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|----|--------------------------------|---------------------------------|
| 1. | <b>Field of study</b>          | <b>Environmental Protection</b> |
| 2. | Faculty                        | Faculty of Natural Sciences     |
| 3. | Academic year of entry         | 2025/2026 (winter term)         |
| 4. | Level of qualifications/degree | first-cycle studies             |
| 5. | Degree profile                 | general academic                |
| 6. | Mode of study                  | full-time                       |

|                                                                                   |                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.                                                                                | <b>General information about the module</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Module name</b>                                                                |                                             | <b>Introduction to the use of X-ray methods in environmental protection</b>                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Module code                                                                       |                                             | 1OS_23_60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Number of the ECTS credits                                                        |                                             | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Language of instruction                                                           |                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Purpose and description of the content of education                               |                                             | The course aims to provide students with knowledge of X-ray methods in the quantitative and qualitative analysis of environmental materials. Students will learn about obtaining and basic properties of X-rays and the structure of matter, including elements of crystallography and electron structure. The classes will also discuss the basics of X-ray diffraction on crystals, X-ray fluorescence and absorption phenomena, and the operation of selected diffractometers and X-ray spectrometers. |
| List of modules that must be completed before starting this module (if necessary) |                                             | not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| 8.   | Learning outcomes of the module                                                                                                                                                                                    |                                                                |                                 |  |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|---------------------------------|--|
| Code | Description                                                                                                                                                                                                        | Learning outcomes of the programme                             | Level of competence (scale 1-5) |  |
| E1   | Learned the structure of matter, including basic concepts of crystallography and electron structure of the atom                                                                                                    | 1OS_K05<br>1OS_U05<br>1OS_U07<br>1OS_W02                       | 4<br>2<br>4<br>2                |  |
| E2   | Knows the properties of X-rays, their obtaining and interaction with matter, in particular, knows the phenomena of X-ray diffraction, fluorescence and absorption                                                  | 1OS_U07<br>1OS_W01<br>1OS_W02                                  | 4<br>4<br>4                     |  |
| E3   | Knows the methods of characterization of environmental materials using X-rays, is capable of planning an experiment and conducting analysis of measurement data, and preparing a report on the completed research. | 1OS_K02<br>1OS_U01<br>1OS_U02<br>1OS_U04<br>1OS_U08<br>1OS_W06 | 3<br>4<br>3<br>3<br>4<br>4      |  |

|    |                                                                              |         |   |
|----|------------------------------------------------------------------------------|---------|---|
|    |                                                                              | 1OS_W07 | 3 |
|    |                                                                              | 1OS_W15 | 3 |
| E4 | Ensures the safety of his/her own work and that of others and the workplace. | 1OS_K03 | 3 |
|    |                                                                              | 1OS_K05 | 4 |

| 9. Methods of conducting classes |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|----------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Code                             | Category                             | Name (description)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| a05                              | Lecture methods / expository methods | Explanation/clarification<br><i>explication involving the derivation of a predetermined theorem from other, already known ones, in the number of steps specified by the person teaching the course</i>                                                                                                                                                                                                                                                                                            |  |
| b02                              | Problem-solving methods              | Lecture-discussion<br><i>transmission of content involving interaction with the lecture audience; discussion of lecture-related issues is one of its elements or constitutes its follow-up</i>                                                                                                                                                                                                                                                                                                    |  |
| b07                              | Problem-solving methods              | Activating methods: a case study<br><i>a comprehensive description of a phenomenon connected with the selected discipline; reflecting the reality, presenting the 'what', 'where' and 'how' of the phenomenon, i.e., all of its key aspects to be discussed in class; used as a reproduction, presentation, discussion or diagnosis of factors that shape the phenomenon or interact with it; an in-depth qualitative analysis and evaluation of a selected phenomenon</i>                        |  |
| b09                              | Problem-solving methods              | Activating method – flipped classroom<br><i>anticipatory learning; work in class is based on previously studied material indicated by the person teaching the course; preparation outside the classroom serves the purpose of getting familiar with the issues whose knowledge is necessary for participating in the in-class discussion and the training in the related practical skills; the activity is based on the work of students under the guidance of the person teaching the course</i> |  |
| c02                              | Demonstration methods                | Video show<br><i>reproducing a film or video material in its entirety or in fragments in order to illustrate the content taught in class, to submit it to analysis and evaluation or to use it as an exercise in image perception; a film/video can be a work of art, an illustration (also technical illustration) of a content/phenomenon/object, a private record of an action, a media image, etc.</i>                                                                                        |  |
| c06                              | Demonstration methods                | Demonstration-imitation<br><i>a presentation of a model way of performing specific activities accompanied by a commentary; it aims at triggering imitation activities in an individual or in a group of participants observing the activities of the person teaching the course until the right habit is formed through regular exercise; the demonstration-imitation method is combined with a physical practice of activities/behaviours</i>                                                    |  |
| c07                              | Demonstration methods                | Screen presentation<br><i>a presentation of synthetic image content using computer graphics, e.g., a series of slides or other multimedia forms, usually accompanied by a commentary; typical components of a screen presentation include text organized into bulleted points, charts, images and animations, sometimes sound effects or music; a multimedia illustration of course content presented in the form of a projected image</i>                                                        |  |
| d01                              | Programmed learning methods          | Working with a computer<br><i>e.g., Webquest; implementation of educational tasks using electronic and digital devices, computer programs and Internet applications; the academic teacher acts as a consultant; students' work is carried out step by step according to the plan laid own by the person teaching the course and following his instructions, and proceeds towards producing the indicated results within the set deadline</i>                                                      |  |
| e01                              | Practical methods                    | Laboratory exercise / experiment                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |

|     |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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|     |                          | <i>[also conducted as fieldwork] a method of practical application of knowledge; implemented in three stages: the recognition of a problem induced by the task content, the formulation of the problem and the attempt to solve it accompanied by the assessment of the effects; the goal is to acquire skills, abilities and habits, and to consolidate the acquired knowledge so that it becomes operational; the laboratory method assumes greater independence of learners than carrying out an experiment</i> |
| f01 | Methods of self-learning | Self-education<br><i>a method which involves independent acquisition of knowledge, skills and social competences, extending their scope and quality; complementary to the learning process taking place in class; taking on the task of developing and adjusting qualifications on one's own; self-study</i>                                                                                                                                                                                                       |
| f02 | Methods of self-learning | Individual work with a text<br><i>searching for and acquiring new information using textbooks and other written sources (including their digital versions); searching for texts, selecting fragments for analysis/interpretation, using other texts to solve a problem related to the studied issue</i>                                                                                                                                                                                                            |

| 10. Forms of teaching |          |                 |                                                   |                                 |                                                       |
|-----------------------|----------|-----------------|---------------------------------------------------|---------------------------------|-------------------------------------------------------|
| Code                  | Name     | Number of hours | Assessment of the learning outcomes of the module | Learning outcomes of the module | Methods of conducting classes                         |
| War1                  | workshop | 30              | course work                                       | E1, E2, E3, E4                  | a05, b02, b07, b09, c02, c06, c07, d01, e01, f01, f02 |

| 11. The student's work, apart from participation in classes, includes in particular: |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Code                                                                                 | Category                                                  | Name (description)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Is it part of the BUNA? |
| a01                                                                                  | Preparation for classes                                   | Search for materials and review activities necessary for class participation<br><i>reviewing literature, documentation, tools and materials as well as the specifics of the syllabus and the range of activities indicated in it as required for full participation in classes</i>                                                                                                                                                                                                                             | No                      |
| a02                                                                                  | Preparation for classes                                   | Literature reading / analysis of source materials<br><i>reading the literature indicated in the syllabus; reviewing, organizing, analyzing and selecting source materials to be used in class</i>                                                                                                                                                                                                                                                                                                              | No                      |
| a03                                                                                  | Preparation for classes                                   | Developing practical skills<br><i>activities involving the repetition, refinement and consolidation of practical skills, including those developed during previous classes or new skills necessary for the implementation of subsequent elements of the curriculum (as preparation for class participation)</i>                                                                                                                                                                                                | Yes                     |
| b01                                                                                  | Consulting the curriculum and the organization of classes | Getting acquainted with the syllabus content<br><i>reading through the syllabus and getting acquainted with its content</i>                                                                                                                                                                                                                                                                                                                                                                                    | Yes                     |
| b02                                                                                  | Consulting the curriculum and the organization of classes | Verification / adjustment / discussion of syllabus provisions<br><i>consulting the content of the syllabus, possibly in the presence of the year tutor or members of the class group, and, if necessary, reassessing the provisions concerning special conditions for class participation, e.g., space and time requirements, technical and other requirements, including conditions for participation in classes outside the walls of the university, classes organized in blocks, organized online, etc.</i> | Yes                     |
| c01                                                                                  | Preparation for verification of learning outcomes         | Determining the stages of task implementation contributing to the verification of learning outcomes<br><i>devising a task implementation strategy embracing the division of content, the range of activities, implementation time and/or the method(s) of obtaining the necessary materials and tools, etc.</i>                                                                                                                                                                                                | Yes                     |
| c02                                                                                  | Preparation for verification of learning outcomes         | Studying the literature used in and the materials produced in class                                                                                                                                                                                                                                                                                                                                                                                                                                            | No                      |

|     |                                                                 |                                                                                                                                                                                                                                                                                                                          |     |
|-----|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|     |                                                                 | <i>exploring the studied content, inquiring, considering, assimilating, interpreting it, or organizing knowledge obtained from the literature, documentation, instructions, scenarios, etc., used in class as well as from the notes or other materials/artifacts made in class</i>                                      |     |
| c03 | Preparation for verification of learning outcomes               | Implementation of an individual or group assignment necessary for course/phase/<br>examination completion<br><i>a set of activities aimed at performing an assigned task, to be executed out of class, as an obligatory phase/element of the verification of the learning outcomes assigned to the course</i>            | Yes |
| d01 | Consulting the results of the verification of learning outcomes | Analysis of the corrective feedback provided by the academic teacher on the results of the verification of learning outcomes<br><i>reading through the academic teacher's comments, assessments and opinions on the implementation of the task aimed at checking the level of the achieved learning outcomes</i>         | No  |
| d02 | Consulting the results of the verification of learning outcomes | Development of a corrective action plan as well as supplementary/corrective tasks<br><i>reviewing and selecting tasks and activities enabling the elimination of errors indicated by the academic teacher, their verification or correction resulting in completing the task with at least the minimum passing grade</i> | Yes |

Information on the details of the module implementation in a given academic year can be found in the syllabus available in the USOS system: <https://usosweb.us.edu.pl>.