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. Course Identification Data

2.1 Course Title			**MANAGEMENT OF INNOVATIVE RESEARCH METHODOLOGIES 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**				
2.3 Seminar coordinator			**Prof. univ. dr. habil. Lucian Mihail BÎRSĂ**				
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	**1.5**	**3.3** Seminars	**0.5**
3.4 Total hours according to the curriculum	**28**	**3.5** Lectures	**21**	**3.6** Seminars	**7**

Time allocation	hours
Study based on textbooks, course materials, bibliographic sources, and other relevant resources	15
Additional research in the library, on specialized electronic platforms, and in the field	30
Preparation for seminars, assignments, papers, portfolios, essays	15
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	General competence in the use of scientific language specific to the field of Chemistry; the ability to analyze and interpret information from specialized literature; competence in documentation, synthesis, and structured presentation of a research approach; as well as competence in using a personal computer and common applications from the Microsoft Office package (Word, PowerPoint, Excel, Outlook).

5. Conditions (if applicable)

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

	Compliance with institutional regulations regarding the organization of doctoral studies.
5.2 Conduct of the seminar	Appropriate teaching spaces for seminar activities, equipped with multimedia equipment (video projector, PC), with access to the Internet, institutional IT infrastructure, and specialized resources, including 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, plan, and manage scientific research approaches in the field of Chemistry using modern and innovative methodologies appropriate to the objectives of doctoral research; • Competence to select, adapt, and apply advanced research methods, including modern experimental and instrumental techniques, in order to obtain relevant and reproducible scientific results; • Competence to critically analyze and evaluate research methodologies used in the field of Chemistry in relation to the current state of scientific knowledge and international good practices; • Competence to integrate interdisciplinary approaches and transfer methods from related fields to address complex chemical research problems; • Systematic and in-depth knowledge of innovative research methodologies in Chemistry, their limitations and potential, as well as the ability to communicate effectively with specialists in related fields.
Transversal competences	• Competence to organize, coordinate, and manage scientific research activities, both individually and within research teams; • Competence to assume responsibility and autonomy in decision-making related to the methodological strategy of doctoral research; • Competence to initiate and develop innovative research projects in academic and professional contexts, in compliance with ethical principles and good scientific practices.

7. Course Objectives (derived from the acquired competences)

7.1. General objective	To develop the competence to plan, organize, and manage innovative research methodologies in the field of Chemistry through the use of advanced methods and interdisciplinary approaches, in order to substantiate and optimize the doctoral research approach.
7.2. Specific objectives	Upon completion of the course, the doctoral student will be able to: • understand and apply principles of scientific research management in the field of Chemistry; • select, adapt, and apply innovative research methodologies appropriate to the research objectives and available resources; • critically evaluate the efficiency and relevance of the research methods used in relation to the current state of scientific knowledge; • integrate interdisciplinary approaches and method transfer in addressing complex chemical research problems; • demonstrate responsibility, autonomy, and scientific rigor in managing the methodological approach of doctoral research.

8. Content

8.1	**Lecture Topics**	**Teaching methods***	**Notes** (hours / references)
1.	Methodologies and techniques for preparing samples for analysis	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [1,2]) C-CF&TAC-01
2.	Management of chromatographic analysis methods	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [1,2]) C-CF&TAC-02

3.	Management of spectrometric analysis methodsă	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [1,2]) C-CF&TAC-03
4.	Management of electrochemical methods of analysis	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [1,2]) C-CF&TAC-04
5.	Advanced mass spectrometry methods	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [1,2]) C-CF&TAC-05
6.	Problematization in the context of chemical analysis	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [1,2]) C-CF&TAC-06
7.	Standard Operating Procedures in Chemical Analysis	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [3,4]) C-CF&TAC-07
8.	Basic concepts in statistics. Tool in experimental data processing	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [3,4]) C-CF&TAC-08
9.	Methods and techniques of characterization of analysis methodsă	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [3,4]) C-CF&TAC-09
10.	calibration management in chemical analysis	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [3,4]) C-CF&TAC-10
11.	Investigate the level of correlation between the data. Correlation coefficient	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(2 hours, [3,4]) C-CF&TAC-11
12.	Methodologies for estimating errors in chemical analyses	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [3,4]) C-CF&TAC-12
13.	The role of multiple variable analysis techniques	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [3,4]) C-CF&TAC-13
14.	Experience planning management and optimization procedures	Interactive lecture, explanation, conversation, conceptual demonstration, problematization	(1 hour, [3,4]) C-CF&TAC-14

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

Bibliography

1. Skoog, D. A.; Holler, F. J.; Crouch, S. R. Principles of Instrumental Analysis. Cengage Learning, **2016**.
2. Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumental Methods and Techniques. Wiley, **2007**.
3. Arsene, C.; Olariu, R. I. Analytical and statistical methods in the investigation of chemical systems. Performantica, Iași, **2009**.
4. Otto, M. Chemometrics. Statistics and Computer Applications in Analytical Chemistry. Wiley-VCH, **2017**.

8.2	**Seminar Topics**	**Teaching methods***	**Notes** (hours / references)
1.	Methodologies and techniques for preparing samples for analysis	Conversation, explanation, applicative analysis, problematization	(1 hour, [1,2])
2.	Management of instrumental analysis techniquesă	Conversation, explanation, applicative analysis, problematization	(1 hour, [1,2])
3.	Standard Procedures and Operating Methodologies in Chemical Analysis	Conversation, explanation, applicative analysis, problematization	(1 hour, [3,4])
4.	Methods of characterization of the methods of analysisă.	Conversation, explanation, applicative analysis, problematization	(1 hour, [3,4])

5.	The Role of Calibration Management in Chemical Analysis	Conversation, explanation, applicative analysis, problematization	(1 hour, [3,4])
6.	Methodologies for estimating errors in chemical analyses	Conversation, explanation, applicative analysis, problematization	(1 hour, [3,4])
7	Experience planning management and optimization procedures	Conversation, explanation, applicative analysis, problematization	(1 hour, [3,4])

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Bibliography

1. Skoog, D. A.; Holler, F. J.; Crouch, S. R. Principles of Instrumental Analysis. Cengage Learning, **2016**.
2. Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumental Methods and Techniques. Wiley, **2007**.
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4. Otto, M. Chemometrics. Statistics and Computer Applications in Analytical Chemistry. Wiley-VCH, **2017**.

9. Learning Outcomes

Knowledge and understanding	• explain fundamental concepts and principles related to the management of research methodologies used in modern Chemistry; • describe the main instrumental methods and techniques of chemical analysis and their role in obtaining and validating experimental results; • understand the operating principles, advantages, and limitations of chromatographic, spectrometric, electrochemical, and statistical methods used in chemical research; • recognize the importance of methodological management in ensuring the quality, reproducibility, and relevance of scientific research.
Application and analysis	• apply appropriate methodologies and techniques for sample preparation and chemical analysis in accordance with the research objectives; • use instrumental and statistical methods for the analysis, interpretation, and validation of experimental data; • critically analyze the performance and suitability of analytical methods used in case studies and applied research; • correlate experimental data with analytical methods and strategies in order to optimize the experimental process.
Critical Assessment and Accountability	• critically and constructively evaluate research methodologies from the perspective of the precision, accuracy, and reliability of the obtained results; • assess the impact of methodological choices on the quality and validity of scientific research; • demonstrate responsibility and autonomy in planning, managing, and optimizing the methodological approach of doctoral research; • justify the importance of compliance with good methodological practices and quality standards in chemical research.
Academic Communication	• communicate methodological aspects and research results clearly and in a well-argued manner, both orally and in writing; • use scientific language specific to the field of Chemistry and appropriate terminology related to data analysis and processing methods; • participate actively and in a reasoned manner in academic discussions and debates on the selection and optimization of research methodologies; • present methodological strategies and experimental results clearly, critically, and in a structured manner 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 *Management of innovative research methodologies in chemistry – Module I* is aligned with the requirements of the academic community and scientific research by developing the competences necessary for the effective management and application of experimental methodologies within the research process.

Upon completion of the discipline, the doctoral student will acquire the knowledge and competences required to select appropriate experimental techniques in relation to the research objectives and to correctly understand and apply the concepts and statistical tools necessary for the processing, interpretation, and validation of the obtained experimental data.

11. Assessment

Activity	**11.1 Assessment criteria**	**11.2 Assessment methods**	**11.3 Weight in final grade (%)**
11.4 Course	Correctness and coherence of responses, demonstrating understanding and application of modern experimental methodologies and techniques presented in the course.	Colloquium – oral presentation of a modern experimental technique used in chemical research.	75
11.5 Seminar	Correctness of answers and ability to apply statistical methods in the processing and interpretation of experimental data.	Presentation – oral presentation of a statistical technique used in experimental data processing.	25
11.6 Minimum Performance Standard			
In order to pass the discipline, the doctoral student must demonstrate: • knowledge of the meaning of the main statistical terms used in the analysis of experimental data (discrete and random variables, probability distribution functions, mean, variance, sample size, sampling distribution, and sample parameters); • the ability to process experimental data using appropriate statistical procedures; • the ability to assess the accuracy and reliability of the obtained data; • knowledge and application of statistical methods for identifying and eliminating erroneous data.			

Date of completion
26.09.2025

Course coordinator

Prof. univ. dr. Ionel MANGALAGIU
Prof. univ. dr. habil. Romeo Iulian OLARIU
Prof. univ. dr. Aurel PUI

Seminar coordinator

Prof. univ. dr. habil. Lucian Mihail BÎRSĂ

Date of approval
29.09.2025

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