# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Introduction to Nanotechnology [S1ETI1>WdN]

## Course

Field of study
Education in Technology and Informatics

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

## Number of hours

Lecture
26

Laboratory classes
15

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

## Number of credit points

5,00

## Coordinators

dr hab. Arkadiusz Ptak prof. PP
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## Lecturers

## Prerequisites

Knowledge of experimental physics, contemporary physics, mathematics, chemistry, and materials science within the scope of the curriculum covered in semesters 1-3 of the first cycle studies in 'education in technology and informatics'. The ability to solve simple physics problems based on acquired knowledge, the skill to gather information from specified sources. Understanding the necessity of expanding one's competencies, readiness to collaborate within a team, and demonstrating responsibility for one's own work.

## Course objective

1. Providing students with knowledge about the specific properties of materials on the nanometer scale and their utilization in science, industry, and medicine. 2. Familiarizing students with fundamental measurement methods and techniques used in nanoscience, as well as the basics of atomic scale modeling of materials. 3. Introducing students to common methods and technologies for manufacturing nanostructures. 4. Developing students' abilities to solve physical and technical problems related to nanoscience and nanotechnologies, conducting experiments, and interpreting results based on acquired knowledge. 5. Cultivating teamwork skills among students.

## Course-related learning outcomes

Knowledge:
1. knows and understands the mathematical apparatus necessary for the description and analysis of the basic issues of nanometric materials engineering, mechanics and computer science [k1_w01], [k1_w16].
2. is familiar with the state of the art in nanoscience and nanotechnology, functional materials and is aware of the latest trends in this topic [k1_w02], [k1_w17].
3. is familiar with the current state of industry applications and is familiar with the latest measurement techniques for surface and nanostructure characterization and in the latest applications of nanotechnology products [k1_w05, k1_w12].
3. prepare well-documented studies/or presentations on the latest developments in nanoscience and nanotechnology and applications of nanotechnology products. [k1_u01, k1_u02, k1_u03, k1_u05].

Skills:
students gain ability how to:
1. apply basic laws of physics and simplified models to solve problems in the programme content of the subject [k1_u04], [k1_u20].
2. make use of the knowledge from indicated literature sources (list of basic literature) and acquire

Social competences:
1. understands the need and knows the possibilities for continuous further training and improvement of professional, personal and social competences [k1_k03].
2. she/he will be able to transmit information related to technology and information technology in a commonly understood manner (k1_k05, k1_k06]
3. understands the importance of the non-technical aspects and effects of nanotechnology engineering activities [k1_k09]

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Outcome: Verification method: Assessment criteria:
(symbol) [percentage of correct answers]
W1-4, U01, K03 Written / Oral exam 3: 50.1%–70.0%
4: 70.1%–90.0%
5: from 90.1%
U1-4, K1-2 Activity assessment in exercises and laboratories, tests; criteria as above
U1-4, K3-4 Assessment of laboratory exercises completion, reports; criteria as above

## Programme content

I. INTRODUCTION
1. Historical overview
2. Definitions of nanoscience and nanotechnology
3. Hopes, limitations, and challenges of nanotechnology
II. BASIC RESEARCH TOOLS IN NANOSCALE
1. Scanning tunneling microscopy (STM)
2. Atomic force microscopy (AFM)
3. Electron microscopy and spectroscopy
4. X-ray microscopy and spectroscopy
5. Near-field microscopy
6. Confocal microscopy
III. NANOSTRUCTURE MANUFACTURING TECHNOLOGIES
1. 'Top-down' technologies
2. 'Bottom-up' technologies
IV. BASIC TYPES OF NANOSTRUCTURES AND THEIR PROPERTIES
1. Properties and classification of solids on the nanometer scale
2. Semiconductor nanostructures - quantum dots, wires, and wells
3. Magnetic nanomaterials
4. Carbon nanostructures - fullerenes, nanotubes, graphene, and its derivatives
5. Metal and oxide nanoparticles, and other materials
V. APPLICATIONS AND SAFETY OF NANOPRODUCTS

1. Examples of applications
2. Risk assessment of nanoparticles
3. EU regulations and ISO standards
Additionally, in tutorials and laboratories - basics of atomic scale modeling of materials.

## Teaching methods

Lecture:
multimedia presentation, presentation illustrated with examples given on the board, demonstrations of nanomaterials and their properties.

Tutorials:
computational issues related to modeling and simulation of materials on an atomic scale.

Laboratories:
practical exercises in atomic scale modeling of materials and handling of probe microscopes: STM and AFM; result analysis, discussion, teamwork.

## Bibliography

Basic
1. Teaching materials provided by lecturer in the form of PDF files.
2. A practical guide to scanning probe microscopy, R. Howland, L. Benatar, Park Scientific Instruments.
3. Nanoscale Science and Technology, Ed. R. W. Kelsall, I. W. Hamley, M. Geoghegan.
4. Mikroskopia elektronowa, red. A. Barbacki, Wydawnictwo Politechniki Poznańskiej, Poznań 2003.

Additional
1. Nanoscience: Nanotechnologies and Nanophysics, C. Dupas, Ph. Houdy, M. Lahmani (Eds), Springer-Verlag, Berlin 2007.
2. Molecular Modeling Techniques in Material Sciences, J.-R. Hill, L. Subramanian, A. Maiti, Taylor&Francis 2005.
3. Understanding Molecular Simulation. From Algorithms to Applications, D. Frenkel, B. Smit, Academic Press.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 120 | 5,00 |
| Classes requiring direct contact with the teacher | 70 | 3,00 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 60 | 2,00 |