COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCES		
DEPARTMENT	DEPARTMENT OF CHEMISTRY		
LEVEL OF STUDIES	ISCED level 6 – Bachelor's or equivalent level		
COURSE CODE	YN302	**SEMESTER OF STUDIES**	**3rd**
COURSE TITLE	Organic Chemistry II		

INDEPENDENT TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**CREDIT UNITS**
THEORY	4	7

COURSE TYPE *general background, specific background, specialization, general knowledge, skills development*	SPECIFIC BACKGROUND
PREREQUISITE COURSES:	There are no prerequisite courses. To better understand the course, students should be familiar with the material from Organic Chemistry I.
LANGUAGE OF INSTRUCTION and EXAMS :	Greek
THE COURSE IS OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	https://eclass2.emt.duth.gr/courses/CHEM-N3102/

(2) LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

The course aims to provide an understanding of radical reactions, the relationship between the structure and chemical behavior of specific classes of organic compounds, and an introduction to the basic principles of spectroscopic techniques used to determine the structure of organic compounds.

In this course, students will acquire the knowledge and skills necessary to understand:
✓ The reactions that occur through free radical intermediates, including their structure, reactivity, and role in the chemical industry and human health.
✓ The structure and properties of alcohols and phenols, including methods of preparation, ways to protect the hydroxyl group during various transformations, and the reactions of substitution, elimination, and oxidation.
✓ The structure and properties of ethers and crown ethers, along with their preparation methods and associated reactions.

The text outlines various topics in organic chemistry, including:
- The preparation reactions of epoxides, the enantioselectivity of epoxidation, and the ring-opening reactions of epoxides.
- The structure and properties of thiols and sulfides.
- The nomenclature of aromatic compounds, their structures, stability, and aromaticity according

to Hückel's rule (4n + 2).
- The reactions of aromatic electrophilic substitution and nucleophilic aromatic substitution.
- Carbonyl chemistry, including nucleophilic addition reactions to the carbonyl bond, the role of oxygen and nitrogen nucleophiles, the formation of acetals, imines, and enamines, and the synthesis strategies and spectroscopic analysis of aldehydes and ketones.
- Synthetic strategies, selection of appropriate reagents, functional group transformations, carbon chain extension, and retrosynthetic analysis.
- The interaction of matter with electromagnetic radiation.
- Visible and ultraviolet spectroscopy (theory and applications).
- Spectrometry, including the principles of the method, the decomposition processes of various classes of organic compounds, along with examples and applications.
- Nuclear magnetic resonance spectroscopy (NMR), focusing on chemical equivalence, scaling, chemical shifts, spin-spin coupling, integration, decoupling techniques, and DEPT in obtaining ^{13}C-NMR spectra.
- The combined use of spectroscopic techniques in the identification of organic compounds.
- Conjugated π systems and pericyclic reactions, including Diels-Alder reactions, electrocyclic reactions, and sigmatropic rearrangements.

Skills Development

- Identifying the weakest C-H bond in a compound
- Designing radical coordination structures
- Drawing the mechanism of radical halogenation
- Predicting the selectivity and stereochemical effects of radical bromination
- Predicting the products of radical reactions
- Designing steps to change the identity or position of a functional group or to modify the carbon skeleton
- Planning the steps for retrosynthetic analysis
- Comparing the acidity of alcohols
- Identifying oxidation and reduction reactions and predicting their products
- Preparing alcohols and selecting appropriate reagents
- Preparing ethers and epoxides
- Designing mechanisms and predicting products for epoxide reactions
- Selecting the appropriate Grignard reaction
- Nomenclature of benzene derivatives
- Determining the aromaticity of a structure
- Assessing the directing effects of substituents in electrophilic aromatic substitution
- Preparing aldehydes and ketones, selecting reagents, and determining nucleophilic addition products to carbonyls
- Designing compounds, transforming functional groups, and introducing two adjacent functional groups
- Analyzing IR spectra
- Distinguishing between two compounds using IR spectroscopy
- Analyzing mass spectra and understanding characteristic fragmentation patterns of organic compound classes
- Analyzing 1H-NMR and 13C-NMR spectra, determining the expected number of signals, identifying proton and carbon atom characteristics, predicting signal multiplicity, and differentiating compounds.
- Determining the degree of unsaturationon
- Determination of Molecular Structure Using Combined Spectroscopic Techniques:**
- Mechanism design and product prediction for electrophilic addition to conjugated diene compounds.

- Predicting the product of a Diels-Alder reaction.
- Predicting the product of an electrocyclic reaction.
- Using Woodward-Fieser rules to estimate λ max (maximum wavelength).

Upon completing the course, students will have developed the following key skills:

1. The ability to search for, analyze, and synthesize data and information using relevant technologies.
2. A strong respect for the natural environment.
3. The practice of critical thinking and self-reflection.
4. The promotion of creative and inductive thinking.

General Skills

Taking into account the general competencies that the graduate must have acquired (as listed in the Diploma Supplement and listed below), which of these does the course aim to achieve?

Search, analysis and synthesis of data and information, using the necessary technologies	*Project planning and management*
Adapting to new situations	*Respect for diversity and multiculturalism*
Decision making	*Respect for the natural environment*
Autonomous work	*Demonstrate social, professional and ethical responsibility and sensitivity to gender issues*
Teamwork	*Practicing criticism and self-criticism*
Working in an international environment	*Promoting free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Generation of new research ideas	*Other…*
	…….

(3) COURSE CONTENT

1. Radical Reactions: Structure and activity of radical processes in the chemical industry, including autoxidation and antioxidants.

2. Alcohols and Phenols: Structure and properties, acidity, preparations and reactions, protection of the hydroxyl group.

3. Ethers, Epoxides, Thiols, and Sulfides: Structure and properties, preparations and reactions, enantioselectivity in epoxidation, ring-opening reactions of epoxides.

4. Synthesis Strategies: Selection of appropriate reagents, functional group transformations, carbon chain extension, retrosynthetic analysis.

5. Benzene and Aromaticity: Nomenclature of aromatic compounds, structure and stability, aromaticity according to Hückel's rule (4n + 2 rule).

6. Aromatic Electrophilic Substitution: Synthesis of aromatic compounds, nucleophilic aromatic substitution.

7. Conjugated π Systems and Conjugated Dienes: Electrophilic addition, pericyclic reactions, Diels-Alder reactions, electrocyclic reactions, sigmatropic rearrangements.

8. UV-Vis Spectroscopy: Woodward-Fieser rules, color theory, the chemistry of vision.

9. Introduction to Mass Spectrometry: Characteristics of MS spectra, fragment analysis, high-resolution mass spectrometry, gas chromatography-mass spectrometry (GC-MS), and the degree of unsaturation.

10. Infrared Spectroscopy: Signal characteristics including wavenumber, intensity, and shape, spectrum analysis, and the discrimination of two compounds using IR spectroscopy.

11. Nuclear Magnetic Resonance (NMR) Spectroscopy: Characteristics of proton NMR (^{1}H-NMR) spectra, including the number of signals, chemical shift, integration, spin-spin coupling, spectrum analysis.

12. Carbon-13 NMR Spectroscopy: Decoupling techniques, number of signals, chemical shift, DEPT spectra for ^{13}C-NMR.

13. Structure Determination: Determining the structure using a combination of spectroscopic techniques.

14. Nucleophilic Addition Reactions: Nucleophiles such as oxygen, nitrogen, and sulfur; reactions involving acetals, imines, and enamines; nucleophiles, hydride and carbon; Bayer-Villiger oxidation; and spectroscopic analysis of aldehydes and ketones.

15. Synthesis Strategies: Further exploration of appropriate reagents, functional group transformations, carbon chain extension, retrosynthetic analysis.

(4) LEARNING AND TEACHING METHODS – EVALUATION

DELIVERY METHOD *Face to face, Distance learning, etc.*	Face to face
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES *Use of ICT in Teaching, Laboratory Education, Communication with students*	The use of Information and Communication Technology (ICT), such as PowerPoint, enhances the teaching process. It involves a problem-solving methodology and the development of effective teaching strategies. Providing exemplary solutions to exercises and conducting self-assessment tests are also key components. Additionally, the learning process is supported by the e-Class platform, which facilitates communication with students via email to address any doubts or questions they may have.
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards* .	

Activity	***Load Monthly Work***
Lectures (3 hours per week X 13 weeks)	39
Tutorial (1 hour per week X 13 weeks) with solving representative exercises	13
Final exam (3 hours)	3
Literature study and analysis	13
Self-assessment test	13
Student study hours and preparation for the final exam	65
Total course (24 hours of workload per credit unit)	146 hours (total workload)

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	Student evaluation is conducted through a written final exam (in Greek) that includes: ✓ multiple choice questions (formative) ✓ short answer questions (inferential) ✓ responses to critical questions (conclusions) ✓ combinatorial problems (inferential) Rate 100

(5) RECOMMENDED BIBLIOGRAPHY

- Recommended Bibliography:

1. Οργανική Χημεία. Αριθμός τόμου: Ι. Έκδοση: 4η αμερικανική-2η ελληνική/2024. Συγγραφείς: David Klein. ISBN: 9786185800130. Τύπος: Σύγγραμμα
Διαθέτης (Εκδότης): UTOPIA ΕΚΔΟΣΕΙΣ Μ. ΕΠΕ.
Κωδικός Βιβλίου στον Εύδοξο: 122094654

2. Οργανική Χημεία. Αριθμός τόμου: ΙΙ. Έκδοση: 4η αμερικανική-2η ελληνική/2024. Συγγραφείς: David Klein. ISBN: 9786185800147. Τύπος: Σύγγραμμα
Διαθέτης (Εκδότης): UTOPIA ΕΚΔΟΣΕΙΣ Μ. ΕΠΕ.
Κωδικός Βιβλίου στον Εύδοξο: 122094658

3. Οργανική Χημεία - Δομή και λειτουργικότητα. Τόμοι Α και Β. P. Vollhardt, N. Schore. Απόδοση στα ελληνικά: Ε. Μαλαμίδου-Ξενικάκη, Ν. Ρόδιος, Σ. Σπυρούδης, Λ. Χατζηαράπογλου, Εκδοτικός οίκος Αδελφών Κυριακίδη, 2017, Θεσσαλονίκη.

4. Βασική Οργανική Χημεία. Έκδοση: 1/2023. Συγγραφείς: Bruice P.Y. ISBN: 9789963258208. Τύπος: Σύγγραμμα. Διαθέτης (Εκδότης): BROKEN HILL PUBLISHERS LTD. Κωδικός Βιβλίου στον Εύδοξο: 122074092

5. ΟΡΓΑΝΙΚΗ ΧΗΜΕΙΑ. Συγγραφείς: Carey Francis A., Giuliano Robert M., Allison Neil T., Bane Susan L. (Συγγρ.) - Τρογκάνης Αναστάσιος, Ρασσιάς Γεράσιμος, Τσοτίνης Ανδρέας (Επιμ.), Έκδοση: 1η έκδ./2020, ISBN: 978-960-586-343-2. Κωδικός Βιβλίου στον Εύδοξο: 94645265, Διαθέτης (Εκδότης): ΕΚΔΟΣΕΙΣ ΚΡΙΤΙΚΗ ΑΕ

6. ΟΡΓΑΝΙΚΗ ΧΗΜΕΙΑ. Συγγραφείς: John McMurry. ISBN: 978-960-524-491-0. Κωδικός Βιβλίου στον Εύδοξο: 68370521

- Relevant Scientific Journals:

Journal of Chemical Education
European Journal of Organic Chemistry
Organic Chemistry Frontiers
Organic Syntheses
Organic Letters