COURSE GUIDE: 2013-14

DETAILS OF THE COURSE

Course:	Organic Chemistry II		
Code:	50902209	Plan:	Chemistry Degree (Program 2009)
Academic period:	2013-14	Degree Level:	Undergraduate Level
Academic year	2nd	Type:	Mandatory
Period:	Second Semester		

DISTRIBUTION OF HOURS

Credits:	6	Number of In-class Hours:	45
		Number of Out-of-class Hours:	105
		Total Hours:	150
USE OF THE VIRTUAL PLATFORM:		Teaching Support	

PROFESSORS DETAILS

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PLAN OF ACTIVITIES		
Learning activities and workload of the student (in hours)		
I. ACTIVITIES OF THE STUDENT(In-class/ Online)	• Large Group	0.0
	• Teaching Group	26.0
	• Work Group/Small Group	19.0
	Total Hours (In-class/On line) ...	45.0
II. OUT-OF-CLASS ACTIVITIES OF THE STUDENT (Autonomous work)	• (Team work, Individual work)	105
	Total Hours (Out-of-class) ..	105
TOTAL WORKING HOURS OF THE STUDENT		150.0

COURSE DESCRIPTION

Contents

The course is a continuation of Organic Chemistry I. In this course, students complete the basic study of the organic compounds classified on the basis of functional groups. The course includes the properties, characteristic chemical reactivity and methods of preparation of amines, carbonyl and carboxylic compounds as well as their derivatives. It is expected that by the end of term, students will have acquired an overview of Organic Chemistry.

Courses with which this course is related in the Undergraduate Program

- Chemistry
- Organic Chemistry I
- Experimental Organic Chemistry
- Advanced Organic Chemistry

Previous knowledge

Knowledge of General Chemistry is a prerequisite. Knowledge acquired in the course Organic Chemistry I (OCI) will be the starting point for this course. Building on the concepts studied in OCI will be an essential activity to progress appropriately in Organic Chemistry II.

Requirements set in the Plan

Being enrolled or to have passed the course Organic Chemistry I

COMPETENCIES

General Competencies

Generic Competencies of the University of Almería

- Problem Solving

Other Generic Competencies

- Application of knowledge

Specific Competencies

Cognitive (knowledge)

- To know the main types of chemical reactions and their most important features.
- To know how to provide a mechanistic interpretation of chemical reactions.
- To know the properties of aliphatic and aromatic compounds.
- To know the nature and behavior of the functional groups in organic molecules, particularly the aldehyde, ketone, carboxylic acid groups and derivatives.
- To know the reactivity of difunctional compounds.
- To know the main synthetic pathways in organic chemistry, including the interconversion of functional groups and the formation of carbon-carbon and carbon-heteroatom bonds

Procedural/instrumental (applied knowledge)

- Capacity to solve problems of Organic Chemistry.
- Capacity for evaluation, interpretation and synthesis of data and chemical information.

AIMS/LEARNING OUTCOMES

- Acquiring the capacity to apply the theoretical content of the course to the solution of problems related with the mechanisms of organic reactions, reactivity, properties and preparation of aromatic systems, aldehydes, ketones, amines, carboxylic acids and derivatives, as well as reactions of enolates and difunctional compounds.
- Knowing the most common organic chemical reactions.
- Having the capacity to relate the reactivity of the different types of organic molecules with their structural features.
- Being able to predict some fundamental properties and reactivity of aliphatic and aromatic compounds.
- Having the capacity to propose transformations of functional groups based on their reactivity.
- Having the capacity to propose simple synthesis of organic compounds through sequences of functional group transformations.

SYLLABUS

Group of contents	Aromatic Compounds

Contents/Topic

1. Structure and properties of the aromatic compounds

- The discovery of benzene
- Structure and properties of benzene
- The molecular orbitals of benzene
- The cyclobutadiene according to the molecular orbital theory
- Aromatic, antiaromatic and nonaromatic compounds
- Hückel's rule
- Molecular orbital theory derivation of Hückel's rule
- Aromatic Ions
- Heterocyclic aromatic compounds
- Polynuclear aromatic hydrocarbons
- Aromatic allotropes of carbon
- Fused heterocyclic compounds
- Nomenclature of benzene derivatives
- Physical properties of benzene and its derivatives
- Spectroscopy of aromatic compounds

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		2,0
Work Group/Small Group	Problem solving		2.0

Description of the autonomous work of the student

Contents/Topic

2. Reactivity of aromatic compounds

- Electrophilic aromatic substitution
- Halogenation of benzene
- Nitration of benzene
- Sulfonation of benzene
- Nitration of toluene: effect of alkyl substitution
- Activating, ortho- and para-directing substituents
- Deactivating, meta-directing substituents
- Halogen substituents: deactivating, but ortho-, para-directing
- Effects of multiple substituents on electrophilic aromatic substitution
- The Friedel-Crafts alkylation
- The Friedel-Crafts acylation
- Nucleophilic aromatic substitution
- Addition reactions of benzene derivatives
- Side-chain reactions of benzene derivatives
- Reactions of phenols

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		2.8
	Evaluation session		0.2
Work Group/Small Group	Problem based learning		2.0

Description of the autonomous work of the student

Group of contents	Ketones and Aldehydes

Contents/Topic

3. Structure, properties and synthesis of ketones and aldehydes

- Carbonyl compounds
- Structure of the carbonyl group
- Nomenclature of ketones and aldehydes
- Physical properties of ketones and aldehydes
- Spectroscopy of ketones and aldehydes
- Industrial importance of ketones and aldehydes
- Review of syntheses of ketones and aldehydes
- Synthesis of ketones and aldehydes from 1,3-dithianes
- Synthesis of ketones from carboxylic acids
- Synthesis of ketones from nitriles
- Synthesis of aldehydes and ketones from acid chlorides

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		3.0
Work Group/Small Group	Problem based learning		2.0

Description of the autonomous work of the student

Contents/Topic

4. Reactivity of ketones and aldehydes

- Reactions of ketones and aldehydes: nucleophilic addition
- The Wittig reaction
- Hydration of ketones and aldehydes
- Formation of cyanohydrins
- Formation of imines
- Condensation with hydroxylamine and hydrazines
- Formation of acetals
- The use of acetals as protecting groups
- Oxidation of aldehydes

	• Other reduction reactions of ketones and aldehydes

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		0.8
	Evaluation session		0.2
Work Group/Small Group	Problem based learning		2.0

Description of the autonomous work of the student

Group of contents	Amines

Contents/Topic

	5. Structure and properties of amines • Nomenclature of amines • Structure of amines • Physical properties of amines • Basicity of amines • Ammonium salts, phase transfer catalysts • Spectroscopy of amines

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		2.0
Work Group/Small Group	Problem based learning		1.0

Description of the autonomous work of the student

Contents/Topic

	6 Reactivity of amines • Reaction of amines with aldehydes and ketones (review) • Electrophilic aromatic substitution in arylamines and pyridine (review) • Nucleophilic aromatic substitution reactions • Alkylation of amines by alkyl halides • Acylation of amines by acid chlorides • Formation of sulfonamides • Amines as leaving group: the Hofmann elimination • Oxidation of amines. The Cope elimination • Reaction of amines with nitrous acid • Reactions of arendiazonium salts

	• Synthesis of amines

Teaching Method			
Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		2.8
	Evaluation session		0.2
Work Group/Small Group	Problem based learning		2.0

Description of the autonomous work of the student

Group of contents	Carboxylic acids and derivatives
Contents/Topic	
	7. Carboxylic acids • Nomenclature of carboxylic acids • Structure and physical properties of carboxylic acids • Acidity of carboxylic acids • Carboxylic acid salts • Commertial sources of carboxylic acids • Spectroscopy of carboxylic acids • Synthesis of carboxylic acids • Reactions of carboxylic acids and their derivatives. Nucleophilic acyl substitution • Condensation of acids with alcohols: Fischer esterification • Esterification using diazomethane • Condensation of acids with amines: direct synthesis of amides • Reduction of carboxylic acids • Alkylation of carboxylic acids to form ketones • Synthesis and use of acid chlorides

Teaching Method			
Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		3.0
Work Group/Small Group	Problem based learning		2.0

Description of the autonomous work of the student

Contents/Topic	
	8. Carboxylic acid derivatives • Structure and nomenclature of carboxylic acid derivatives • Physical properties of carboxylic acid derivatives

	• Spectroscopy of carboxylic acid derivatives • Interconversion of carboxylic acid derivatives by nucleophilic acyl substitution • Transesterification • Hydrolysis of carboxylic acid derivatives • Reduction of carboxylic acid derivatives • Reaction of carboxylic acid derivatives with organometallic reagents • Summary of the chemistry of acid chlorides • Summary of the chemistry of anhydrides • Summary of the chemistry of esters • Summary of the chemistry of amides • Summary of the chemistry of nitriles • Thioesters • Esters and amides of carbonic acid

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		3.8
	Evaluation session		0.2
Work Group/Small Group	Problem based learning		3.0

Description of the autonomous work of the student

Group of contents	Reactions of enols and enolates. Reactions of difunctional compounds.

Contents/Topic

	9. Sustituciones en alfa, y condensaciones de enoles y de iones enolato • Enols and enolate ions • Alkylation of enolate ions • Formation and alkylation of enamines • α-Halogenation of ketones • α-Bromination of acids: The Hell-Volhard-Zelinsky (HVZ) reaction • The aldol condensation of ketones and aldehydes • Dehydration of aldols • Crossed aldol condensations • Aldol cyclizations • Designing syntheses using aldol condensations • The Claisen ester condensation • The Dieckmann condensation: A Claisen Cyclization • Crossed Claisen condensations • Syntheses using ß-dicarbonyl compounds • The malonic ester synthesis • The acetoacetic ester synthesis • Conjugate additions: The Michael reaction

	• The Robinson annulation

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		3.8
	Evaluation session		0.2
Work Group/Small Group	Problem based learning		2.0

Description of the autonomous work of the student

Group of contents	Structure and reactivity of natural and synthetic organic compounds

Contents/Topic

10. Carbohydrates

- Classification of carbohydrates
- Monosaccharides
- Erythro and threo diastereomers
- Epimers
- Cyclic structures of monosaccharides
- Anomers of monosaccharides; mutarotation
- Reactions of monosaccharides: Side reactions in base
- Reduction of monosaccharides
- Oxidation of monosaccharides. Reducing sugars
- Nonreducing sugars: Formation of glycosides
- Ether and ester formation
- Reactions with phenylhydrazine: osazone formation
- Chain shortening: The Ruff degradation
- Chain lengthening: The Kiliani-Fischer synthesis
- Summary: Reactions of carbohydrates
- Fischer proof of the configuration of glucose
- Determination of ring size; Periodic acid cleavage of sugars
- Disaccharides
- Polysaccharides

Teaching Method

Organizational Mode	*Learning Activities*	*Comments*	*In-Class/On line Hours*
Teaching Group	Lectures/participative		0.8
	Evaluation session		0.2
Work Group/Small Group	Problem based learning		1.0

Description of the autonomous work of the student

MODE OF EVALUATION OF COMPETENCIES

Marking Criteria

METHOD A (Final exam) Any student enrolled in the course Organic Chemistry II may attend the final exams of the course (official call), according to the university regulations. Such exams will be in written format and both the generic and specific competencies will be assessed.

METHOD B (Continuous evaluation): Students performance will be graded as follows: 1) A minimum attendance of 80% of the scheduled sessions for both the Teaching Group and Small Group is required; 2) Periodical tests done during class time will contribute to 30% to the final grade; 3) Exercises and problem solving, as well as supervised papers will contribute 30% to the final grade; 4) Participation, defense of arguments and presentations will contribute 20% to the final grade; 5) A final test which requires a minimum score of 4 out of 10, will contribute 20% to the final grade.

Percentage of Evaluation of the Activities developed by the students

	Activity	*(hours)*	*Percentage*
I. ACTIVITIES OF THE STUDENT (In-class/ Online)	• Large Group	(0)	0 %
	• Teaching Group	(26)	40 %
	• Work Group/Small Group	(19)	20 %
II. OUT-OF-CLASS ACTIVITIES OF THE STUDENT (Autonomous work)	• (Team work, Individual work)	(105)	40 %

Evaluation Tools

- Progress reports
- Tests, exercises, problems.
- Observation of the process.
- Final tests (written or oral).

Monitoring mechanisms

- Attendance of tutorials
- Attendance and participation in seminars
- Access to “Aula Virtual”
- Submission of assigned work in class
- Submission of assigned work in “Aula Virtual”
- Others: Class attendance

BIBLIOGRAPHY

Recommended Bibliography
• Cuestiones y ejercicios de Química Orgánica. Una guía de autoevaluación *(E. Quiñoá, y R. Riguera,)* - Bibliografía básica • Foundations of Organic Chemistry: Worked Examples *(Michael Hornby, Josphine Peach)* - Bibliografía básica • Organic Chemistry *(Clayden, Greeves, Warren, Wother)* - Bibliografía básica • Problemas resueltos de Química Orgánica *(F.García y J.A. Dobado)* - Bibliografía básica • Química Orgánica *(K.P.C. Volhardt y N.E. Schore,)* - Bibliografía básica • Química orgánica v.1 *(L. G. Wade, Jr.)* - Bibliografía básica • Química orgánica v.2 *(L. G. Wade, Jr.)* - Bibliografía básica •

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