

## SYLLABUS

### 1. Information regarding the programme

|                                     |                                               |
|-------------------------------------|-----------------------------------------------|
| 1.1 Higher education institution    | <b>Babeş-Bolyai University of Cluj-Napoca</b> |
| 1.2 Faculty                         | <b>Environmental Science and Engineering</b>  |
| 1.3 Department                      | <b>Environmental Analysis and Assessment</b>  |
| 1.4 Field of study                  | <b>Environmental Engineering</b>              |
| 1.5 Study cycle                     | <b>Bachelor</b>                               |
| 1.6 Study programme / Qualification | <b>Environmental Engineering</b>              |

### 2. Information regarding the discipline

|                            |                                                   |              |          |                         |           |                        |           |
|----------------------------|---------------------------------------------------|--------------|----------|-------------------------|-----------|------------------------|-----------|
| 2.1 Name of the discipline | <b>Methods for separating chemical pollutants</b> |              |          |                         |           |                        |           |
| 2.2 Course coordinator     | <b>Conf.Dr.Habil. Beldean-Galea Mihail Simion</b> |              |          |                         |           |                        |           |
| 2.3 Seminar coordinator    | <b>Conf.Dr.Habil. Beldean-Galea Mihail Simion</b> |              |          |                         |           |                        |           |
| 2.4. Year of study         | <b>IV</b>                                         | 2.5 Semester | <b>8</b> | 2.6. Type of evaluation | <b>Ex</b> | 2.7 Type of discipline | <b>Op</b> |

### 3. Total estimated time (hours/semester of didactic activities)

|                                                                                       |           |                      |           |                        |           |
|---------------------------------------------------------------------------------------|-----------|----------------------|-----------|------------------------|-----------|
| 3.1 Hours per week                                                                    | <b>4</b>  | Of which: 3.2 course | <b>2</b>  | 3.3 seminar/laboratory | <b>2</b>  |
| 3.4 Total hours in the curriculum                                                     | <b>56</b> | Of which: 3.5 course | <b>28</b> | 3.6 seminar/laboratory | <b>28</b> |
| Time allotment:                                                                       |           |                      |           |                        | hours     |
| Learning using manual, course support, bibliography, course notes                     |           |                      |           |                        | <b>10</b> |
| Additional documentation (in libraries, on electronic platforms, field documentation) |           |                      |           |                        | <b>10</b> |
| Preparation for seminars/labs, homework, papers, portfolios and essays                |           |                      |           |                        | <b>10</b> |
| Tutorship                                                                             |           |                      |           |                        | <b>8</b>  |
| Evaluations                                                                           |           |                      |           |                        | <b>4</b>  |
| Other activities: .....                                                               |           |                      |           |                        | <b>0</b>  |
| 3.7 Total individual study hours                                                      | <b>42</b> |                      |           |                        |           |
| 3.8 Total hours per semester                                                          | <b>98</b> |                      |           |                        |           |
| 3.9 Number of ECTS credits                                                            | <b>4</b>  |                      |           |                        |           |

### 4. Prerequisites (if necessary)

|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1. curriculum   | <ul style="list-style-type: none"> <li>It is advisable to promote disciplines in the categories of analytical chemistry, instrumental analysis, and physics.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.2. competencies | <ul style="list-style-type: none"> <li>Cognitive skills: possession of basic acquisitions in the fields of chemical analysis in general.</li> <li>Action skills: information and documentation, group work, argumentation and use of information technologies for acquisition + processing of analytical data; carrying out active and critical analyses; operationalization and application of knowledge.</li> <li>Affective-attitudinal skills: ability to be involved in the teaching process, in an active and interactive manner; ability to perform complex experiments.</li> </ul> |

## 5. Conditions (if necessary)

|                                      |                                                                                                                                                                                                                          |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.1. for the course                  | <ul style="list-style-type: none"><li>• Classroom equipped with video projector and multi-media system.</li></ul>                                                                                                        |
| 5.2. for the seminar /lab activities | <ul style="list-style-type: none"><li>• Laboratory equipped with related equipment: Thin layer chromatography, liquid and gas chromatography, equipment for extraction and purification of extracts, computer.</li></ul> |

## 6. Specific competencies acquired

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Professional competencies</b> | <ul style="list-style-type: none"><li>• Knowledge, understanding, analysis and application in inter- and trans-disciplinary perspectives, of phenomena and processes related to advanced and ultra-performance analytical separation techniques for investigating environmental quality.</li><li>• The ability to make a pertinent and contextualized choice of analytical methods / techniques / optimizations in strict accordance with concrete situations and available resources.</li><li>• Determination of concentration levels of chemical pollutants, with an emphasis on hazardous chemical compounds at trace levels.</li><li>• Choice of appropriate environmental investigation techniques, depending on the polluting factors and the targeted environmental compartments.</li><li>• Acquisition of extremely useful practical skills related to the determination of chemical pollutants through advanced separation techniques.</li></ul> |
| <b>Transversal competencies</b>  | <ul style="list-style-type: none"><li>• Development of action skills – information and documentation, group work, argumentation and use of information technologies for acquisition and processing of analytical data.</li><li>• Competence to reflect – individually and collectively – on various issues, topics, problems.</li><li>• Practicing cognitive flexibility.</li><li>• Achieving effective communication (verbal and written).</li><li>• Active and interactive participation of students in the teaching process.</li><li>• Methodological skills: taking notes, systematizing, ordering, etc.; formulating research topics; formulating problem situations and solving them; establishing hypotheses and verifying them; writing texts; relating to and empathizing with those around them; collaboration and group work; involvement in the management of an activity.</li></ul>                                                          |

## 7. Objectives of the discipline (outcome of the acquired competencies)

|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.1 General objective of the discipline  | <ul style="list-style-type: none"><li>• Acquiring knowledge on a series of analytical techniques applicable for the determination of chemical compounds in mixtures from various environmental factors</li></ul>                                                                                                                                                                                                                                   |
| 7.2 Specific objective of the discipline | <ul style="list-style-type: none"><li>• Acquiring the basic concepts and principles of the main analytical techniques used for the determination of chemical compounds in mixtures.</li><li>• Knowing the fields of applicability of analytical separation techniques</li><li>• Acquiring a set of practical skills specific to ultra-trace chemical analysis, including instrumentation calibration and validation of analysis methods.</li></ul> |

## 8. Content

| 8.1 Course                                                                                                                                                                                                                                                                                               | Teaching methods                                                    | Remarks                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| The diversity of pollutants that affect environmental health requires the use of methods capable of determining in a single analysis a large number of organic compounds and at the same time quantifying them at extremely low concentration levels. Analytical separation techniques have demonstrated | Interactive Lecture<br><br>Exposition<br><br>Problem-Based Learning | Attendance at the course is optional, but recommended.<br><br>Attendance at applied activities and seminars |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>over time high performance and an applicability that makes them indispensable in environmental studies. The course presents the essential theoretical and practical notions related to the analytical separation techniques most used in environmental studies, emphasizing the applicability of these techniques for well-defined purposes.</p> <p>The acquisition of this knowledge will help students in choosing and applying the most appropriate methods for analyzing pollutants and mixtures of pollutants in various environmental matrices as well as in processing and interpreting the results obtained from measurements.</p> <p><b>CONTENT:</b></p> <ol style="list-style-type: none"> <li>1. MODULE 1. Introduction to Analytical Separology. Requirements. Performance. Applicability. [4 hours]</li> <li>2. MODULE 2. Classification of analytical separation techniques. Retention mechanisms. Gaussian distribution. Chromatographic peak. Chromatograms. [4 hours]</li> <li>3. MODULE 3. Terms specific to separation techniques. Retention parameters. Capacity factor. Resolution. Asymmetry. Qualitative and quantitative analysis. [4 hours]</li> <li>4. MODULE 4. Liquid chromatography. Types of liquid chromatography methods. Thin layer chromatography. Column chromatography. HPLC, IC [4 hours]</li> <li>5. MODULE 5. Gas chromatography. Instrumentation. Electrophoretic techniques. Coupled techniques. TLC-MS, HPLC-MS, GC-MS [4 hours]</li> <li>6. MODULE 6. Two- and multidimensional separation methods. Introductory notions. Orthogonality. Peak capacity. Construction and representation of the chromatogram [4 hours]</li> <li>7. MODULE 7. Notions of validation of analytical methods. Processing and interpretation of measurement data. [4 hours]</li> </ol> | <p>Problematization</p> <p>Exercises and Problem Solving</p> <p>Case Study Presentation</p> <p>Heuristic Conversation</p> <p>Explanation</p> <p>Modeling</p> | <p>is mandatory. The number of absences accepted in special situations is a maximum of 20% of the total number of hours.</p> <p>Students who are absent from the seminar / laboratory cannot appear for the exam.</p> <p>The individual project is handed to the course instructor before the exam.</p> <p>Plagiarism involves the cancellation of the work developed by the student.</p> <p>Cases of exam fraud involve: automatic exclusion from the exam, awarding a grade of 1 and the proposal to expel the student in question.</p> |
| <p><b>Bibliography:</b></p> <p>a) Required bibliography:</p> <ol style="list-style-type: none"> <li>1. Liteanu C., Gocan S., Bold A. - Analytical Separology, Dacia Publishing House, Cluj-Napoca, 1981.</li> <li>2. Gocan S. - High-performance chromatography, Part I-II, Dacia Publishing House, Cluj-Napoca, 1998-2000.</li> <li>3. Săndulescu R., Roman L. - Validation of analysis and control methods. Theoretical and practical foundations, Medical Publishing House, Cluj-Napoca, 1998.</li> <li>4. Beldean-Galea M. S. - Course material - unpublished material</li> </ol> <p>b) Optional bibliography:</p> <ol style="list-style-type: none"> <li>5. Petrovici M. et al. Environmental Analysis: Emerging Pollutants, Liquid Chromatography: Application, Chapter 14. Elsevier, 2013, <a href="http://dx.doi.org/10.1016/B978-0-12-415806-1.00014-0">http://dx.doi.org/10.1016/B978-0-12-415806-1.00014-0</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

6. Blumberg L.M., Theory of Gas Chromatography, Chap. 2, Gas chromatography, Elsevier, 2012, file:///C:/DOCUME~1/SIMION/LOCALS~1/Temp/3-s2.0-B978012385540400002X-main.pdf
7. Jennings G., Poole C.F., Chapter 1 - Milestones in the Development of Gas Chromatography, Gas Chromatography, 2012, pp. 1-17, [http://ac.els-cdn.com/B9780123855404000018/3-s2.0-B9780123855404000018-main.pdf?\\_tid=c00000aabb0f27&acdnat=1413025831\\_2cb60f78084b872ddebba9d71ad84d7e](http://ac.els-cdn.com/B9780123855404000018/3-s2.0-B9780123855404000018-main.pdf?_tid=c00000aabb0f27&acdnat=1413025831_2cb60f78084b872ddebba9d71ad84d7e)
8. Purcaro G. et al., Hyphenated liquid chromatography–gas chromatography technique: Recent evolution and applications, Journal of Chromatography A, Volume 1255, 2012, pp. 100-111
9. Seeley J.V., Chapter 7 - Multidimensional and Comprehensive Gas Chromatography, 2012, Pages 161-185, [http://ac.els-cdn.com/B9780123855404000079/3-s2.0-B9780123855404000079-main.pdf?\\_tid=200000aabb0f26&acdnat=1413025997\\_75ef31ee65d8cc751f2a2ff8a6827467](http://ac.els-cdn.com/B9780123855404000079/3-s2.0-B9780123855404000079-main.pdf?_tid=200000aabb0f26&acdnat=1413025997_75ef31ee65d8cc751f2a2ff8a6827467)

| 8.2 Seminar / laboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Teaching methods                                                                                                                                                              | Remarks |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| <p>Objectives: Developing students' skills to choose and apply a specific analysis method for the determination of certain classes of pollutants. It is desired that students know different analysis methods, their performances and applicability as well as how to use and statistically interpret the measurement results obtained in practical applications.</p> <p>Content:</p> <ol style="list-style-type: none"> <li>1. Specific terms used in analytical separology. Retention parameters. Capacity factor. Resolution. Asymmetry. Chromatograms, interpretation. Qualitative and quantitative analysis [4 hours]</li> <li>2. Liquid chromatography. Thin layer chromatography. Applications to the determination of some dyes in liquid samples [4 hours]</li> <li>3. Column liquid chromatography. Applications to the determination of some pesticides in liquid samples [4 hours]</li> <li>4. Gas chromatography. Applications to the determination of volatile/semivolatile pollutants in ambient air. [4 hours]</li> <li>5. Techniques coupled with mass spectrometry. GC-MS. Qualitative and quantitative analysis in GC-MS. [4 hours].</li> <li>6. Notions of validation of analytical methods. Numerical applications and statistical calculation [4 hours]</li> <li>7. Presentation of experimental results papers [2 hours]</li> </ol> | <p>Problem-Based Learning</p> <p>Experiment</p> <p>Problematization</p> <p>Exercises and Problem Solving</p> <p>Heuristic Conversation</p> <p>Explanation</p> <p>Modeling</p> |         |

|                                                   |  |  |
|---------------------------------------------------|--|--|
| 8. Lab activity examination [2 hours]             |  |  |
| Bibliography:<br>Similar to that provided in 8.1. |  |  |

**9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program**

- The discipline possesses a special epistemological status, with intense inter- and transdisciplinary valences.
- The discipline integrates with currently critical areas of interest internationally, such as the detection and determination of trace chemical compounds present in mixtures in various environmental factors.
- Therefore, the studied discipline offers graduates the ability to contribute to solving complex situations related to pollution and its effects.

**10. Evaluation**

| Type of activity                                                                                                                                                                                                                                                                                                                                                                                     | 10.1 Evaluation criteria                                                                                                                                                                                                | 10.2 Evaluation methods                                                     | 10.3 Share in the grade (%) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------|
| 10.4 Course                                                                                                                                                                                                                                                                                                                                                                                          | Correctness of answers<br>The ability to identify problems with critical status                                                                                                                                         | Exam                                                                        | 60%                         |
| 10.5 Seminar/lab activities                                                                                                                                                                                                                                                                                                                                                                          | The ability to apply acquisitions in various concrete situations<br>The ability to solve problems and integrate the acquisitions acquired in the study of this discipline with the acquisitions of related disciplines. | Essay / portfolio<br>Continuous assessment, through oral verification tests | 40%                         |
| 10.6 Minimum performance standards                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                         |                                                                             |                             |
| <ul style="list-style-type: none"> <li>• Knowledge of the basic concepts of the discipline and awareness of the interdependencies between them.</li> <li>• Application of acquisitions to problem solving and practical applications</li> <li>• Systematic integration of the acquisitions of this discipline with acquisitions characteristic of other disciplines of the study program.</li> </ul> |                                                                                                                                                                                                                         |                                                                             |                             |

Date

**04.12.2024**

Signature of course coordinator

Signature of seminar coordinator

Date of approval

Signature of the head of department