Micro and nanorobots

Course description sheet

Basic information

Field of study Innovation courses **Major** All **Organisational unit** AGH University Database of Electives **Study level** University database of electives **Form of study** Full-time studies **Profile** General academic	**Didactic cycle** 2024/2025 **Course code** UBPOPIS.A200000.12905.24 **Lecture languages** Polish **Mandatoriness** Elective **Block** General Modules **Course related to scientific research** Yes
Course coordinator	Aleksandra Szkudlarek
Lecturer	Aleksandra Szkudlarek

Period Summer semester	**Method of verification of the learning outcomes** Completing the classes **Activities and hours** Lectures: 15 Auditorium classes: 15	**Number of ECTS credits** 3

Goals

C1	Transferring knowledge to students about the history of the development of micro and nanorobotics, as well as such systems existing in nature.
C2	Acquainting the students with the technologies of producing nanostructures and nanosystems.
C3	Conducting a discussion about functional properties of materials used in the construction of nano- and microcircuits.
C4	Analyzing of application areas in which nanosystems are used, e.g. medicine, energy, enviromental engineering.
C5	Providing students with an understanding of mechanisms and phenomena related to the collective movement of nanodevices.

Course's learning outcomes

Code	Outcomes in terms of	Learning outcomes prescribed to a field of study	Methods of verification
Knowledge – Student knows and understands:			
W1	fundamental methods for fabrication and characteriztion of materials at nanoscale		Execution of exercises, Presentation
W2	functional properties of materials, which the components of nanodevices are build of		Execution of exercises, Presentation
W3	mechanisms of operation of nanobots and areas of their applications		Execution of exercises, Presentation
Skills – Student can:			
U1	organize the received content in the form of a mind map		Execution of exercises
U2	nanosystems, specifying methods for their fabrication and developing research plans for the characterization of physicochemical and functional properties		Execution of exercises
U3	indicate the areas in which microrobotics and nanorobotics are developing along with examples of specific applications		Execution of exercises, Case study
Social competences – Student is ready to:			
K1	active work in a team in accordance with the Design Thinking methodology		Participation in a discussion, Involvement in teamwork
K2	construct the opinions, conduct the discussion according to the rules of Oxford debate		Participation in a discussion, Involvement in teamwork

Program content ensuring the achievement of the learning outcomes prescribed to the module

1.Existing microsystems in nature and the history of micro and nanorobotics. 2. Basic methods for manufacturing micro and nanostructures (production of nanoparticles and thin films using ALD, CVD, and PVD techniques; obtaining three-dimensional nanostructures using optical/electron/ion lithography). 3. Functional properties of materials used for powering and controlling nanodevices (magnetic, photocatalytic, optical). 4. Application of micro and nanodevices in energy, environmental engineering, biotechnology, and medicine. 5. Active matter: collective motion of micro and nanodevices.

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Lectures	15
Auditorium classes	15
Preparation for classes	30
Realization of independently performed tasks	30
Student workload	**Hours** 90
Workload involving teacher	**Hours** 30

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities
1.	The lecture consists of the following modules: 1. Micro and nanodevices existing in nature and the history of micro and nanorobotics. 2. Technologies for manufacturing materials on a nanoscale. 3. Analysis of the functional properties of components comprising micro and nanorobots (magnetic, photocatalytic, optical, etc.). 4. Designing nanodevices. 5. Applications of micro and nanomotors in areas such as energy, environmental engineering, medicine, and biotechnology.	W1, W2, W3	Lectures

No.	Program content	Course's learning outcomes	Activities
2.	Auditorium practicals include: 1. Creating mind maps encompassing the topics covered during the lecture based on a case study utilizing the methodology of questioning. Classification of technologies for the fabrication of nanostructures using top-down and bottom-up approaches with the focus on advantages and limitations of individual techniques in terms of the possibility of scaling, commercialization, environmental impact, etc. 2. Designing simple nanosystems based on the desgin thinking methodology Getting to know the design tools used in the design thinking methodology (defining, ideation, prototyping) 3. Structured discussion of the issues raised during the lecture in the form of an Oxford debate (formulating a thesis, presenting arguments, presenting scientific data)	U1, U2, U3, K1, K2	Auditorium classes

Extended information/Additional elements

Teaching methods and techniques :

Team Based Learning, Work with source text, Socratic questioning, Visual thinking (mind mapping, concept mapping, sketchnoting), Oxford debate, Design thinking, Group work, Case study, Discussion

Activities	Methods of verification	Credit conditions
Lectures	Case study, Presentation	The condition for positive evaluation of the lecture is obtaining a positive exam grade
Audit. classes	Participation in a discussion, Execution of exercises, Involvement in teamwork	The conditions for positive evaluation of the practical part are to obtain min. half of the points assigned to each successive form of verification of learning outcomes

Conditions and the manner of completing each form of classes, including the rules of making retakes, as well as the conditions for admission to the exam

The condition for passing the lecture is to prepare and deliver a presentation on a given topic, including the issues discussed in the lecture.
The condition for passing the exercises is to obtain min. 50% of points from the total number of points assigned to individual activities. If the grade is unsatisfactory, it will be possible to correct it on two consecutive dates in the form of a final test. The maximum score in the first term is 4.0, and in the second term is 3.0.

Method of determining the final grade

Assessment of the lecture = assessment of the self-prepared and presented presentation on the issues raised during the lecture
Assessment of practicals = percentage of the total number of points obtained from individual learning outcomes

(performance of exercises, active participation in classes, preparation of materials and involvement in the discussion) scaled according to the table
91 - 100% very good (5.0), 81 - 90% plus good (4.5), 71 - 80% good (4.0), 61 - 70% plus sufficient (3.5), 51 - 60% satisfactory (3.0), below 50% insufficient (2.0),

Manner and mode of making up for the backlog caused by a student justified absence from classes

The possibility of catching up for the topics, which were covered on the course during the student's absence will be determined individually depending on the material processed during the classes in which the student was absent. On this basis, tasks will be assigned to work by him/herself.

Prerequisites and additional requirements

There are no prerequisites. The course is dedicated to students from all faculties of AGH who are interested in the development of the branch of nanotechnology, concerning micro and nanorobotics.

Rules of participation in given classes, indicating whether student presence at the lecture is obligatory

Attendance at the lecture is advisable but not obligatory. Attendance at the exercises is obligatory with max. two possible absences.

Literature

Obligatory

1. Smart Materials for Microrobots, Fernando Soto, Emil Karshalev, Fangyu Zhang, Berta Esteban Fernandez de Avila, Amir Nourhani, and Joseph Wang, https://doi.org/10.1021/acs.chemrev.0c00999
2. Soft Micro- and Nanorobotics, Chengzhi Hu, Salvador Pané, and Bradley J. Nelson, https://doi.org/10.1146/annurev-control-060117-104947

Optional

1. Multistimuli-responsive microrobots: A comprehensive review, Zameer Hussain Shah, Bingzhi Wu, Sambeeta Das, https://doi.org/10.3389/frobt.2022.1027415

Scientific research and publications

Publications

1. Aleksandra Szkudlarek, Katarzyna E Hnida-Gut, Kamila Kollbek, Mateusz M Marzec, Krzysztof Pitala, Marcin Sikora Cobalt-platinum nanomotors for local gas generation, DOI: 10.1088/1361-6528/ab53bd