COURSE DESCRIPTION CARD - SYLLABUS

Course name

Foundations of nanotechnology

Course

Field of study

Technical Physics

Year/Semester

3/5

Area of study (specialization)

Profile of study

general academic

Level of study

First-cycle studies

Course offered in

Polish

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

30

Laboratory classes

30

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

5

Lecturers

Responsible for the course/lecturer:

prof. dr hab. Ryszard Czajka

e-mail: ryszard.czajka@put.poznan.pl

tel. 61-665 3234

Wydział Inżynierii Materiałowej i Fizyki Technicznej, Instytut Fizyki

ul. Piotrowo 3, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Knowledge of experimental physics and the basic issues of quantum mechanics, atomic, molecular and solid physics in the scope of the program content implemented in semesters 1-4 in the field of technical physics. The ability to: solve elementary problems in physics with the use of appropriate models, carry out standard physical measurements, make a qualitative and quantitative analysis of the experimental results, formulate simple conclusions based on the obtained results, obtain information from the indicated sources. Understanding the need to expand one's competences, readiness to cooperate as part of a team, demonstrating responsibility for one's own work.

Course objective

1. To provide students with knowledge about the specific properties of materials in the nanometer scale and their use in science, industry and medicine.

2. To familiarize students with the basic measurement methods and techniques used in nanoscience.

3. To familiarize students with common methods and technologies of producing nanostructures.

4. To develope students' skills in solving physical and technical problems related to nanosciences and nanotechnologies, performing experiments and interpreting results based on the acquired knowledge.
5. To shape students' teamwork skills.

Course-related learning outcomes

Knowledge

1. The student understands the specifics of the nanometer scale in relation to other size scales, e.g. macro or micrometer scales; knows the definitions of such terms as nanoscience, nanotechnologies, nanomaterials - [K1_W11, K1_W12].

2. The student knows the basic methods of testing materials in the nanometer scale - [K1_W12, K1_W13].

3. The student knows the basic technologies of nanostructures production - [K1_W12, K1_W13].

4. The student has the knowledge to characterize the basic types of nanomaterials and provide examples of their use - [K1_W11, K1_W12 K1_W13].

Skills

The student is able to:

1. compare and select the appropriate method of material characterization in the micro and nanometer scale - [K1_U14];

2. carry out measurements of the surface topography of materials in the micro and nanometer scale using scanning probe microscopes, identify the basic factors disturbing the measurements - [K1_U17];

3. make a qualitative and quantitative analysis of images (maps) obtained using scanning probe microscopes, interpret the results and formulate conclusions on conducted research - [K1_U17];

4. prepare a presentation in Polish on a topic related to nanosciences and nanotechnologies, in particular on the application of nanotechnology products - [K1_U03, K1_U04, K1_U05];

5. use the indicated sources of knowledge and acquire knowledge from other sources, including the resources of Internet - [K1_U02].

Social competences

The student acquires competences allowing for:

1. engaging in solving the assigned tasks, independently develop and expand their competences - [K1_K01, K1_K03];

2. fulfilling the duties entrusted as part of the division of work in a team, assuming joint responsibility for the results of the team's work - [K1_K01];

3. noticing the social and environmental effects of nanotechnology development, as well as understanding the need for reliable information on these issues in society - [K1_K06, K1_K09].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcome (symbol)	Method of assessment	Assessment criteria	
W01-04, U01, K03	written / oral exam	3	50.1%–70.0%
		4	70.1%–90.0%
		5	from 90.1%
U02-03, K01-02	assessment of activity during laboratory exercises	as above	
U03-05, K01-02	evaluation of the laboratory exercise - report	as above	

Programme content

I. INTRODUCTION: historical outline (Feynman lecture), definitions of nanoscience and nanotechnology, problems and challenges

II. BASIC EXPERIMENTAL METHODS IN NANOSCALE

1. Scanning tunneling microscopy (STM)

2. Atomic force microscopy (AFM)

3. Electron microscopy

4. X-ray microscopy and spectroscopy

5. Confocal microscopy

6. Near field microscopy

III. TECHNOLOGIES FOR NANOSTRUCTURE MANUFACTURING

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: fulllerenes, nanotubes, graphene and its derivatives

5. Nanoparticles of metals and oxides

V. APPLICATIONS AND SAFETY OF NANOPRODUCTS

1. Examples of applications in electronics (molecular electronics, spintronics), machine and vehicle industry (automotive, aviation, space), coatings (paints, varnishes) and lubricants, construction, medicine, dentistry, cosmetology, agriculture and food industry and others

2. Risk assessment of nanoparticles

3. EC regulations and ISO standards

VI. BASIC ISSUES OF NANOTRIBOLOGY

Teaching methods

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

2. Laboratory exercises: practical exercises (in the use of scanning probe microscopes), carrying out measurements, analysis of results, discussion, team work.

Bibliography

Basic

1. A practical guide to scanning probe microscopy, R. Howland, L. Benatar, Park Scientific Instruments

2. Nanoscale Science and Technology, Ed.: R. W. Kelsall, I. W. Hamley, M. Geoghegan

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	5,0
Classes requiring direct contact with the teacher	64	3,0
Student's own work (literature studies, preparation for laboratory classes, preparation for exam, report preparation) [1]	61	2,0

[1] delete or add other activities as appropriate