COURSE DESCRIPTION

1. Programme Identification Data

1.1 Higher Education Institution	**„ALEXANDRU IOAN CUZA” UNIVERSITY OF IAŞI**
1.2 Faculty	**FACULTY OF CHEMISTRY**
1.3 Department / Doctoral School	**DOCTORAL SCHOOL OF CHEMISTRY**
1.4 Field of Study	**CHEMISTRY**
1.5 Cycle of Studies	**DOCTORATE**
1.6 Study Programme / Qualification	**ADVANCED UNIVERSITY STUDIES – DOCTORAL SCHOOL OF CHEMISTRY / PhD IN CHEMISTRY**

2. Data about the discipline

2.1 Course Title			**FUNDAMENTAL CONCEPTS AND CURRENT TRENDS IN CHEMISTRY – MODULE I**				
2.2 Course coordinator (lectures)			**Prof. univ. dr. Ionel MANGALAGIU Prof. univ. dr. habil. Romeo Iulian OLARIU Prof. univ. dr. Aurel PUI Prof. univ. dr. habil. Gheorghiță ZBANCIOC**				
2.3 Seminar coordinator			**Prof. univ. dr. Ionel MANGALAGIU Prof. univ. dr. habil. Romeo Iulian OLARIU Prof. univ. dr. Aurel PUI Prof. univ. dr. habil. Gheorghiță ZBANCIOC**				
2.4 Year of study	**I**	**2.5** Semester	**1**	**2.6** Type of assessment	***C**	**2.7** Disciple regime	****CC**

*[E – exam / C – colloquium] **[CC = Compulsory Course / OC = Optional Course]

3. Estimated Total Workload (hours per semester)

3.1 Hours per week	**2**	**3.2** Lectures	**1**	**3.3** Seminars	**1**
3.4 Total hours according to the curriculum	**28**	**3.5** Lectures	**14**	**3.6** seminars	**14**

Time allocation	hours
Study based on textbooks, course materials, bibliographic sources, and other relevant resources	20
Additional research in the library, on specialized electronic platforms, and in the field	20
Preparation for seminars, assignments, papers, portfolios, essays	20
Academic tutoring	4
Assessment activities	4
Other activities	4

3.7 Total hours of individual study	72
3.8 Total hours per semester	100
3.9 Number of credits	**4**

4. Preconditions (if applicable)

4.1 Curriculum prerequisites	Completion of a Master’s degree (or equivalent) and enrolment in the doctoral study programme in Chemistry, according to the regulations of the Doctoral School.
4.2 Competences prerequisites	Basic competence in the use of scientific language specific to the field of Chemistry; the ability to analyze and interpret scientific information; basic competence in documenting and synthesizing the scientific literature; as well as competence in using a personal computer and common applications from the Microsoft Office suite (Word, PowerPoint, Excel, Outlook).

5. Conditions (if applicable)

5.1 Conditions for lectures	Appropriate teaching spaces for doctoral activities, equipped with a video projector and PC, with access to the Internet, institutional IT infrastructure, and specialized resources (scientific databases relevant to the field of Chemistry).

	Compliance with institutional regulations regarding the organization of doctoral studies.
5.2 Conditions for seminars	Appropriate teaching spaces for doctoral activities, equipped with a video projector and PC, with access to the internet, to the institutional IT infrastructure and to specialized resources (scientific databases relevant to the field of Chemistry). Compliance with institutional regulations regarding the organization of doctoral studies.

6. Specific competences accumulated

Professional competences	• Competence to conceive and substantiate original scientific research approaches in the field of Chemistry through the use of advanced methods and both fundamental and emerging concepts, with the aim of advancing scientific knowledge; • Competence to critically and constructively evaluate scientific research projects and results in relation to the current state of theoretical and methodological knowledge and to research priorities in the field; • Competence to select, adapt, and apply advanced research principles, theories, and methods, including interdisciplinary approaches, to address complex theoretical and applied problems; • Competence to explain and interpret complex chemical phenomena and processes from multiple perspectives, based on fundamental concepts and current trends in chemical research; • Systematic and in-depth knowledge of current concepts, research methods, debates, and hypotheses in the field of Chemistry, as well as the ability to communicate and engage in scientific dialogue with specialists in related fields.
Transversal competences	• Competence to initiate and develop research projects with a creative and innovative component, as a foundation for professional development and research excellence; • Competence to assume responsibility for, and to organize and coordinate, activities specific to scientific research within professional teams or structures; • Competence to initiate, plan, and develop innovative theoretical and applied projects in academic and advanced research contexts.

7. Discipline Objectives (derived from the acquired competences)

7.1. General objective	To strengthen and deepen knowledge of fundamental concepts in the field of Chemistry and to develop the competence for critical analysis of current trends in chemical research, in relation to the specialized literature and the research directions promoted within the Doctoral School of Chemistry, in order to guide and substantiate the doctoral research approach.
7.2. Specific objectives	Upon completion of the course, the doctoral student will acquire the competence to: • understand and use fundamental concepts of Chemistry in the analysis and interpretation of phenomena and processes specific to the field; • critically analyze specialized scientific literature and identify current trends and emerging research directions in the field of Chemistry; • formulate and substantiate possible doctoral research topics and directions in relation to the current state of scientific knowledge; • develop syntheses and review analyses on relevant research topics using appropriate methods for documentation and source evaluation; • demonstrate a responsible, critical, and ethical approach in the use of fundamental concepts and scientific research results in order to achieve excellence in doctoral research.

8. Content

8.1	**Lecture Topics**	**Teaching methods***	**Notes** (hours / references)
1.	Advanced methods and applications in nuclear magnetic resonance spectroscopy (MRI). Influence of molecular symmetry and chirality on proton magnetic resonance spectra	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [1÷2]) C-CF&TAC-01

2.	Two-dimensional nuclear magnetic resonance spectroscopy. Fundamental principles of two-dimensional MRI. Graphical representation and interpretation of 2D MRI spectra	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [1÷2]) C-CF&TAC-02
3.	Chemistry of azaheterocycles with fluorescent properties. Structure–property relationships and applications	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [1,11]) C-CF&TAC-03
4.	Organic retrosynthesis. Analysis of organic compounds with a single functional grouping obtained by retrosynthetic strategies	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [6]) C-CF&TAC-04
5.	Methods of synthesis of coordination compounds with organic ligands	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [7,8]) C-CF&TAC-05
6.	Investigation of the structure of coordination compounds by modern characterization methods	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [7,8]) C-CF&TAC-06
7.	Theory of sonochemistry. Current trends in sonochemistry	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [3÷5]) C-CF&TAC-07
8.	Ultrasonic synthesis of new organic compounds. Synthesis of photoactive materials by sonication	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [3÷5]) C-CF&TAC-08
9.	Azaheterocyclic compounds with biological activity	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [11]) C-CF&TAC-09
10.	Microwaves in chemistry: fundamental theoretical notions	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour [10,11]) C-CF&TAC-10
11.	Microwave reactors: single-mode and multi-mode reactors	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(0.5 hours, [10,11]) C-CF&TAC-11
12.	Applications of microwaves in chemistry	Interactive lecture, explanation and demonstration, academic	(0.5 hours, [10,11]) C-CF&TAC-12

		conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	
13	Chemistry of the atmosphere. Development of predictive capabilities and modern research tools in atmospheric chemistry	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [12,13]) C-CF&TAC-13
14	Atmospheric chemical processes in a changing world. The role of atmospheric oxidants in controlling the lifespan, distribution and products of chemical species	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [12,13]) C-CF&TAC-14
15	Research trends and priorities in atmospheric chemistry. Development of priority scientific areas	Interactive lecture, explanation and demonstration, academic conversation and debate, critical analysis of the specialized literature and problematization of current research topics.	(1 hour, [12,13]) C-CF&TAC-15

*In cases of force majeure, teaching activities may be conducted online, in accordance with current legislation.

Bibliography:

1. Roos, G.; Roos, C. Organic Chemistry Concepts: An EFL Approach. Academic Press, **2014**.
2. Günther, H. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry. Wiley-VCH, **2013**.
3. Colmenares, J. C.; Chatel, G. (eds.). Sonochemistry: From Basic Principles to Innovative Applications. Topics in Current Chemistry Collections, Springer International Publishing, **2017**.
4. Luche, J. L.; Bianchi, C. Synthetic Organic Chemistry. Kluwer Publishers, Dordrecht, **1998**.
5. Mason, T. J. (ed.). Advances in Sonochemistry, Vols. 1–5. JAI Press, New York, **1990÷1999**.
6. Sunjic, V.; Peroković, V. Organic Chemistry: From Retrosynthesis to Asymmetric Synthesis. Springer, **2016**.
7. Garnovskii, A. D.; Kharisov, B. I. Direct Synthesis of Coordination and Organometallic Compounds. Elsevier, **1999**.
8. Schubert, U.; Hüsing, N.; Laine, R. (eds.). Materials Syntheses: A Practical Guide. Springer, Wien–New York, **2008**.
9. Bruce, D. W.; O'Hare, D. Inorganic Materials. John Wiley & Sons, **1997**.
10. Loupy, A. Microwaves in Organic Synthesis. Wiley-VCH, Weinheim, **2002**; **2006**.
11. Kappe, O. C.; Stadler, A. Microwaves in Organic and Medicinal Chemistry. Wiley-VCH, Weinheim, **2005**.
12. Committee on the Future of Atmospheric Chemistry Research. The Future of Atmospheric Chemistry Research: Remembering Yesterday, Understanding Today, Anticipating Tomorrow. National Academies Press, Washington DC, **2016**.
13. Committee on the Future of Atmospheric Chemistry Research. Atmospheric Chemistry in a Changing World: Recent Advances and Future Directions. National Academies Press, Washington DC, **2020**.

8.2	**Seminar Topics**	**Teaching methods***	**Notes** (hours / references)
1.	Two-dimensional nuclear magnetic resonance spectroscopy. Fundamental principles of two-dimensional MRI spectroscopy and applications in structural elucidation	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(2 hours, [1÷3]) S-CF&TAC-01
2.	Ultrasonically Assisted Synthesis of New Organic Compounds	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in	(2 hours, [4,8]) S-CF&TAC-02

		solving research problems.	
3.	Dipole 3+n cycloaddition reactions under the action of ultrasound	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(2 hours, [4,8]) S-CF&TAC-03
4.	Organic retrosynthesis. Specific synthesis methods and applications in synthesis design	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(2 hours, [5]) S-CF&TAC-04
5.	FTIR spectroscopy used in determining the structure of chemical compounds	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(2 hours, [3,7]) S-CF&TAC-05
6.	Synthesis of new organic compounds and materials assisted by ultrasound	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(2 hours, [5,8]) S-CF&TAC-06
7.	Development of tools for research in atmospheric chemistry	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(1 hour, [9.10]) S-CF&TAC-07
8.	Research priorities in atmospheric chemistry. Development of priority scientific areas and directions	Interactive lecture, explanation, conversation and debate, critical analysis of examples and case studies, problematization and application of modern methods in solving research problems.	(1 hour, [9,10]) S-CF&TAC-08

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1. Roos, G.; Roos, C. Organic Chemistry Concepts: An EFL Approach. Academic Press, **2014**.
2. Günther, H. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry. Wiley-VCH, **2013**.
3. Pouchert, C.J. and Behnche. J., The Aldrich Library of 13-C and 1-H FT NMR Spectra.Vol 1-3, Aldrich Chemical Company, Milwaukee, Wisconsil, USA 53210. ISBN 0-941633-34-9, *1993*.
4. C. Oliver Kappe, O. C., Dallinger, D., Murphree, S. S., Practical Microwave Synthesis for Organic Chemists, Wiley, Weinheim, Germany, **2005**.
5. K. S. Suslick. Sonochemistry, in Kirk-Othmer Encyclopedia of Chemical Technology, 4th Ed. J. Wiley & Sons: New York, vol. 26, 517-541, **1998;** Colmenares, J. C.; Chatel, G. (eds.). Sonochemistry: From Basic Principles to Innovative Applications. Topics in Current Chemistry Collections, Springer International Publishing, **2017**.
6. Sunjic, V.; Peroković, V. Organic Chemistry: From Retrosynthesis to Asymmetric Synthesis. Springer, **2016**.
7. R. Salzer, R., and Siesler, H., Infrared and Raman Spectroscopic Imaging, Wiley-VCH Verlang, **2009**.
8. .Mangalagiu I., Lucrari stiintifice **2000-2022.**
9. Committee on the Future of Atmospheric Chemistry Research. The Future of Atmospheric Chemistry Research: Remembering Yesterday, Understanding Today, Anticipating Tomorrow. National Academies Press, Washington DC, **2016**.
10. Committee on the Future of Atmospheric Chemistry Research. Atmospheric Chemistry in a Changing World: Recent Advances and Future Directions. National Academies Press, Washington

DC, **2020**.

9. Learning Outcomes

Knowledge and understanding	• explain fundamental concepts in the field of Chemistry relevant to advanced scientific research; • describe current trends and emerging research directions in modern Chemistry based on the scientific literature; • understand the principles, methods, and advanced techniques used to investigate the structure and properties of chemical compounds; • recognize the interdisciplinary role of Chemistry in current research contexts, including materials chemistry and atmospheric chemistry.
Application and analysis	• apply advanced concepts and methods for the analysis and interpretation of complex chemical phenomena and processes; • use modern characterization techniques and synthesis strategies in the analysis of relevant case studies; • critically analyze the scientific literature and identify research trends and priorities in the field of Chemistry; • correlate experimental data with theoretical results in order to elucidate the structure and behavior of chemical compounds.
Critical Assessment and Accountability	• critically and constructively evaluate scientific research results in relation to the current state of knowledge; • assess the limits and potential of methods used in advanced chemical research; • demonstrate responsibility and autonomy in guiding and substantiating the doctoral research approach; • justify the importance of rigorous and responsible use of fundamental concepts and scientific data.
Academic Communication	• communicate concepts, methods, and results of chemical research coherently and in a well-argued manner, both orally and in writing; • use scientific language specific to the field of Chemistry when interacting with specialists in related fields; • participate actively and in a reasoned manner in academic discussions and debates on topics related to current trends in Chemistry; • present research directions and results clearly, concisely, and critically in academic and scientific contexts.

10. Correlation of the course content with the expectations of community representatives, professional associations, and representative employers in the field related to the program.

The content of the course *Fundamental concepts and current trends in chemistry – Module I* is aligned with the expectations of the academic and research community in the field of Chemistry, as well as with the requirements of the professional and institutional environment, by addressing fundamental concepts and current research trends relevant at both national and international levels. Upon completion of the discipline, the doctoral student will acquire the competence to identify and substantiate a potential doctoral research topic and to develop a research project on a given topic, based on a documented and critical review of the specialized literature, in accordance with the priorities and development directions of the field of Chemistry.

11. Assessment

Activity	11.1 Assessment criteria	11.2 Assessment methods	11.3 Weight in final grade (%)
11.4 Lectures	Correctness, coherence, and completeness of the acquired knowledge, as evidence of understanding fundamental concepts and current trends in the field of Chemistry; the ability to analyze and integrate scientific information; appropriate use of specialized scientific language.	Colloquium – oral and well-reasoned presentation of a research topic in the field of interest, based on specialized literature.	75

11.5 Seminars	Correctness and relevance of the answers; the ability to critically analyze topics addressed during the seminar; application of discussed concepts and methods in research contexts; active participation in academic debates.	Oral presentation on a topic discussed during the seminar, including discussion and feedback..	25

11.6 Minimum Performance Standard

In order to pass the discipline, the doctoral student must demonstrate:

- a clear understanding of the fundamental concepts and the main current trends in the field of Chemistry;
- the capacity to analyze and interpret scientific information and research results using appropriate specialized terminology;
- the capacity to select and apply suitable investigation and analysis methods in accordance with the research objectives;
- the capacity to present a research topic in a coherent and well-argued manner, based on a critical and documented study of the relevant literature.

Date of completion	Course coordinator	Seminar coordinator
26.09.2025		
	Prof. univ. dr. Ionel MANGALAGIU	Prof. univ. dr. Ionel MANGALAGIU
	Prof. univ. dr. habil. Romeo Iulian OLARIU	Prof. univ. dr. habil. Romeo Iulian OLARIU
	Prof. univ. dr. Aurel PUI	Prof. univ. dr. Aurel PUI
	Prof. univ. dr. habil. Gheorghiță ZBANCIOC	Prof. univ. dr. habil. Gheorghiță ZBANCIOC

Date of approval
29.09.2025

Director of the Doctoral School of Chemistry
Prof. univ. dr. habil. Cecilia ARSENE