

COURSE OFFERED IN THE DOCTORAL SCHOOL

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|--------------------------------|---|--------------------------------|--|---|------------|---------|
| Code of the course | 4606-ES-000EIKP-0280 | Name of the course | Polish | Nanozanieczyszczenia środowiska: źródła, występowanie, analiza i losy | | |
| | | | English | Environmental nanopollutants: sources, occurrence, analysis and fate | | |
| Type of the course | Specialty course | | | | | |
| Course coordinator | Prof. Ryszard Łobiński, Ph.D., D.Sc., Eng | | Course teacher | Prof. Ryszard Łobiński, Ph.D., D.Sc., Eng | | |
| Implementing unit | Faculty of Chemistry | Scientific discipline | chemical sciences; biotechnology; chemical engineering; environmental engineering, mining and energy | | | |
| Level of education | Doctoral studies | Semester | summer | | | |
| Language of the course | English | | | | | |
| Type of assessment | Graded credit, ZAL | Number of hours in a semester | 30 | ECTS credits | 2 | |
| Minimum number of participants | 12 | Maximum number of participants | | Available for students (BSc, MSc) | Yes/No | |
| Type of classes | | Lecture | Auditory classes | Project classes | Laboratory | Seminar |
| Number of hours | in a week | 2 | | | | 2 |
| | in a semester | 20 | | | | 10 |

1. Prerequisites

Fundamentals of chemistry and/or environmental sciences

2. Course objectives

Introduce the subject, define nanopollutants and their classification. Discuss typical problems related to the presence of individual classes of nanopollutants (metal-containing, carbon-based, nanoplastics etc.) in different environmental compartments and their interaction with aquatic organisms and plants. Students will be introduced to the principles of analytical techniques used in environmental analysis of nanopollutants. The analytical approaches discussed will be focused number concentration, size and size distribution determination as well as imaging techniques at the single cell level. The existing European Union Legislation addressing nanosafety and the environment and perspectives for its development will be presented.

3. Course content (separate for each type of classes)

Lecture

- Occurrence of nanoparticles in different environmental compartments: an overview
- The challenge of the analysis of nanoplastics in the environment: current status and perspectives
- Presence of carbon-based nanomaterials in the environment: current analytical challenges and uncertainties
- Uptake of metal-containing engineered nanoparticles by aquatic organisms and plants and their possible transformations
- Analytical tools for the environmental analysis of nanopollutants: determination of number concentration, size, size distribution, transformation products and imaging at cellular level
- Nanosafety legislation in Europe and perspectives of its development - the focus on the environment

Seminar

Presentation of a selected problems related to the presence of nanopollutants in the environment.

4. Learning outcomes

| Type of learning outcomes | Learning outcomes description | Reference to the learning outcomes of the WUT DS | Learning outcomes verification methods* |
|---------------------------|--|--|--|
| Knowledge | | | |
| K01 | Student is able to identify different sources and individual classes of nanopollutants in environment | SD_W1 | evaluation of activity during class, presentation evaluation |
| K02 | Student is familiar with state-of-the-art analytical instrumental techniques adapted to study different aspects of the presence of nanopollutants in environmental compartments | SD_W2 | evaluation of activity during class, presentation evaluation |
| Skills | | | |
| S01 | The student is able to identify sources of emissions, propose a strategy for monitoring the degree of environmental contamination and a method for the determination of relevant aspects of the presence of nanopollutants in environmental compartments | SD_U1 SD_U3 SD_U4 SD_U5 SD_U6 | evaluation of activity during class, presentation evaluation |
| S02 | Students is able to discuss problems related to the presence of different classes of nanopollutants in environmental compartments on the basis of specialized scientific English-language literature | SD_U3 SD_U4 SD_U5 SD_U6 | evaluation of activity during class, presentation evaluation |
| Social competences | | | |
| SC01 | The student understands the importance of on-going research related to the presence of nanopollutants in different environmental compartments. He/she is able to popularize this knowledge and understands the importance of complying with EU regulations in this area. | SD_K2 SD_K3 SD_K4 | evaluation of activity during class, presentation evaluation |

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

Active presence during lectures and seminars will produce the final grade.

6. Literature

Primary references:

- [1] Environmental Nanopollutants: Sources, Occurrence, Analysis and Fate, Editors: Joanna Szpunar, Javier Jiménez-Lamana, Royal Society of Chemistry, 2022 DOI DOI:10.1039/9781839166570
- [2] Alimi, O.S., Farner Budarz, J., Hernandez, L.M., Tufenkji, N., Microplastics and Nanoplastics in Aquatic Environments: Aggregation, Deposition, and Enhanced Contaminant Transport, (2018) Environmental Science and Technology, 52 (4), pp. 1704-1724, DOI: 10.1021/acs.est.7b05559
- [3] Bundschuh, M., Filser, J., Lüderwald, S., McKee, M.S., Metreveli, G., Schaumann, G.E., Schulz, R., Wagner, S. Nanoparticles in the environment: where do we come from, where do we go to? (2018) Environmental Sciences Europe, 30 (1), art. no. 6, DOI: 10.1186/s12302-018-0132-6

55 h, w tym: 1. Godziny kontaktowe 15 h - obecność na wykładach; 2. przygotowanie do egzaminu i obecność na egzaminie 40 h;

| 7. PhD student's workload necessary to achieve the learning outcomes** | | |
|--|--|-----------------|
| No. | Description | Number of hours |
| 1 | Hours of scheduled instruction given by the academic teacher in the classroom | 20 |
| 2 | Hours of consultations with the academic teacher, exams, tests, etc. | 2 |
| 3 | Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework | 20 |
| 4 | Amount of time devoted to the preparation for exams, test, assessments | 18 |
| Total number of hours | | 60 |
| ECTS credits | | 2 |

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

| 8. Additional information | |
|--|---|
| Number of ECTS credits for classes requiring direct participation of academic teachers | 1 |
| Number of ECTS credits earned by a student in a practical course | 1 |