COURSE DESCRIPTION CARD - SYLLABUS

Course name

Foundations of nanotechnology

Course

Field of study

Technical Physics

Area of study (specialization)

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

3/6

Profile of study

general academic

Course offered in

Polish

Requirements

compulsory

Number of hours

Lecture

60

Tutorials

Laboratory classes

45

Projects/seminars

15

Other (e.g. online)

Number of credit points

12

Lecturers

Responsible for the course/lecturer:

Prof. dr. hab. Tomasz Martyński

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dr hab. Arkadiusz Ptak, prof. PP

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Faculty of Materials Engineering and Technical Physics

Piotrowo street 3, 60-965 Poznan, Poland

Responsible for the course/lecturer:

Prerequisites

General knowledge of physics, mathematics and the basics of programming at the level achieved after two years of study in the field of technical physics. The ability to solve simple physical problems based on the acquired knowledge, the ability to obtain information from indicated sources. Understanding the necessity of self-training.

Course objective

1. To acquaint students with the elements of statistical physics, methods of molecular dynamics, models of thermally activated escape from the potential well and technical aspects of computer simulations.

2. To develope the ability to combine knowledge from various areas of knowledge, in particular physics, mathematics and computer science.

3. To develope the ability to independently use a computer to analyze macroscopic and microscopic physicochemical properties of materials, including molecular systems and nanoparticles.

Course-related learning outcomes

Knowledge

1. The student knows the basic statistical distributions used in classical physics [K1_W01].

2. The student knows the molecular dynamics algorithms [K1_W01, K1_W05, K1_W13].

3. The student knows the basic models of thermally activated escape from the potential well and examples of their applications [K1_W02, K1_W13].

Skills

The student is able to:

1. apply the appropriate mathematical apparatus (statistical distribution, molecular dynamics algorithm) for a given molecular phenomenon or process [K1_U01, K1_U09, K1_U14];

2. carry out computer simulations of basic physical phenomena and technical processes using standard software [K1_U19];

3. select the method of solving a physical or technical problem, including the selection of appropriate algorithms, software and computer resources [K1_U02, K1_U09, K1_U14].

Social competences

The student acquires competences allowing for:

1. independent and creative work on the given task [K1_K01, K1_K08];

2. understanding the needs and possibilities of continuous training [K1_K03].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcome (symbol)	Method of assessment	Assessment criteria
Lecture:		
W01–W03, U01–U03, K01, K02	open question test	3: 50.1%–70.0%

4: 70.1%–90.0%

5: from 90.1%

Project:

assessment of transitional work – carried out by the promoter

Laboratory:

assessment of activity in a specialized laboratory – carried out by the promoter

Programme content

1. Elements of statistical physics.

2. Molecular dynamics simulation methods:

a) motion equation integration algorithms,

b) periodic boundary conditions,

c) steered molecular dynamics,

d) Langevin dynamics,

e) Monte Carlo dynamics.

3. Models of thermally activated escape from the potential well and examples of their applications.

1. Methods of shaping the spatial, temporal and spectral characteristics of light generated by the laser

2. Methods of stabilizing the work of lasers

3. Mechanisms of interaction of laser radiation with living tissue, review of lasers used in medicine and their basic properties, lasers in ophthalmology, laser lancet surgical, laparoscopy, lasers in oncology, photodynamic laser therapy, selective destruction tumor tissue

4. Laser analysis of environmental pollution, lidars

5. Laser spectroscopy of atoms, ions and molecules in scientific research, spectroscopy systems linear and nonlinear. Laser cooling, ion and atomic traps, quantum metrology

6. Laser cutting of materials and welding, types of lasers used, required parameters beams, power density calculation, laser engraving and drilling, microtechnology.

7. Information recording and reading by laser, CD recorders and players, printers laser, holography, methods of recording and reading a holographic image, types of holograms.

8. Laser distance meters. Distortion measurements, laser interferometry, anemometry, gyroscope fiber optic

9. Military applications of lasers, laser sights, chemical lasers, images created with laser beams, multimedia shows

1. To acquaint students with modern methods and experimental techniques in the field of nanotechnology, solid state physics and solid state spectroscopy used for the characterization and research of physical processes occurring in materials and physical structures.

2. Methods of producing and characterizing monolayers at the interface, swirled and poured layers with the use of functional materials. The use of ultrasonic waves for material analysis and medical applications. Familiarization with the Fourier system for the study of infrared materials and the principles of operation of Raman spectrometers. Construction and operation of optical fibers and photonic crystals. Properties of nonlinear materials and up-conversion processes.

3. Sampling probe microscopy: the basics of operation and working modes of AFM and STM microscopes and their design variants.

4. Presentation in the form of a test report of the results obtained in a specialized laboratory with the use of selected experimental methods and techniques used for research as part of the prepared thesis.

Teaching methods

Conversational lecture: multimedia presentation, simulation demonstrations, examples given on the blackboard, solving research problems.

Laboratory exercises: performing specialized experiments, discussion, individual work (most often).

Project: individual student's project work, discussion.

Bibliography

Basic

1. Materials from lectures (in Polish)

2. Fundamentals of statistical physics (Podstawy fizyki statystycznej), Kerson Huang

3. Understanding Molecular Simulation. From Algorithms to Applications, D. Frenkel, B. Smit, Academic Press

Additional

1. Molecular Modeling Techniques in Material Sciences, J.-R. Hill, L. Subramanian, A. Maiti, Taylor&Francis 2005

2. Molecular Modeling and Simulation. An Interdisciplinary Guide, T. Schlick, 2nd edition, Springer 2010

Breakdown of average student's workload

	Hours	ECTS
Total workload	250	12,0
Classes requiring direct contact with the teacher	120	6,0
Student's own work (literature studies, preparation for laboratory classes, preparation for exam, report preparation) [1]	130	6,0

[1] delete or add other activities as appropriate