COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced Specialist Laboratory

Course

Field of study
Technical Physics

Area of study (specialization)

Level of study
Second-cycle studies

Form of study
full-time

Year/Semester
1/1

Profile of study
general academic

Course offered in
Polish

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
	90	
Tutorials	Projects/seminars	

Number of credit points

6

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:

Prerequisites

Basic knowledge of mathematics in mathematical analysis. Detailed knowledge of methods for measuring physical volumes and analyzing measurement results. Basic knowledge of surface physics and scanning probe microscopy. Basic knowledge in the field of atomic and quantum physics. Basic knowledge of electronics and optics to understand the operating principles of the advanced apparatus. The basics of molecular spectroscopy. Ability to identify a physical problem. Skills to solve elementary problems with physics based on gained knowledge, skills in obtaining information from the indicated sources. Ability to select materials with appropriate physico-chemical properties for applications in electronics and optoelectronics. Ability to use a mathematical apparatus and selected computer programs to analyze experimental results. Understanding the need to expand own competences, willingness to cooperate within the team.

Course objective

1. Transfer of practical skills to perform non-destructive methods for characterization of the physical properties of solid surfaces and nanostructures, analyses of the composition of investigated materials or objects produced therein and provide students with knowledge of the theoretical bases and practical solutions used in experimental absorption and emission spectroscopy techniques.

2. Developing students' skills in planning, analyzing and interpreting experimental results, preparing research reports.

3. Shaping students' teamwork skills

Course-related learning outcomes

Knowledge

1. Student will gain knowledge of the use of scanning methods of scanning probe microscopy in the characterization of the physical properties of surfaces and nanostructures (K2_W10].

2. Student possesses basic knowledge of molecular modelling methods and simulation of the physical properties of nanostructures [K2_W03].

3. Student has a basic knowledge of metrology and knows the different methods of performing spectral analysis. He/she can indicate the applications of optical spectroscopy methods in science and in modern technologies. Student can define spectral parameters and structure of selected functional materials for optoelectronics [K2_W06].

4. Student possesses well-established, detailed knowledge related to selected issues of analysis of the functional materials properties on the nano, micro and macro scales. Student knows the current state of the art, research and development in nanotechnology, condensed phase physics, surface physics, electronics, quantum computing, bioelectronics, spintronics, nonlinear and material optics and optoelectronics; possesses knowledge on technologies transfer.

Skills

Student:

1. may use mathematical knowledge in the field of function analysis to elaborate measurement results and analyse their accuracy [K2_U01].

2. may use with the understanding the indicated literature sources, is capable to obtain information from databases, formulate and justify opinions [K2_U02].

3. can handle scanning probe microscopes in the field of basic working modes (STM, AFM in contact and non-contact options, etc.) and analyze the electrical properties of the surface, magnetic structure and nanomechanical properties, as well as properly interprets the resulting measurement data [K2_U06, [K2_U17].

4. is able to identify appropriate molecular modelling and simulation methods and density functional methods for theoretical verification of experimental methods in the field of nanotechnology (K2_U01, [K2_U14].

5. can perform qualitative spectral analysis with the pulse laser; can operate selected uv-vis spectrometers [K2_U06]

6. can plan the selection of materials used (e.g. dyes, liquid crystals) for selected experimental techniques [K2_U06].

Social competences

1. Student is capable to cooperate within the team, performs the duties entrusted in the division of work in the team, demonstrates responsibility for his own work and co-responsibility for the results of the team's work. Student is responsible for the safety of his own and the team's work. [K2_K01]

2. Student will be responsible for the reliability of the results of his work and its interpretation [K2_K03].

3. He is actively involved in solving the problems raised, independently developing and expanding his competences [K2_K04].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Effect	Evaluation Form	Evaluation criteria
K2_ W03, K2_W06, K2_W10		
	Individual evaluations for oral response during	50.1%-70.0% (3)
	laboratory exercises with issues given by	70.1%-90.0% (4)
	of the exercise operator	from 90.1% (5)
K2_U01, K2_U02, K2_U06, K2_U14, K2_U17		
	Evaluation of individually compiled written report	50.1%-70.0% (3)
	of the measurements carried out using of computer programs,	70.1%-90.0% (4)
	in particular quality of the conclusions	from 90.1% (5)
K2_K01 , K2_K03, K2_K04		
	Assessment of individual activity during measurements,	50.1%-70.0% (3)
	ability to cooperate with other team members	70.1%-90.0% (4)
	and an assessment of the quality of implementation of the shared tasks	from 90.1% (5)

Programme content

1. Basic options and modes of operation of scanning tunnel microscopes and atomic forces.

2. Characterisation of structural, electron and nanomechanical properties of solids and nanostructures by scanning probe microscopy and spectroscopy.

3. Basics of molecular modelling and simulation of the physical properties of nanocompoes.

4. Application of spectral analysis.

5. Spectrum testing techniques due to the type of excitation in the source.

6. Optical spectrum recording apparatus. Measurements of the wavelength of spectral lines.

7. Processes of excitation of atoms and ions.

8. Construction and principle of operation of the laser microbe.

9. Liquid crystals - the basic structures and properties.

10. Orientation in single-axis liquid crystal phases.

11. Selected electrooptic effects used to visualize information.

• Twisted nematic effect.

• Guest-host effect.

12. Identification of liquid crystal phases.

13. The use of absorption and polarised light emission to determine the orientation order.

14. Experimental methods of the (dis)order investigations in solids and liquid crystals.

• Polarizing Microscope

• Absorption Anisotropy

• Emission Anisotropy

Teaching methods

Laboratory exercises: practical exercises, conducting experiments, performing measurements and discussion of the results, teamwork.

Bibliography

Basic
1. Script entitled "Electron microscopy" under ed. A. Barbicki, chap. 6, R. Czajka. "Scanning Probe Microscopy", Poznań University of Technology Publishing House, Edition II, 2005, Issue III, 2007

2. R. Howland, L. Benatar, crowd. M. Woźniak, J.A. Kozubowski, "STM/AFM microscopes with the scanning probe – elements of theory and practice", Warsaw 2002; original title "A Practical Guide to Scanning Probe Microscopy" - pdf collection available on the Internet

3. Richard Martin, "Electronic structure theory: Basis theory and practical methods", (Cambridge UP)

4. M. Bertrandt – "II Physical Laboratory"; Poznań University of Technology Publishing House, Poznan 2008;

5. Fundamental issues of spectral nuclear analysis, PWN 1963

6. Żmija J., Zieliński J., Nowinkowski-Kruszelnicki, E., Liquid Crystal Displays, Physics, Technology, Application, Warsaw, PWN 1993.

7. Barltrop J. A., Coyle J. D., Photochemistry – Basics, Warsaw, PWN 1987

Additional

1. E. Meyer, H.J. Hug,R. Bennewitz, Scanning Probe Microscopy – The Lab on a Tip, Springer-Verlag, Berlin, 2003.

2. Lakowicz J., Principles of fluorescence spectroscopy, Plenum, NYC,1983,

3. De Gennes P., The Physics of Liquid Crystals, Oxford, Clarendon Press, 1975.

4. Massalski J. Massalska M. Physics for Engineers, Edition 5. T. I, II WNT 2005

Breakdown of average student's workload

	Hours	ECTS
Total workload	150	6,0
Classes requiring direct contact with the teacher	94	4,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	56	2,0

[1] delete or add other activities as appropriate