COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of Nanotechnology [S1FT2>PN]

Course

Field of study
Technical Physics

Year/Semester
3/5

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
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

5,00

Coordinators

prof. dr hab. Ryszard Czajka
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Lecturers

Prerequisites

Knowledge of experimental physics, in addition to understanding of basic issues in quantum mechanics, atomic physics, molecular physics, and solid-state physics as taught in semesters 1-4 of the Technical Physics program. Skills in solving elementary physics problems using appropriate models, conducting standard physical measurements, performing qualitative and quantitative analysis of experimental results, formulating simple conclusions based on obtained results, and gathering information from indicated sources. Understanding the need for expanding one's competencies, willingness to collaborate within a team, and showing responsibility for one's work.

Course objective

To convey knowledge to students about the specific properties of materials at the nanoscale and their application in science, industry, and medicine. To introduce students to basic research methods and techniques used in nanoscience. To acquaint students with common methods and technologies for manufacturing nanostructures. To develop students' skills in solving physical and technical problems related to nanoscience and nanotechnologies, conducting experiments, and interpreting results based on acquired knowledge. To cultivate teamwork skills among students.

Course-related learning outcomes

Knowledge:
The student understands the specificity of the nanoscale compared to other scales, such as macro or micrometers; knows definitions such as nanoscience, nanotechnologies, nanomaterials
The student knows basic methods for researching materials at the nanoscale
The student knows basic technologies for manufacturing nanostructures
The student has the knowledge to characterize basic types of nanomaterials and provide examples of their application

Skills:
The student can:
Compare and choose the appropriate method for characterizing materials at the micro- and nanoscale
Perform measurements of material surface topography at the micro- and nanoscale using scanning probe microscopes, identify basic factors disturbing the measurement
Perform qualitative and quantitative analysis of images (maps) obtained using scanning probe microscopes, interpret results, and formulate conclusions regarding the conducted research
Prepare a presentation in Polish on a topic related to nanoscience and nanotechnologies, particularly on the applications of nanotechnology products
Use, with understanding, indicated sources of knowledge and acquire knowledge from other sources, including using internet resources

Social competences:
The student will gain competences allowing for:
Engagement in solving assigned tasks, independently developing and expanding their competencies
Fulfilling duties assigned within the team's division of work, accepting co-responsibility for the team's work results
Recognizing the social and environmental impacts of nanotechnology development, as well as understanding the need to accurately inform society about these issue

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written/Oral Exam:
Grade 3: 50.1%-70.0%
Grade 4: 70.1%-90.0%
Grade 5: from 90.1%
Assessment of Activity in Laboratory Exercises: as above.
Assessment of Laboratory Exercise Execution - Report: as above.

Programme content

I. INTRODUCTION: historical outline (Feynman's lecture), definitions of nanoscience and nanotechnology, challenges and problems.
II. BASIC NANOSCALE RESEARCH METHODS:
Scanning Tunneling Microscopy (STM)
Atomic Force Microscopy (AFM)
Electron Microscopy
X-ray Microscopy and SpectroscopyConfocal Microscopy
6. Near-field Microscopy
III. NANOSTRUCTURE MANUFACTURING TECHNOLOGIES:
"Top-down" nanostructure manufacturing technologies
"Bottom-up" nanostructure manufacturing technologies
IV. BASIC TYPES OF NANOSTRUCTURES AND THEIR PROPERTIES:
Properties and classification of solids at the nanometer scale
Semiconductor nanostructures - quantum dots, wires, and wells
Magnetic nanomaterials
Carbon nanostructures - fullerenes, nanotubes, graphene, and its derivatives
Metal and oxide nanoparticles
V. APPLICATIONS AND SAFETY OF NANOPRODUCTS:
Examples of applications in electronics (molecular electronics, spintronics), machinery and vehicle industry (automotive, aviation, space), coatings (paints, varnishes), lubricants, construction, medicine,

dentistry, cosmetology, agriculture, food industry, and others
Risk assessment of nanoparticles
EU regulations and ISO standards
VI. BASIC CONCEPTS IN NANOTRIBOLOGY

Course topics

none

Teaching methods

Lecture: Multimedia presentation, presentation illustrated with examples given on the board, demonstrations of nanomaterials and their properties.
Laboratory Exercises: Practical exercises (on the operation of scanning probe microscopes), conducting measurements, analysis of results, discussion, teamwork.

Bibliography

Basic:
1. STM/AFM mikroskopy ze skanującą sondą (org. A practical guide to scanning probe microscopy, R. Howland, L. Benatar, Park Scientific Instruments, wydaniepolskie, Warszawa 2002
2. Nanotechnologie (org. Nanoscale Science and Technology), red. R. W. Kelsall, I. W. Hamley, M. Geoghegan, PWN, Warszawa 2008
3. 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. Spektroskopia ciała stałego, red. M. Drozdowski, Wydawnictwo Politechniki Poznańskiej, Poznań 2001

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	62	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	63	2,50