Organic Chemistry of Functional Groups-I

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**XO202**	**SEMESTER**	**2nd**
COURSE TITLE	ORGANIC CHEMISTRY OF FUNCTIONAL GROUPS I		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Organic Chemistry).
PREREQUISITE COURSES:	Typically, there are not prerequisite courses. Essentially, the students should possess the knowledge provided through the previously taught theoretical course "Structure, Reactivity and Mechanisms in Organic Chemistry'' (1st semester).
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Teaching may be however performed in English in case foreign students attend the course.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

By the end of this course the student will be able to:

Be familiar with the general chemistry of the following classes of organic compounds: alkanes, alkenes, alkynes, alkyl halides (halo alkanes), alcohols, phenols, ethers. epoxides, benzene and its derivatives.

Specifically:

Alkanes

Account for "strain" in small rings. Relate the difficulty of forming cyclic systems to the size of ring required.

Alkenes

Use simple orbital overlap theory to account for non-rotation about *pi* bonds, conjugation, the stability of allyl carbocations, and the features of the Diels-Alder reaction. Utilise the chemo- and stereo-selective nature of the Lindlar catalyst.

Aromatic compounds

Explain the structure, stability and reactivity of benzene using the concept of resonance. Identify simple non-benzenoid aromatic molecules by using Hückel's rule. Distinguish between Friedel-Crafts alkylation and acylation reactions for use in synthesis. Explain the stability of the benzyl free radical, cation and anion, and show how this determines the chemistry of toluene and its side-chain derivatives.

Explain how reaction conditions determine the position of substitution in naphthalene.

Alkyl halides (haloalkanes and haloaromatic compounds)

Exploit the usefulness of alkyl halides in synthesis, especially through substitution and organometallic reagents. Account for the reduced reactivity of "non activated" halo aromatics and halo alkenes.

Alcohols and phenols, ethers and epoxides

Exploit the usefulness of alcohols and epoxides in synthesis. Account for the acidity of phenols. Explain the behaviour of crown ethers.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

By the end of this course the student will, furthermore, have developed the following skills (general abilities):

1. Ability to exhibit knowledge and understanding of the essential facts, concepts, theories and applications which are related to Organic Chemistry.
2. Ability to apply this knowledge and understanding to the solution of problems related to Organic Chemistry of non-familiar nature.
3. Ability to adopt and apply methodology to the solution of non-familiar problems of Organic Chemistry.
4. Study skills needed for continuing professional development.
5. Ability to interact with others in chemical or of interdisciplinary nature problems.

Generally, by the end of this course the student will, furthermore, have develop the following general abilities (from the list above):

Searching, analysis and synthesis of facts and information, as well as using the necessary technologies

Adaptation to new situations

Decision making

Autonomous (Independent) work

Group work

Exercise of criticism and self-criticism

Promotion of free, creative and inductive thinking

Respect to natural environment

Work design and management

3. SYLLABUS

Alkanes

Sources, preparation, oxidation, free radical halogenation, combustion. Cycloalkanes - small, medium and large rings, ring strain.

Alkenes

Electronic structure, *cis-trans* isomers, preparation via elimination reactions. Addition reactions - hydrogenation, electrophilic addition of HX, H2O, halogens, orientation of alkene addition reactions, Markovnikov's rule, carbocation structure and stability, addition in the presence of peroxides - anti-Markovnikov. Hydroboration. Oxidation of alkenes by manganate(VII), peroxo-acids, and ozone. Conjugated dienes, resonance, stability of allylic carbocations, 1,2- and 1,4- addition to dienes. Cycloaddition reactions (Diels-Alder).

Alkynes

Structure and preparation. Electrophilic addition of H_2, water, HX and X_2, acidity, formation of alkyne anions, coupling reactions.

Aromatic Compounds

Structure and stability of benzene, resonance, Hückel's rule, simple non-benzenoid aromatics (cyclopentadienyl, tropylium). Electrophilic aromatic substitution - halogenation, nitration, sulfonation, the Friedel- Crafts alkylation and acylation reactions. Isomerism of benzene derivatives, reactivity and orientation of reactions on substituted aromatic rings, oxidation and reduction of aromatic compounds. Side-chain halogenation, benzyl as a free radical, cation and anion. Naphthalene. Kinetic *vs* thermodynamic control.

Alkyl halides (haloalkanes and haloaromatic compounds)

Preparation from alcohols, nucleophilic substitution reactions, elimination reactions, Grignard reagents. Haloaromatics and haloalkenes, their resistance to nucleophilic attack. Allylic bromination.

Alcohols and phenols, ethers and epoxides

Primary, secondary and tertiary alcohols. Acidity of alcohols and phenols, hydrogen bonding. Synthesis of alcohols from alkenes and from carbonyl compounds. Reactions of alcohols - with hydrogen halides, phosphorus halides, dehydration, reaction with metals, acylation, oxidation. Synthesis and reactions of phenols - oxidation, acylation. Williamson ether synthesis, acidic cleavage, cyclic ethers and crown ethers. Synthesis and ring-opening reactions of epoxides.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of PowerPoint presentation in teaching.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	

Activity	*Semester workload*
Lectures (3 contact hours per week x 13 weeks) Tutorials (1 contact hour per week x 13 weeks – Analysis of problem solving strategy and solution of representative problems)	52
Two (2) progress examinations, one at the middle (mid-term) and one the end of semester (2 contact hours for each exam)	4
Final examination (3 contact hours)	3
Hours for private study of the student	66
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure*	1. Optionally, two (2) progress examinations, one at the middle and one the end of semester (mid-term). Minimum passing grade for each: 5.

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	2. Written examination after the end of the semester. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. L. G. Wade JR, "Organic Chemistry", Translation to Greek: D. Komiotis et al, A. Tziolas and Sons Publications, 2010.
2. J. McMurry, "Organic Chemistry", Translation to Greek: A. Varvoglis, M. Orfanopoulos, I. Smonou et al, University of Crete Publications, 2012.
3. Devid Klein, "Organic Chemistry", Translation to Greek: G. Kokotoset al, Utopia Publications, 2015.
4. T. Mavromoustakos, T Tselios, K. Papakonstantinou, "Basic Principles of Organic Chemistry", in Greek language, Symemtria Publications, 2014.