

# SYLLABUS

## 1. Information regarding the programme

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

## 2. Information regarding the discipline

|                            |                                                          |              |   |                         |              |                              |                  |
|----------------------------|----------------------------------------------------------|--------------|---|-------------------------|--------------|------------------------------|------------------|
| 2.1 Name of the discipline | <b>Instrumental Analyzes in Environmental Protection</b> |              |   |                         |              |                              |                  |
| 2.2 Course coordinator     | <b>Dr. Bocoş-BinţiŃan Victor, Assoc. Prof.</b>           |              |   |                         |              |                              |                  |
| 2.3 Seminar coordinator    | <b>Dr. Bocoş-BinţiŃan Victor, Assoc. Prof.</b>           |              |   |                         |              |                              |                  |
| 2.4 Year of study          | 2                                                        | 2.5 Semester | 4 | 2.6. Type of evaluation | <b>Coll.</b> | 2.7 Regime of the discipline | <b>Mandatory</b> |

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

|                                                                                         |    |                         |    |                        |      |
|-----------------------------------------------------------------------------------------|----|-------------------------|----|------------------------|------|
| 3.1 Number of hours per week                                                            | 4  | Of which:<br>3.2 course | 2  | 3.3 seminar/laboratory | 2    |
| 3.4 Total hours in the curriculum                                                       | 56 | Of which:<br>3.5 course | 28 | 3.6 seminar/laboratory | 28   |
| Time assignment:                                                                        |    |                         |    |                        | hrs. |
| Learning using manuals, course support, bibliography and course notes                   |    |                         |    |                        | 15   |
| Supplementary documentation in the library, using electronic platforms and in the field |    |                         |    |                        | 15   |
| Preparation of seminars/laboratories, homework themes, reports, portfolios and essays   |    |                         |    |                        | 8    |
| Tutorship                                                                               |    |                         |    |                        | 2    |
| Examinations                                                                            |    |                         |    |                        | 2    |
| Other activities: .....                                                                 |    |                         |    |                        | 0    |
| 3.7 Total individual study hours                                                        | 42 |                         |    |                        |      |
| 3.8 Total hours per semester                                                            | 98 |                         |    |                        |      |
| 3.9 Number of ECTS credits                                                              | 4  |                         |    |                        |      |

## 4. Prerequisites (when necessary)

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.1 Of curriculum:   | <ul style="list-style-type: none"> <li>Exact science disciplines graduation, such as environmental chemistry, physics, and biology, is highly recommended.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4.2 Of competencies: | <ul style="list-style-type: none"> <li>Cognitive competencies: holding basic acquirements from the field of chemistry &amp; physics.</li> <li>Action competencies – related to/concerning: information &amp; documentation activities; group activities; argumentation and utilization of information technologies for data acquisition + processing of analytical data; realization of active and critical analyses; operationalization and application of the acquired knowledge.</li> <li>Affective-attitudinal competencies: availability to imply himself in the didactic process in an active and inter-active manner; availability to design and realize complex experiments.</li> </ul> |

## 5. Conditions (when necessary)

|                                 |                                                                                                                                                       |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.1 For the course              | <ul style="list-style-type: none"><li>• Course-dedicated room, which includes a PC, an associated video-projector and a multi-media system.</li></ul> |
| 5.2 For the seminary/laboratory | <ul style="list-style-type: none"><li>• Laboratory with the appropriate analytical instrumentation.</li></ul>                                         |

## 6. Specific Competencies acquired

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Professional competencies</b> | <ul style="list-style-type: none"><li>• Knowledge, understanding, analysis and application – in both inter-disciplinary and trans-disciplinary perspectives – of those phenomena and processes related to analytical techniques used for investigating environmental quality.</li><li>• Ability of making an appropriate and contextualized choice of most appropriate analytical methods / techniques, in compliance with both the concrete situations and the available resources.</li><li>• Measurement of concentration levels for chemical pollutants, with emphasis on most important classes of chemical compounds and on field-used analytical technologies.</li><li>• Choose of most appropriate instrumental techniques for investigating the quality of a pollution-affected environment, function of both pollutant(s) and environmental compartments that are contaminated.</li><li>• Acquiring useful practical skills related to measurement of chemical pollutants using most applied instrumental analytical techniques.</li></ul> |
| <b>Transversal competencies</b>  | <ul style="list-style-type: none"><li>• Development of actional competencies – information and documentation, group activity, argumentation and use of information technology for both acquisition and processing of analytical data.</li><li>• Competence of reflecting (individually and collectively) to various topics and problems.</li><li>• Practicing cognitive flexibility.</li><li>• Realization of an efficient communication (verbal and written).</li><li>• Active and interactive participation of students to the teaching process in its integrality.</li><li>• Methodological competencies: taking notes &amp; their systematization, ordering, etc.; formulation of research topics/subjects; enunciation of problem-situations and their solving; establishing hypotheses and verifying them; drafting of texts; relationship with others and empathizing with them; collaboration and group work; involvement in the management of an activity.</li></ul>                                                                       |

## 7. Objectives of the discipline (based onto the acquired competencies)

|                                         |                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.1 General objective of the discipline | <ul style="list-style-type: none"><li>• Acquiring most relevant knowledge related to instrumental techniques of analysis most applied to detection &amp; quantification in monitoring chemical pollutants present in environmental samples – either water, soil, air or biota samples.</li></ul> |
| 7.2 Specific objectives                 | <ul style="list-style-type: none"><li>• Acquisition of basic knowledge related to sampling, followed by storage and preparation of environmental samples.</li><li>• Systemic knowledge of analytical techniques, with an emphasis on</li></ul>                                                   |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>instrumental ones, usable for verifying the environmental quality. Acquiring the basic concepts and principles with which the essential, most used in practice, instrumental analytical techniques operate.</p> <ul style="list-style-type: none"> <li>• Knowledge of the fields of applicability of main instrumental analysis methods. Description of the principal analysis techniques that can be used for investigating environmental samples (water, air, soil, respectively biota), depending on the targeted analyses.</li> <li>• Acquiring a set of practical skills specific to chemical analysis using instrumental methods, including instrumentation calibration.</li> </ul> |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 8. Contents

| 8.1 Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Teaching methods                                                                                                                                                                                                                             | Remarks                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>The course presents a series of concepts related to: environmental samples; sampling methods; sample preparation methods and techniques; various analytical techniques that can be used for the analysis of contaminants in a range of environmental samples (water, air, soil, biological materials), and the preparation of standards for the calibration of analytical instrumentation.</p> <p>In order to achieve the above mentioned tasks, both basic terminology (absolutely necessary as a starting point) and practical examples (useful for deepening and understanding concrete issues) are provided. For an increased accessibility &amp; clarity, numerous figures, sketches, tables and images have been used, which facilitate a good intuition of the major impact that the procedures of sampling + preparation/storage + chemical analysis of environmental samples have on obtaining useful analytical information, accurate and precise.</p> <p>By the type and multitude of information involved, this course is characterized by a high degree of inter-disciplinarity and trans-disciplinarity, as it includes &amp; integrates various complex information from the fields of chemistry, physics, electronics, etc.</p> <p>CONTENT:</p> <p><b>1. Introduction to the chemical analysis of environmental samples.</b> Classification of analytical methods. The main stages of chemical analysis. Choosing an analytical method – concentration range, accuracy and precision, selectivity, detection limit. [2 hours]</p> <p><b>2. Classification &amp; use of instrumental analytical techniques.</b> Performance evaluation of an instrumental analysis method used in the analysis of environmental samples. [2 hours]</p> <p><b>3. Analytical techniques for water samples – I.</b> Sample collection and storage. [2 hours]</p> <p><b>4. Analytical techniques for water samples – II.</b> Major components. Analysis of common ions. [2 hours]</p> | <p>Interactive lecture</p> <p>Demonstration</p> <p>Problem-based learning</p> <p>Problematization</p> <p>Exercises and problem solving</p> <p>Case studies presentation</p> <p>Heuristic conversation</p> <p>Explication</p> <p>Modeling</p> | <p>Attending the course is facultative, but highly recommended.</p> <p>Attending the applicative activities and seminars is mandatory. Number of absences accepted is maximum 20% of the total number of hours.</p> <p>Students that have a large number of absences at seminars/laboratory cannot attend the final exam.</p> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>5. Analytical techniques for water samples – III.</b> Trace components in water. A. Organic pollutants. Part 1: Chromatographic separation and analysis techniques. [2 hours]</p> <p><b>6. Analytical techniques for water samples – III.</b> Trace components in water. A. Organic pollutants. Part 2: Other analysis techniques. [2 hours]</p> <p><b>7. Analytical techniques for water samples – III.</b> Trace components in water. B. Metals. Part 1: Analysis by atomic spectrometry techniques. [2 hours]</p> <p><b>8. Analytical techniques for water samples – III.</b> Trace components in water. B. Metals. Part 2: Other usable analytical techniques. Speciation of metals. [2 hours]</p> <p><b>9. Analytical techniques for solid samples – IV.</b> Soils, sediments, biota. Part 1: Principles of sample collection, storage and pre-treatment. [2 hours]</p> <p><b>10. Analytical techniques for solid samples – IV.</b> Soils, sediments, biota. Part 2: Analytical techniques applicable to the analysis of organic compounds and metals. [2 hours]</p> <p><b>11. Analytical techniques for air samples.</b> Part 1: Analysis of ambient and indoor air pollutants - measurement of average concentrations. [2 hours]</p> <p><b>12. Analytical techniques for air samples.</b> Part 1: Analysis of ambient and indoor air pollutants - measurement of momentary concentrations. [2 hours]</p> <p><b>13. Analytical techniques for air samples.</b> Part 2: Analysis of ambient and indoor air pollutants - determination of solid particles. [2 hours]</p> <p><b>14. Analytical techniques for pollutants present at ultra-trace levels.</b> Analytical methods used for the detection and quantification of polychlorodibenzo-dioxins. [2 hours]</p> <p><i>TOTAL: 28 hours / semester (2 hours / week × 14 weeks).</i></p> |  | <p>The individual written report is handed to course coordinator <i>before</i> the final exam.</p> <p>Plagiarism results in cancelling the student's written report.</p> |
| <p><b>Bibliography:</b></p> <p><b>a) Mandatory Bibliography:</b></p> <ol style="list-style-type: none"> <li>1. Rouessac, Francis; Rouessac, Annick, „<i>Chemical Analysis – Modern Instrumentation, Methods and Techniques</i>”, Third Edition, John Wiley &amp; Sons, 2022.</li> <li>2. Fifield, F.W.; Haines, P.J., „<i>Environmental Analytical Chemistry</i>”, Blackwell Science Inc., London, 2000.</li> <li>3. Skoog, D.A.; Holler, F.J.; Nieman, T.A., „<i>Instrumental Analysis – 5<sup>th</sup> Edition</i>”, Saunders College Publishing, 1998.</li> <li>4. Perez-Bendito, D.; Rubio, S., „<i>Environmental Analytical Chemistry</i>”, Elsevier Science, 1998.</li> <li>5. <b>Course Support</b> – Assoc. Prof. Dr. Bocoş-BinţiŃan Victor.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |                                                                                                                                                                          |

***b) Supplementary Bibliography:***

6. Radojevic, M.; Bashkin, V.N., „*Practical Environmental Analysis*”, Springer Verlag, Berlin, 1999.
7. Pawliszyn, Janusz, „*Sampling and Sample Preparation for Field and Laboratory*”, Wilson & Wilson's Comprehensive Analytical Chemistry Series (Edited by D. Barceló) Vol. XXXVII, Elsevier Press, 2002.
8. Reeve, Roger N., „*Introduction to Environmental Analysis*”, John Wiley & Sons Ltd., 2002.
9. Lodge, James P. (Ed.), „*Methods of Air Sampling and Analysis*” (3<sup>rd</sup> Edition, CRC Press, Taylor & Francis, USA, 2000.

| 8.2 Seminar / laboratory                                                                                                                                                                                                         | Teaching methods              | Remarks                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------|
| <b>Content:</b>                                                                                                                                                                                                                  |                               |                                                              |
| 1. Chemistry of low concentrations – applied to environmental pollutants. Labor protection in the laboratory. [4 hours]                                                                                                          | Problem-based learning        | Some experiments are accomplished in a demonstrative manner. |
| 2. LABORATORY #1: Determination of metals in water samples by UV/VIS absorption spectrometry. Direct determination of copper – (a) Tracing the absorption spectrum in VIS; (b) Obtaining the calibration line. [4 hours]         | Experiments                   |                                                              |
| 3. LABORATORY #2: Determination of pollutants in water samples by UV/VIS absorption spectrometry. Determination of free residual chlorine in drinking water samples and study of its concentration decrease over time. [4 hours] | Problematization              |                                                              |
| 4. LABORATORY #3: Analysis of gaseous pollutants. Determination of chlorine present in air samples using absorbent solutions. [4 hours]                                                                                          | Exercises and problem solving |                                                              |
| 5. LABORATORY #4: Analysis of gaseous pollutants. Rapid detection and determination of reference inorganic pollutants in air using sensor-based instrumentation. [2 hours]                                                       |                               |                                                              |
| 6. LABORATORY #5: Rapid detection and quantification of air pollutants (ambient and indoor) using PID technology (photoionization-based detectors). [2 hours]                                                                    | Heuristic conversation        |                                                              |
| 7. LABORATORY #6: Rapid determination of hydrocarbon vapors emitted by soil samples polluted with petroleum fuels using PID type detectors. [2 hours]                                                                            | Explication                   |                                                              |
| 8. Chromatographic methods – basic notions and their main applications in the analysis of environmental samples – retention parameters; qualitative and quantitative analysis. [2 hours]                                         | Modeling                      |                                                              |
| 9. Determination of metals using atomic absorption spectrometry. AAS type instrumentation (Flame AAS + Graphite Furnace AAS). [2 hours]                                                                                          | Case studies                  |                                                              |
| 10. Calibration of analytical instrumentation – the basic elements. Preparation of analytical standards – in solid, liquid and gaseous phase. [2 hours]                                                                          |                               |                                                              |
| TOTAL: 28 hours / semester (2 hours/week × 14 weeks).                                                                                                                                                                            |                               |                                                              |

Bibliography:  
Similar to that presented at 8.1.

**9. Corroboration of the contents associated to discipline with the expectations of the representatives of epistemic community, professional associations and principal employers acting in the field related to the programme**

- The discipline possesses strong inter-disciplinary and trans-disciplinary valences.
- The discipline is correlated currently to critical topics worldwide, such as detection and quantification of toxic chemicals.
- Therefore, this discipline offers the bachelor students the capacity to bring a contribution to solving complex problems related to chemical pollution of the environment.

**10. Evaluation**

| Type of activity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10.1 Evaluation criteria                                                                                                                | 10.2 Evaluation methods                                                      | 10.3 Share in the final grade |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------|
| 10.4 Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Correctness of the answers                                                                                                              | Colloquium                                                                   | 60%                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Capacity to identify problems having a critical status                                                                                  |                                                                              |                               |
| 10.5 Seminar/laboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Capacity to apply the knowledge acquired to concrete situations                                                                         | Lab written reports / portfolio.<br>Continuous evaluation over the semester. | 40%                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Capacity of problem solving and of integrating the acquired knowledge in the discipline with the acquisitions from related disciplines. |                                                                              |                               |
| 10.6 Minimal standard of performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                         |                                                                              |                               |
| <ul style="list-style-type: none"><li>• Knowing the basic notions specific to this discipline and understanding the interdependencies between them.</li><li>• Familiarizing students with the preparation of samples and the analysis of chemical pollutants, as well as with the interpretation of analytical data.</li><li>• Knowledge of those instrumental analysis techniques that are most used &amp; most often encountered – both in the laboratory and on the field.</li><li>• Application of all mentioned acquisitions to solving problems and practical applications, with different degrees of complexity. Developing students' skills to draw calibration curves and work with them.</li><li>• Systematic integration of the acquisitions from this discipline with acquisitions characteristic of other disciplines of the bachelor's degree study program.</li></ul> |                                                                                                                                         |                                                                              |                               |

Date:

Signature of course coordinator

Signature of seminar coordinator



**05.12.2024**

Date of approval in the department

Signature of the Head of Department

.....

\_\_\_\_\_ .