E2	1st	José Luis Segura Castedo	segura@ucm.es	QB-344	QO
	1st	José Osío Barcina	josio@ucm.es	QB-414	QO

II.- OBJECTIVES

GENERAL OBJECTIVES

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

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

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

OG4. To introduce the student to 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 them 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:

Structure and reactivity of the main organic functional groups. Knowledge of the fundamental organic reaction mechanisms (substitution, elimination, addition reactions, etc.). Basic knowledge of stereochemistry and conformational analysis. Competence in basic experimental techniques used in 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. Introduction to Organic Synthesis.

Laboratory contents:
Organic syntheses selected based on the biological, technological or industrial interest of the products and/or on the synthetic methodology employed (use of organometallic reagents, catalysis, etc.) Use of spectroscopical techniques for the characterization of products and synthetic intermediates.

■ PROGRAM:

THEORY:

- ***Lesson 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 problem-solving in structural determination through the combined use of spectroscopical and spectrometrical techniques.
- ***Lesson 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 carbonyl compounds: conjugated addition, Michael addition and Robinson annelation.
- ***Lesson 3. Introduction to organic synthesis***
- 3.1. Basic concepts. Objectives of organic synthesis.
- 3.2. Functional group interconversion.
- 3.3. Functional group protection.
- 3.4. Retrosynthetic analysis.

- ***Lesson 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. Characterization of organic compounds by spectroscopical techniques (transversal content to be developed in all sessions).
2. Chemistry of enolates I (2 sessions)
3. Heterocyclic Chemistry in the context of Green Chemistry (1 session)
4. Chemistry of enolates II (1 session)
5. Luminescence of organic compounds (1 session)
6. Functional Groups Protection (4 sessions)
7. Chemistry of enolates III (2 sessions)

V.- 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 and their synthetic equivalents in alkylation and condensation reactions.
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 group transformations and the main strategies of functional group activation and protection.
4. Know and apply the basic Retrosynthetic Analysis methodologies to make simple molecules.

5. Know the structure and reactivity of carbohydrates, aminoacids, 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, seminar classes, tutorials/guided activities, and practical classes (laboratory).

Theory lectures
These lectures will be held in the classroom by the professor. They will cover the most important points of the topics outlined in the course syllabus. They will allow the students to gain 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 those contents already studied with other contents from the course or form other courses. Prior to the presentation, all the teaching materials necessary for the classes will be available to the students at the UCM Virtual Campus, or in the course textbook (if applicable).

Seminar sessions
The aim of the seminars will be to apply the acquired knowledge to questions/exercises-solving. For this purpose, students will be given a set of questions/exercises related to each topic of the course. In some cases, the students may be asked to solve some exercises individually and submit them to the professor. The professor 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 the 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 course contents. In these tutoring sessions the professor will review and correct, if necessary, the solutions proposed by the students, will solve the questions 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:
The laboratory sessions (12 sessions, 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 write a laboratory notebook about their actual work, reflecting in detail each one of the operations and reactions carried out. The laboratory notebook will be submitted 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.: "Organic Chemistry", 10th ed., Cencage Learning, 2023 (ISBN 978-1-951693-98-5).
    - 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 assessment, students must attend all laboratory activities, and must have participated in, at least, 70% of the in-person activities.

All marks will be based on a 10-point scale and in accordance with the scale established by law (RD 1125/2003). The final mark will be calculated as the weighted average of the assessed activities. However, to pass the course, it is necessary to achieve the minimum mark established for each of them. If this requirement is not met, the final mark will be the weighted average obtained, capped at 4.5 out of 10. This criteria will be applied to all partial and final examinations.

The grades of the activities foreseen for the evaluation of the course (partial exams, laboratory sessions, problem submission...) 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 to accommodate 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 knowledge acquired by the student will be evaluated through several exams that will have questions on the application of concepts learned during the course and related practical issues. The course content is divided into two independent parts:

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

Part II, Synthesis and Reactivity (Lessons 2-4, 45%) corresponds to two exams: *Exam 2* (Lesson 2, 15%) and *Exam 3* (Lessons 3 and 4, 30%). The students having a grade of at least 5.0 *on each of* the two exams (*Exam 2* and *Exam 3*), do not have to repeat this part in the final exam.

The students who did not pass any of the parts need to take the final exam. Those students who passed only one of the parts can take only the failed one in the final exam. In both cases, the weighted average grade of Part I and II must be equal to or higher than of 5.0 points.

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 necessary to pass the course. There will be several tests throughout the year to evaluate this competence.

■ PERSONAL WORK AND GUIDED ACTIVITIES: 15%

Tutorials, exercises, seminars and active participation in classroom activities:

The student's skills in problems- and exercises-solving will be evaluated through exercises proposed in seminar classes, tutoring exercises and control tests.

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 PRACTICUM 15%

Once finished the experimental sessions, the students will submit a *laboratory notebook* and will take a **written exam**. Qualification of the laboratory sessions will comprise a weighted grading of the work carried out in the laboratory, including the laboratory notebook contents, (70%), and the grade obtained in the written exam (30%). The grade of both the exam and the laboratory work must have a minimum value of 4.5 points and the average grade of both, according to the percentages indicated above, must be at least 5.0 points. The students who fail the written laboratory exam (but who have passed the rest of the activities: laboratory work and theory exam) will be offered the opportunity to take a complementary written laboratory exam in the regular examination call. If the grade for Laboratory is equal to or higher than 5.0 points, it will be saved for the following two academic years for students who do not pass the course in the current academic year. In agreement, for the academic year 2026-2027, the students who passed the laboratory in 2023-2024 or before, must repeat all the laboratory sessions in person.
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

The assessment criteria for the ordinary examination will also apply to the extraordinary examination.

Extraordinary Exam:	**70%**
A written exam will be held under the same conditions as in the ordinary examination session.	
Personal work and guided activities	**15**
The grade for the personal work and guided activities will be maintained in the extraordinary call.	
Laboratory:	**15%**
The Laboratory evaluation grade will be mantained in case the activity has been passed in the ordinary session. There will be a written exam for those students who only failed the corresponding laboratory written 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 at least a grade of 5.0 in the laboratory written exam to take 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	
Exams	All general, specific and crosscutting competencies	- Proposal, proctoring and correction of the examinations.	- Preparation and completion of exams and other tests.	- Assessment of written exams.	6	21	27	70

Teaching Activity	Associated Competences	Teacher Activity	Student Activity	Evaluation Procedure	IP	NIP	Total	C (%)
		- Student marking.						
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								