

## Subject card

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| Subject name and code                       | Environmental technologies for sustainable development, PG_00159521                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                          |                                         |                                     |                        |            |     |
| Field of study                              | Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                          |                                         |                                     |                        |            |     |
| Date of commencement of studies             | October 2023                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                          | Academic year of realisation of subject |                                     | 2025/2026              |            |     |
| Education level                             | Bachelor's studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                          | Subject group                           |                                     | Optional subject group |            |     |
| Mode of study                               | full-time studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                          | Mode of delivery                        |                                     | at the university      |            |     |
| Year of study                               | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                          | Language of instruction                 |                                     | Polish                 |            |     |
| Semester of study                           | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                          | ECTS credits                            |                                     | 2.0                    |            |     |
| Learning profile                            | academic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                          | Assessment form                         |                                     | credit                 |            |     |
| Conducting unit                             | Laboratory of Photocatalysis -> Department of Environmental Technology -> Faculty of Chemistry -> Rector                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                          |                                         |                                     |                        |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                          | dr inż. Anna Malankowska                |                                     |                        |            |     |
|                                             | Teachers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                          |                                         |                                     |                        |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Lecture                                                  | Tutorial                                | Laboratory                          | Project                | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0.0                                                      | 0.0                                     | 30.0                                | 0.0                    | 0.0        | 30  |
|                                             | E-learning hours included: 0.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                          |                                         |                                     |                        |            |     |
| Learning activity and number of study hours | Learning activity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Participation in didactic classes included in study plan |                                         | Participation in consultation hours |                        | Self-study | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 30                                                       |                                         | 3.0                                 |                        | 15.0       | 48  |
| Subject objectives                          | <div>1. Familiarizing students with methods of wastewater, air and soil purification.</div> <div>2. Familiarizing students with the characteristics of renewable energy sources.</div> <div>3. Familiarizing students with methods of obtaining solar, wind and geothermal energy (heat pumps, photovoltaic cells, solar collectors, windmills).</div> <div>4. Developing the ability to independently conduct an experiment,</div> <div>5. The ability to apply the methodology given in the instructions and interpret the obtained results,</div> <div>6. The ability to present the results in writing.</div> |                                                          |                                         |                                     |                        |            |     |

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| Learning outcomes               | Course outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Subject outcome                                                                                            | Method of verification                                                                         |
|                                 | [CHEML3_U03] Selects the appropriate equipment and laboratory apparatus for conducting uncomplicated chemical experiments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | The student lists and characterizes basic technologies used for purifying sewage, water and air            | [SU3] text preparation/written work<br>[SU8] observation of student's independent or team work |
|                                 | [CHEML3_K05] Observes established procedures in laboratory work and is responsible for the safety of her/his and others' work.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The student follows established research procedures                                                        | [SK6] demonstration of practical skills                                                        |
|                                 | [CHEML3_U07] Prepares documented elaboration on a specific problem in the field of selected chemical and physical issues.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | The student independently searches for information in the literature                                       | [SU3] text preparation/written work                                                            |
|                                 | [CHEML3_W05] Has basic knowledge of the chemical specialisation studied.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The student presents correct technological reasoning in an understandable way, both orally and in writing. | [SW4] test/exam - oral or written<br>[SW1] oral statement/conversation/discussion              |
|                                 | [CHEML3_W06] Chooses higher mathematics techniques to the extent necessary to understand and describe the physical processes important for understanding chemistry.                                                                                                                                                                                                                                                                                                                                                                                                                                         | The student predicts, verifies and criticizes the results of conducted experiments                         | [SW3] text preparation/written work<br>[SW5] implementation of a problem task                  |
| Subject contents                | Carrying out exercises thematically related to the purification of soil, sewage, leachate, air and renewable energy. Determination of the efficiency and effectiveness coefficient of a heat pump, solar collector and photovoltaic cells. Removal of sulfur compounds from air and exhaust gases - study of SO <sub>2</sub> absorption in a spray scrubber. Advanced oxidation technologies for wastewater treatment (AOP): ozonation of an aqueous phenol solution. Removal of phosphorus and iron compounds. Soil purification using in-situ and ex-situ methods. Application of ion exchange processes. |                                                                                                            |                                                                                                |
| Prerequisites and co-requisites | <p>A. Formal requirements</p> <p>1. general chemistry,</p> <p>2. inorganic chemistry,</p> <p>3. analytical chemistry.</p> <p>B. Prerequisites</p> <p>1. knowledge of basic laboratory techniques;</p> <p>2. ability to use chemical terminology and nomenclature;</p> <p>3. knowledge of the properties of chemical elements and compounds and states of matter;</p> <p>4. knowledge of basic types of chemical reactions;</p> <p>5. knowledge of basic properties and reactivity of inorganic compounds;</p>                                                                                               |                                                                                                            |                                                                                                |
| Assessment methods and criteria | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Passing threshold                                                                                          | Percentage of the final grade                                                                  |
|                                 | Written report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                      | 40.0%                                                                                          |
|                                 | Written test for each exercise                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                      | 50.0%                                                                                          |
|                                 | Activity during classes - conducting experiments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 51.0%                                                                                                      | 10.0%                                                                                          |
| Recommended reading             | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Materials in the form of prepared laboratory instructions.                                                 |                                                                                                |

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|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p>1. Zaleska A., Zielińska-Jurek A., Soil remediation technologies, PG Publishing House, Gdańsk 2013</p> <p>2. Koniecznyński J.: Waste gas purification, Silesian University of Technology, Gliwice 1990.</p> <p>3. E. Kulgman-Radziemska, Lewandowski W., Proecological renewable energy sources Compendium, PWN Scientific Publishing House, 2017.</p> <p>4. Kowal A.L., Świdzka-Bróż M., Water purification, PWN Scientific Publishing House, Warsaw 2007</p> |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Example issues/<br>example questions/<br>tasks being completed | <p>1. Explain what determines the choice of soil remediation technique? Describe thermal methods used for soil remediation.</p> <p>2. Explain how to reduce the emission of sulfur compounds into the atmosphere.</p> <p>3. List methods for reducing CO<sub>2</sub> into the atmosphere. Explain what CO<sub>2</sub> sequestration methods consist of.</p> <p>4. Propose a sequence of wastewater treatment processes (in the form of a block diagram) contaminated with: colloidal compounds, microorganisms, solid pollutants, and organic compounds.</p> <p>5. Explain what advanced methods of pollutant oxidation consist of (list the methods used and characterize them).</p> <p>6. Describe the operating principle of a heat pump, solar collector, and photovoltaic cells.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

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