FACULTAD DE
CIENCIAS QUÍMICAS

ORGANIC CHEMISTRY I

COURSE GUIDE

BSc Chemistry

Academic Year 2023-2024

UNIVERSIDAD
COMPLUTENSE
MADRID

SCENARIO 1. FACE-TO-FACE

I.- COURSE IDENTIFICATION

COURSE NAME:	**Organic Chemistry I**
NUMBER OF CREDITS:	**12**
CHARACTER:	**Mandatory**
SUBJECT:	**Organic Chemistry**
MODULE:	**Fundamental**
DEGREE:	**Degree in Chemistry**
SEMESTER/COURSE:	**Annual (2nd year)**
DEPARTMENT/S:	**Organic Chemistry**

PROFESSORS IN CHARGE:

Course Coordinator	**Professor:** **Department:** **Office:** **e-mail:**	LUIS CASARRUBIOS PALOMAR Organic Chemistry QB-307A lcasarru@ucm.es
Laboratory & Spectrometry Seminars Coordinator	**Professor:** **Department:** **Office:** **e-mail:**	LUIS CASARRUBIOS PALOMAR Organic Chemistry QB-307A lcasarru@ucm.es

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Theory Seminars Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	SANTIAGO DE LA MOYA CERERO Organic Chemistry QA-332D santmoya@ucm.es
Group B (Theory)		
Theory Seminars Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	MARIA ÁNGELES HERRANZ ASTUDILLO Organic Chemistry QB-331A maherran@ucm.es
Group C (Theory)		
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Group D (Theory)		
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Group E *(bilingual English/Spanish)* (Theory)		
Theory Seminars Tutorials	**Professor:** **Department:** **Office:** **e-mail:**	GUILLERMO ORELLANA MORALEDA Organic Chemistry QB-413 gorellana@ucm.es
Group F (Theory)		
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Practicum

Group	Quarter	Professor	eMail	Office	Depar
A1	2nd	M. J. Ortiz	mjortiz@quim.ucm.es	QA-327-B	QO
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A4	2nd	B. Benhamú	belly@ucm.es	QB-401-B	QO
B1	2nd	M. J. Mancheño	mjmreal@ucm.es	QB-332	QO
B2	2nd	R. Cuervo	rociocr@ucm.es	QA-325-A	QO
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D2	2nd	A. Gouloumis	agouloum@ucm.es	QA-332-B	QO
D3	2nd	L. Rodríguez	lrodrigu@ucm.es	QA-338	QO
D4	2nd	J. Osío	josio@ucm.es	QB-414	QO
E1	2nd	J. L. Segura	segura@ucm.es	QB-344	QO
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Spectrometry Seminars

Group	Quarter	Professor	eMail	Office	Depar
A	2nd	M. J. R. Yunta	mjryun@ucm.es	QA-329-D	QO
B	2nd	P. Martínez	palmarti@ucm.es	QB-415	QO
C	2nd	L. Rodríguez	lrodrig@ucm.es	QA-338	QO

D	2nd	M. A. Canales	ma.canales@quim.ucm.es	QB-348-A	QO
E	2nd	B. Lora	belora@ucm.es	QB-325-B	QO
F	2nd	H. Vázquez	hvazquez@quim.ucm.es	QB-348-A	QO

II.- OBJECTIVES

■ GENERAL OBJECTIVE

To introduce the student to the study of the fundamentals of the reactivity of the most important functional groups present in organic compounds. We aim that the students:

- Acquire the appropriate knowledge that will allow him/her to know and relate the structure of the main functional groups with their reactivity.
- Acquire a series of manual and intellectual skills that will allow him/her to carry out the synthesis of simple organic compounds, as well as their subsequent separation and purification.
- Become acquainted with the handling and manipulation of the common materials of an organic chemistry laboratory, which will allow him/her to carry out the usual assemblies that are typical of Organic Chemistry procedures, as well as to learn to relate the structure and reactivity of organic compounds with their preparation.

Furthermore, the spectroscopic characteristics of the main functional groups will be illustrated to the student.

■ SPECIFIC OBJECTIVES

- To relate the structure of the main functional groups of organic compounds with their characteristic reactivity and their fundamental spectroscopic features.
- To apply the basic concepts of Organic Chemistry to interpret the course of the fundamental organic reactions.
- To recognize the importance of Organic Chemistry within science, and its impact on today's society (industry, environment, medicine...).
- To plan and carry out the synthesis of simple organic molecules through basic experimental procedures.
- To acquire experimental work habits, knowledge and safety rules in an organic chemistry laboratory.
- To search and use the suggested literature for the development of the course.

III.- BACKGROUND KNOWLEDGE AND RECOMMENDATIONS

■ PRIOR KNOWLEDGE:

Structure and basic nomenclature of hydrocarbons. Structure and nomenclature of the most important functional groups with single and multiple bonds. Types of isomerism. Three-dimensional structure of organic molecules.

■ RECOMMENDATIONS:

It is recommended that students enrolling in this course have previously taken and passed the *General Chemistry, Basic Laboratory Operations* and *Computer Science Applied to Chemistry* courses.

IV.- CONTENTS

BRIEF DESCRIPTION OF THE CONTENTS:

Theory contents

Alkanes, cycloalkanes, alkenes, alkynes, and aromatic hydrocarbons. Compounds with single carbon-heteroatom bond. Compounds with multiple carbon-heteroatom bonds.

Practicum contents:

Synthesis, isolation, purification, and introduction to structural analysis of simple organic compounds.

PROGRAM:

THEORY:

1. Introduction to Organic Chemistry

- General concepts
- Molecular structure and organic reactions

Hydrocarbons

2. Alkanes and cycloalkanes

- Structure
- Characteristic reactivity
- Stereochemical aspects of organic reactions

3. Alkenes, conjugated systems, and alkynes

3.1. Alkenes and cycloalkenes

- Structure
  - General reactivity:
    - Electrophilic additions
    - Radical additions
    - Oxidation reactions

3.2. Conjugated systems

- Structure
- Conjugated dienes
  - Electrophilic addition reactions: 1,2 vs. conjugated addition
  - Diels-Alder reaction

3.3. Alkynes

- Structure
- Acidity of terminal alkynes: acetylides
- Electrophilic addition reactions

4. Arenes

- Structure
- Concept of aromaticity
- General reactivity:
  - Electrophilic aromatic substitution: kinetics and regioselectivity
  - Reactions in the lateral chains

Molecules with carbon-heteroatom single bonds

5. Halogenated derivatives

- Structure
- General reactivity: nucleophilic substitution and elimination reactions Stereochemical aspects
- Organometallic compounds
  - Nomenclature
  - Synthesis and general reactivity

6. Alcohols and phenols

- Structure
- Acidity and basicity
- Nucleophilic substitution reactions
- Elimination reactions
- Oxidation reactions

7. Ethers and epoxides

7.1. Ethers

- Structure
- General reactivity

7.2. Epoxides

- Opening reactions: regioselectivity and stereochemistry

8. Amines. Other nitrogen compounds

8.1. Amines

- Structure
- Acid-base properties
- General reactivity

8.2 Arenediazonium salts

- Structure of the diazonium group
- General reactivity

Molecules with carbon-heteroatom multiple bonds

9. Aldehydes and ketones

- Structure
- General reactivity
- Nucleophilic addition reactions
- Nucleophilic addition-elimination reactions (condensation)
- Oxidation and reduction reactions
- Keto-enol tautomerism and related reactions

10. Carboxylic acids and derivatives

10.1. Carboxylic acids

- Structure

- Acidity
- Reactivity

10.2. Carboxylic acid derivatives and related compounds

- Main classes
- Relative reactivity
- Hydrolysis reactions
- Interconversion reactions
- Other specific reactions
- Nitriles

PRACTICUM:

1. Laboratory sessions

1.1. Separation and purification of the components of a mixture (2 sessions)

- Techniques for isolation of organic compounds: amines, acids, phenols and neutral compounds
- Purification of organic compounds by distillation, recrystallization, and sublimation techniques
- Characterization of the isolated compounds: melting point/boiling point

1.2 Synthesis of two drugs (2 sessions)

- Acetylsalicylic acid: Synthesis, purification by recrystallization and characterization (melting point); calculation of the reaction yield
- Paracetamol: Synthesis, purification by recrystallization and characterization (melting point); calculation of the reaction yield
- Analysis of commercial analgesics by thin-layer chromatography

1.3 Synthesis of* tert*-butyl chloride (1 session)

- Synthesis, purification by distillation and characterization (boiling point); calculation of the reaction yield

1.4 Nitration of chlorobenzene (3 sessions)

- Synthesis, isolation, and purification of *ortho/para* isomers by silica gel column chromatography; calculation of the reaction yield

1.5 Synthesis of camphor and isoborneol (2 sessions)

- Oxidation of borneol to camphor; purification by sublimation and characterization (melting point); calculation of the reaction yield
- Reduction of camphor to isoborneol; purification by sublimation and characterization (melting point); calculation of the reaction yield

2. Spectrometry seminars

Principles of structural elucidation of organic compounds by spectrometric methods

- Principles of the analysis and interpretation of UV-vis and infrared spectra
- Principles of molecular structure elucidation through interpretation of proton nuclear magnetic resonance (NMR) spectra

- Basic molecular structure analysis by interpretation of carbon-13 NMR spectra
- Mass spectrometry: molecular weight and molecular formula determination

V.- TARGET COMPETENCIES

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. Classify organic compounds into series and families.
2. Identify the unique characteristics of the carbon atom in the formation of organic structures.
3. Explain the concepts of functional group and homologous series.
4. Distinguish the different types of isomerism.
5. Name the hydrocarbon skeletons as the basis of organic nomenclature.
6. Identify and name the different functional groups.
7. Establish a biunivocal correspondence between name and structure of monofunctional organic compounds.

8. Establish the nomenclature of simple polyfunctional compounds according to the priority of groups.
9. Identify the main electronic effects in organic molecules.
10. Explain the basic thermodynamic and kinetic aspects of the reaction mechanisms in Organic Chemistry.
11. Apply the three-dimensional structures of organic molecules to stereochemical, chiral, and conformational analysis.
12. Relate molecular structure to the chemical behavior of organic substances.
13. Explain the reactivity of saturated hydrocarbons (alkanes).
14. Explain the chemistry of double and triple bonds in unsaturated hydrocarbons (alkenes and alkynes).
15. Identify and interpret electrophilic addition reactions to the π bond.
16. Interpret the reactivity of conjugated systems.
17. Explain the general concept of aromaticity and decide when a compound is aromatic.
18. Explain the uni- and bi-molecular nucleophilic substitution in halogenated derivatives, alcohols, and derivatives.
19. Relate the differences between oxygenated and sulfur organic compounds, as well as other heteroelements, with the atomic structures of these compounds.
20. Justify the reactivity of amines and other nitrogen compounds.
21. Interpret the behavior of functional groups containing multiple carbon-heteroatom bonds.
22. Explain the nucleophilic addition processes to the carbonyl group.
23. Explain the nucleophilic substitution processes on the acyl group of carboxylic acids and their derivatives.
24. Recognize the analytical and spectroscopic data of organic molecules and apply them to their structural determination.
25. Correlate the basic information obtained from UV-vis, infrared and nuclear magnetic resonance spectroscopy of ^{1}H- and ^{13}C-, as well as mass spectrometry, in simple organic structures.
26. Correctly perform experimental procedures for the isolation and purification of organic substances.
27. Apply the experimental techniques of organic synthesis to the synthesis of simple organic compounds.

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	40	3.2 (80)
Tutorials/guided work	8	12	0.8 (20)
Laboratory seminars	10	10	0.8 (20)
Practicum (laboratory sessions)	35	28	2.52 (63)

Preparation of papers and exams	6	21	1.08 (27)
Total	**135**	**165**	**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 hands-on classes (practicum).**

Theory lectures (2 h/week during the whole course): 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 throughout 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.

Practicum: The practical classes block of the Organic Chemistry course consists of two differentiated and independent parts: the laboratory sessions and the spectrometry seminars.

Laboratory sessions ("practicum"): laboratory sessions with contents directly related to those of the theory classes will be developed to complement and support the latter as well as the seminars. Ten experimental laboratory sessions (3.5 h/session), distributed in two weeks during the second semester, have been scheduled. In these sessions, the experiments selected in the course practicum will be carried out; all of them are included in the practicum syllabus. Prior to the execution of each experience, the students will have to search the literature for all the data and information necessary to carry it out. 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.

Spectrometry seminars ("laboratory seminars"): Independently of the laboratory sessions, a total of 10 h of spectrometry seminars will be taught in the second semester. The seminars will convey basic knowledge on the techniques of structural determination of

organic compounds, and exercises of both theoretical and practical content will be carried out.

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.

■ BASIC:

THEORY

- Vollhardt, K.P.C.; Schore, N. E.: "*Organic Chemistry: Structure and Function*", **5th** ed., W.H. Freeman & Co., 2007. ISBN: 0-7167-9949-9 (Most recent English edition: Vollhardt, K.P.C.; Schore, N.E. *"Organic Chemistry: Structure and Function"*, 8th ed., W.H. Freeman & Co. 2018).

■ COMPLEMENTARY:

THEORY

- Clayden, J.; Greeves, N.; Warren, S.: "*Organic Chemistry*", 2nd Ed., Oxford University Press, 2012. ISBN 978-0-19-927029-3.
- Favre, H.A.; Powell, W.H., "Nomenclature of Organic Chemistry" (**IUPAC Recommendations and Preferred Names 2013**), The Royal Society of Chemistry, Cambridge (UK), 2014.
- Gómez Aspe, R.: "*Teoría y problemas resueltos de Química Orgánica"*, Ed. Síntesis, 2013. ISBN 978-84-995888-4-1.

PRACTICUM

Laboratory

- Csákÿ, A. G.; Martínez Grau, M. A.: "*Técnicas Experimentales en Síntesis Orgánica*", Ed. Síntesis, 2012, ISBN: 84-7738-605-6.
- Rodríguez Yunta, M. J.; Gómez Contreras, F.: "*Curso Experimental en Química Orgánica",* Ed. Síntesis, 2008. ISBN: 978-84-975655-9-2.

Spectrometry Seminars

- Field, L. D.; Sternhell, S.; Kalman, J. R.: "Organic Structures from Spectra", John Wiley *& Sons, 5th Ed., 2015.* ISBN: 978-1118325452.

X.- EVALUATION

For the final evaluation it is mandatory for the student to participate in the proposed activities. Attendance to all the laboratory sessions and the spectrometry seminar 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 (except for the practicum and the spectrometry seminar, both of which require 100% attendance).

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 practicum 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 finals.

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 second 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:

Written examinations	**60%**
The knowledge acquired by the student will be evaluated by means of two mid-term ("partial") exams, one at the end of each quarter, and a final exam. Students who pass the two mid-term exams (grade ≥ 5 in each of them) will not be required to take the final exam. Those *students who take the final exam will have to obtain a minimum grade of 5.0 in that exam to have access to the overall grade of the course*. The evaluation criteria of the regular exam will be maintained in an extraordinary exam (given to the student in case of ordinary exam failure).	
Assessed competencies: CE1-MFQO1, CE14-MFQO1, CE15-MFQO1, CE15-MFQO1	

■ PERSONAL WORK AND GUIDED ACTIVITIES:

Participation in classroom activities:	**15%**
The student's skill 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.	
Assessed competencies: CE1-MFQO1, CE14-MFQO1, CE15-MFQO1, CE15-MFQO1; CT2-MF1, CT3-MF1, CT6-MF1, CT11-MF1	

■ PRACTICUM

Practicum (laboratory evaluation (15%) and spectroscopy seminars (10%)):	**25%**
Evaluation of the student performance in the laboratory sessions accounts for 15% of the final grade of the course. Attendance at all scheduled sessions is mandatory; they will be continuously evaluated together with a **written** (and/or hands-on, if applicable) **exam,** and the completion of the *laboratory notebook.* 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 (and	

practical, if any) exam to be taken at the end of those sessions (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 higher than 5 points to consider the practicum passed. *Failure to pass any of these activities will prevent passing the course*.
Spectrometry seminars account for 10% of the final grade of the course. Both the personal work and the grade obtained in an exam that will include theoretical and practical questions related to these seminars will be considered. *Failure to obtain a minimum grade of 4 points in this part will result in the impossibility of passing the course*.

Assessed competencies: CE1-MFQO1, CE14-MFQO2, CE15-MFQO1, CE16-MFQO1; CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT12-MF2

EXTRAORDINARY GRADING

Extraordinary Exam:	**60%**
The continuous evaluation of the course (tutorials and active participation in classes) will be taken into account in the extraordinary exam (15%). The extraordinary exam, given to those students that failed the regular one, will have a 60% weight.	
Laboratory and spectroscopy seminars:	**25%**
Laboratory: The practicum grade will be kept in case it is ≥ 5. There will be a written exam for those students who have failed the corresponding 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. *Seminar*: If the grade for the seminar in the regular exam is a "fail", and the average grade for the theory is also a "fail", students must take the exam for both parts in the extraordinary exam.	
Assessed competencies: CE1-MFQO1, CE14-MFQO1, CE15-MFQO1, CE15-MFQO1, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT12-MF2	

ACTIVITY PLANNING - CHRONOGRAM

SUBJECT	ACTIVITY	HOURS	GROUPS	HOME	FIN
1. Introduction to Organic Chemistry	Theory classes	5	1	1st Week	2nd Week
	Problem classes	2	1		
2. Alkanes and cycloalkanes	Theory classes	5	1	2nd Week	4th Week
	Problem classes	2	1		
3. Alkenes, conjugated systems and alkynes	Theory classes	9	1	4th Week	8th Week
	Problem classes	3	1		
	Scheduled tutorial	1	1	5th Week	
	Scheduled tutorial	1	1	8th Week	
4. Arenes	Theory classes	8	1	8th Week	13th Week
	Problem classes	3	1		
	Scheduled tutorials	2	1	Weeks 12 and 13	
5. Halogenated derivatives	**First partial exam**	3	1	Exams week end of 1st semester	
	Theory classes	5	1	13th Week	15h Week
	Problem classes	2	1		
	Scheduled tutorial	1	1	15th Week	
6. Alcohols and phenols	Theory classes	4	1	16th Week	17th Week
	Problem classes	2	1		
7. Ethers and epoxides	Theory classes	3	1	18th Week	19th Week
	Problem classes	1	1		
	Scheduled tutorial	1	1	19th Week	
8. Amines and other nitrogen-containing compounds	Theory classes	4	1	20th Week	21th Week
	Problem classes	1	1		
9. Aldehydes and ketones	Theory classes	7	1	22th Week	25th Week
	Problem classes	2	1		

SUBJECT	ACTIVITY	HOURS	GROUPS	HOME	FIN
	Scheduled tutorial	1	1	25th Week	
10. Carboxylic acids and derivatives	Theory classes	6	1	26th Week	28th Week
	Problem classes	2	1		
	Scheduled tutorial	1	1	28th Week	
	Second partial exam	3	1	Week at the end 2nd semester	

SUMMARY OF ACTIVITIES

Teaching activity	Associated competencies	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 theory to the resolution of exercises 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	40	80	
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	– Proposal of detailed resolution of exercises	– 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 practical exercises	8	12	20	
Examinations	All general, specific and cross-cutting 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	60

Teaching activity	Associated competencies	Teacher activity	Student activity	Evaluation procedure	IP	NIP	Total	C (%)
Laboratory seminars	CG6-MF1, CG7-MF1, CG8-MF1, CG11-MF2, CE1-MFQO1, CE14-MFQO2, CE16-MFQO1, CT2-MF1, CT5-MF1, CT7MF1, CT11-MF1	– Materials preparation – Presentation of theoretical concepts – Resolution of model exercises	– 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 practical exercises	10	10	20	10
Laboratories	All general, specific and cross-cutting 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	35	28	63	15
Laboratory tests	All general, specific and cross-cutting competencies	– Proposal, proctoring and correction of the exams – Student marking	– Preparation for and completion of the exams	– Exams evaluation				
IP : In-person; NIP: non in-person (autonomous work); C: rating								