COURSE DESCRIPTION

Mass spectrometry

Academic year 2025-2026

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemistry
1.4. Field	Chemistry
1.5. Level of study	PhD degree
1.6. Degree programme / Qualification	PhD degree
1.7. Form of education	With frequency

2. Course-related data

2.1. Course title	**Mass spectrometry**			Course code	**SDC-19-02**
2.2. Course coordinator	Prof. Anca Silvestru				
2.3. Seminar coordinator	Prof. Anca Silvestru				
2.4. Year of study	I	2.5. Semester	2	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			2.8. Course type	Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**1**
3.4. Total of hours in the curriculum	36	of which: 3.5. course	24	3.6. seminar/ laboratory	**12**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					100
Additional research in the library, on subject-specific electronic platforms, and on-site					100
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					12
Tutoring (professional guidance)					8
Examinations					6
Other activities					100
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**226**	
3.8. Total hours per semester				**250**	
3.9. Number of credits				**10**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Not applicable
4.2 skills-related	Not applicable

5. Specific conditions (where applicable)

5.1. course-related	acces to internet and specific data bases
5.2. seminar/laboratory-related	acces to internet and specific data bases

6.1. Competencies resulting from the completion of the degree programme[1]

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes.

Professional competencies	
Competency code	**Competency**
PC1	Advanced expertise in chemistry and doctoral-level research topics
PC4	Planning, designing, and implementing an original scientific research project, in compliance with academic ethics and integrity
PC5	Applying and developing advanced research and analytical methods; critically interpreting data and formulating innovative solutions
Transversal competencies	
Competency code	**Competency**
TC2	Advanced scientific communication in Romanian and English; collaboration in interdisciplinary and multicultural settings
TC3	Advanced digital skills for research, data analysis, and dissemination; responsible use of digital tools.

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
PC1	Advanced and up-to-date knowledge in chemistry and the research field; critical understanding of the scientific literature.	Applies and synthesizes advanced concepts/theories to formulate research hypotheses; justifies the choice of scientific approaches.
PC4	Advanced research methodologies: experimental design, modern synthesis and characterization techniques, analysis and validation; principles of research project management.	Designs, plans and implements a research project; applies quality and safety procedures and documents stages and data with full traceability.
PC5	Advanced strategies for data analysis, interpretation, and integration; evaluation of methodological limitations, reproducibility, and scientific impact.	Critically analyses complex data, estimates uncertainty and formulates conclusions; proposes methodological improvements and directions for research/innovation.
TC2	Scientific terminology and communication in Romanian and English; the structure of scientific articles and presentations; good citation practices.	Writes and presents scientific results in Romanian/English coherently; provides well-argued responses to comments and peer reviews.
TC3	Digital tools for research, citation, and data processing (databases, specialized software, reference managers); responsible use of digital resources.	Uses discipline-specific digital tools effectively; manages citations; uses digital resources responsibly in research activities.

7. Subject-specific learning outcomes

Knowledge and comprehension
1 Defining the notions, concepts, theories, and models in the field of Mass Spectrometry and their appropriate use in professional communication
2. The use of advanced knowledge in chemistry to explain and interpret concepts specific to Mass Spectrometry
3. Identification and application of advanced concepts, methods, and theories for solving specific problems in Mass Spectrometry
4. Critical analysis and the use of advanced methods and techniques for the quantitative and qualitative evaluation of concepts in the field of Mass Spectrometry

If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

5. The application of advanced concepts and theories in the field of Mass Spectrometry for project development and problem-solving
6. The ability to understand and interpret complementary data for the characterization of compounds and chemical processes, and to express and justify the interpretation of data based on correlating results and comparing them with data from the specialized literature
Specific academic skills
1. Carrying out the requested tasks according to the specified requirements and within the imposed deadlines, while respecting professional ethics and moral conduct, following a predetermined work plan
2. Completing the tasks requested in accordance with the general objectives established by integrating into a work group
3. Ongoing information gathering and documentation in their field of activity
4. Concern for improving the results of professional activity through involvement in carried out activities
5. The ability to prepare written reports and to present these reports publicly

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
8.1.1. General aspects which are specific for mass spectrometry. Ionization methods, sample preparation.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.2. General principles for recording and interpreting mass spectra.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.3. Mass spectra obtained by EI ionization. Principles, characteristics, interpretation of the spectral data.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.4. Mass spectra obtained by CI or DCI ionization. Principles, characteristics, interpretation of the spectral data.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.5. Mass spectra obtained by FAB ionization. Principles, characteristics, interpretation of the spectral data.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.6. Mass spectra obtained by electrospray ionization (ESI). Principles, characteristics, interpretation of the spectral data.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.7. Mass spectra obtained by MALDI. Principles, characteristics, interpretation of the spectral data.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.8. Tandem mass spectrometry. Principles, characteristics, interpretation of the spectral data.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.9. Mass spectrometers. Types and technical performancies.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.10. Applications of mass spectrometry in determining the reaction mechanisms.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.11. Applications of mass spectrometry in biology.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week
8.1.12. Applications of mass spectrometry in quantitative and qualitative analysis of mixtures.	The lecture; The explanation; The conversation; The description; The problematization;	Lecture of 2 hours/week

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Bibliography
1. A. Silvestru, *Spectrometrie de masă. Aplicații în chimia organometalică și coordinativă*, Ed. Casa cărții de știință, Cluj-Napoca, 2005.
2. W. Henderson, J. S. McIndoe, *Mass spectrometry of Inrganic and Organometallic Compounds*, Wiley, Chichester, 2005.
3. J. R. Chapman, *Practical Organic Mass Spectrometry*, Wiley, Chichester, 1997.
Heterocyclic bismuth(III) compounds with transannular N→Bi interactions as catalysts for the oxidation of thiophenol to diphenyldisulfide. A. M. Toma, C. I. Raț, O. D. Pavel, C. Hardacre, T. Rüffer, H. Lang, M. Mehring, A. Silvestru and V. I. Pârvulescu, *Cat. Sci. Technol*., **2017**, *7*, 5343 – 5353.
4. Solid-state structure and solution behaviour of hypervalent organoantimony halides containing 2-(Me_2NCH_2)C_6H_4-moieties, L. M. Opris, A. Silvestru, C. Silvestru, H. J. Breunig and E. Lork, *Dalton Trans.*, **2003**, 4367 – 4374.
5. Synthesis and chemistry of hypervalent *cyclo*-R_4Sb_4, *cyclo*-$(RSbE)_n$ R = 2-(Me_2NCH_2)C_6H_4, E = O, S] and precursors, L. M. Opris, A. Silvestru, C. Silvestru, H. J. Breunig and E. Lork, *Dalton Trans.*, **2004**, 3575-3585.
6. Structural Diversity of Cadmium(II) Complexes of Tetraorganodichalcogenoimidodiphosphinato Ligands: Monomeric $Cd[(SPMe_2)_2N]_2$ and Dinuclear $[Cd\{(OPMe_2)(SPPh_2)N\}_2]_2$, $[Cd_2\{(OPPh_2)_2N\}_4(H_2O)]$ and $K[Cd_2\{(OPPh_2)_2N\}_5]$, M. Ghesner, A. Silvestru, C. Silvestru, J. E. Drake, M. B. Hursthouse, M. E. Light, *Inorg. Chim. Acta*, **2005**, *358*, 3724-3734.
7. Organoselenium compounds containing pyrazole or phenylthiazole groups:Synthesis, structure, tin(IV) complexes and antiproliferative activity. R. A. Popa, E. Licarete, M. Banciu, A. Silvestru. *Appl Organometal Chem*., **2018**; e4252. doi.org/10.1002/aoc.4252.
8. Original papers in the field, published in the last 5 years.

8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
8.2.1. Anaysis and interpretation of EI mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.2. Anaysis and interpretation of CI mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.3. Anaysis and interpretation of FAB mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.4. Anaysis and interpretation of ESI+ mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.5. Anaysis and interpretation of ESI- mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.6. Anaysis and interpretation of MALDI+ mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.7. Anaysis and interpretation of MALDI- mass spectra.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.8. Matrices and solvents for mass spectrometry. Sample preparation.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.9. Applications of mass spectrometry in determining the reaction mechanisms for catalytic processes. Tandem mass spectrometry.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.10. Applications of mass spectrometry in biology. Experimental data for proteins structure assignment.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.11. Applications of mass spectrometry in quantitative and qualitative analysis of mixtures.	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week
8.2.12. Applications of mass spectrometry to determine the structure and chemical composition of compounds. Corelation of MS data with other analytical investigations (NMR, IR, etc.).	The explanation; The conversation; The description; The problematization;	Seminar of 1 hour/week

Bibliography Papers published during the last 5 years in specific journals: Angew. Chem. Int. Ed.; Chem. Eur. J.; Eur. J. Inorg. Chem; Chem. Commun.; Chem. Sci.; Dalton Trans.; Org. Lett.; Organometallics; Inorg. Chem., J. Org. Chem. și Mass Spectrometry.

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	Appropriate answers, correct analysis and interpretation of data.	Oral exam	60%
	Way of thinking and defending the proposed solutions.		
9.5. Seminar/ laboratory	The activity during the seminars.	Interpretation of mass spectra. Correlation with literature data.	40%
	Appropriate answers to the problems raised by the experimental data.		
9.6 Minimum standard for passing			
Grade 5 (five)			

10. SDG labels (Sustainable Development Goals)[6]

	○	Sustainable Development Generic Label

1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO"	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	○	**X**	○	○	○	○	○
10 INEGALITĂȚI REDUSE	11 ORAȘE ȘI COMUNITĂȚI DURABILE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE	13 ACȚIUNE CLIMATICĂ	14 VIAȚA ACVATICĂ	15 VIAȚA TERESTRĂ	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
23.01.2026

Signature of course coordinator

Signature of seminar coordinator

Date of approval in CDSC:

Signature of the Director of DSC
Prof. dr. Niculina Daniela Hădade

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.
[5] Both final evaluation methods and ongoing evaluation strategies should be established.
[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*