University of Gdańsk

Subject card

Subject name and code	Advanced Physics Laboratory, PG_00205743		
Field of study	Medical Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2026/2027
Education level	Master's studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	5.0
Learning profile	academic	Assessment form	credit
Conducting unit	Division of Atomic and Molecular Physics -> Institute of Experimental Physics -> Faculty of Mathematics, Physics and Informatics -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Agata Lazarowska	
	Teachers		

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	60.0	0.0	0.0	60
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	60	0.0	60.0	120

Subject objectives	Experimental verification of physical phenomena discussed in lectures on fundamentals of physics, quantum mechanics and electrodynamics, condensed matter physics, atomic and molecular physics, laser physics, and quantum information. Learning to apply acquired descriptions of phenomena, processes, research methodology, and formalisms to specific experimental tasks performed in the physics laboratory. Performing computer-assisted experiments and using the latest software. Correctly conducting physical experiments, properly analyzing obtained results, and measuring and interpreting errors.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZMEDMU2_W03] Knows and understands to an in-depth degree advanced experimental and numerical techniques that allow for planning and performing complex physical experiments.	The student knows: the laws of physics, with particular emphasis on areas such as electromagnetism, wave optics, the structure of matter, atomic and molecular spectroscopy, lasers, solid-state physics, quantum mechanics, and quantum information the empirical foundations of interpreting physical phenomena the structure and operating principles of modern measuring devices used in physics laboratories in institutions specializing in physics and related fields the operating principles of specific experimental setups modern research techniques used in physics and related sciences and methods of computer-controlled measurements the Lab View graphical environment and the capabilities of Excel and Origin methods for analyzing measurement data and assessing the uncertainty of their results	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZMEDMU2_W04] Knows and understands in depth the theoretical foundations and principles of operation of measurement systems and research, diagnostic and therapeutic equipment specific to the field of physics and medicine.	The student knows: the laws of physics, with particular emphasis on areas such as electromagnetism, wave optics, the structure of matter, atomic and molecular spectroscopy, lasers, solid-state physics, quantum mechanics, and quantum information the empirical foundations of interpreting physical phenomena the structure and operating principles of modern measuring devices used in physics laboratories in institutions specializing in physics and related fields the operating principles of specific experimental setups modern research techniques used in physics and related sciences and methods of computer-controlled measurements the Lab View graphical environment and the capabilities of Excel and Origin methods for analyzing measurement data and assessing the uncertainty of their results	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZMEDMU2_W07] Knows and understands the principles of occupational health and safety to a degree that allows for independent work in medical facilities and research laboratories.	The student knows and understands: - Work restrictions related to performing work in accordance with occupational health and safety regulations - Health and safety regulations applicable in laboratories.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZMEDMU2_U04] Can formulate and test hypotheses related to simple research problems within the scope of acquired knowledge in physics and medicine.	The student is able to: - Formulate conclusions and hypotheses related to conducted physical experiments - Critically evaluate the obtained experimental results	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU5] implementation of a problem task
	[FIZMEDMU2_U05] Can present research results (experimental, theoretical, numerical, medical) in writing, orally, in a multimedia presentation or poster, using specialist terminology.	The student is able to clearly communicate the results of experiments and use appropriate scientific terminology in presentations and statements.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU5] implementation of a problem task

	Course outcome	Subject outcome	Method of verification
	[FIZMEDMU2_K03] He is ready to take a scientific approach to the issues being solved, using scientific literature, as well as expert opinions, in case of difficulties in solving the problem on his own.	The student is ready to cooperate in a team and carry out individual tasks, taking responsibility for their course and results.	[SK2] presentation/project/paper/ report
	[FIZMEDMU2_U02] Can plan and conduct an experiment using new or adapt existing methods and tools, and critically analyse the results of measurements, observations or numerical calculations, assessing the accuracy of the results using known methods and tools.	The student can plan and conduct basic and advanced experiments or observations in specific areas of physics or its applications.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report
	[FIZMEDMU2_U01] Can apply the scientific method in solving physical and medical problems, carrying out experiments and drawing conclusions in the field of physics, medical physics and other fields, based on in-depth knowledge, appropriate selection of sources, and mathematical and computer science methods and tools.	The student can use a scientific approach to analyze physical phenomena, plan experiments, and formulate reasoned conclusions based on observations and data.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report

Subject contents

1. Diffraction of laser light at a slit and a circular aperture. 2. Study of the physical properties of optical fibers. 3. Study of the physical properties of microwaves. Location of telecommunications satellites. 4. Analysis of diffraction images of laser light at an ultrasonic wave. 5. Study of the properties of a silicon photovoltaic module. 6. Determination of the efficiency coefficient of a solar collector under various operating conditions. 7. Study of the properties of a heat pump cooperating with a solar collector. 8. Study of the properties of hydrogen fuel cells (PEM). 9. Determination of the technical parameters of a Stirling engine. 9 A. Determination of the electrical power of a Stirling engine. 11. Determination of particle flow velocity using laser Doppler anemometry. 13. Diffraction of an electron beam on a polycrystalline graphite layer. 14. Determination of the excitation potential of Hg and Ne atoms in the Franck-Hertz experiment. 15. Determination of the specific charge e/m of the electron. 16. The photoelectric effect and determination of Planck's constant. 17. Measurement of relative intensities of spectral lines with doublet and triplet structures. 18. Determination of the iodine dissociation energy from the absorption spectrum. 19. Determination of dipole moments of polar molecules in the ground state. 21. Study of the optical properties of materials doped with transition metal ions. 22. Measurement of the Raman spectra of silicon (Si) and diamond © single crystals. 23. Study of the properties of solid-state lasers. 24. Recording of emission line spectra using a grating spectrograph. 25. The Hall effect in doped p-type and n-type germanium. 26. Study of the properties of ferromagnets based on hysteresis loops. 27. Identification of phase transitions in ferroelectric crystals. 28. Determination of thermistors' characteristics. 29. The Magnetooptic Faraday Effect. 30. The Normal and Anomalous Zeeman Effect. 32. The Kerr Effect in PLZT Electrooptic Ceramics. 33. Study of the Characteristic Intensity of X-ray Radiation of Copper (Cu) and Molybdenum (Mo). 34. X-ray Fine Structure - K-Doublet Splitting of Molybdenum. 35. Determination of the Lattice Constants of Copper (Cu), Molybdenum (Mo), and Potassium Chloride (KCl) Using the Debye-Scherrer Method. 35 A. Determination of the Lattice Constant of Copper Using the Debye-Scherrer Method. 35 B. Determination of the Lattice Constant of Molybdenum Using the Debye-Scherrer Method. 35 C. Determination of the Lattice Constant of Potassium Chloride Using the Debye-Scherrer Method. 36. Study of the Structure of a Single Crystal of Sodium Chloride Using X-ray Irradiation.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
not applicable	51.0%	50.0%
not applicable	51.0%	10.0%
not applicable	51.0%	40.0%

Recommended reading	Basic literature	A. Literature required for final course credit (passing the exam): A.1. Used during the course 1. Comprehensive instructions for all exercises. 2. Encyclopedia of Contemporary Physics, PWN, Warsaw 1983. 3. Encyclopedia of Technology. Chemistry, collective work, WNT, Warsaw 1993. 4. A. Baran, "Determination of the Characteristics of a Silicon Photovoltaic Module," Master's thesis, University of Gdańsk, 2009. 5. A. Berendt, "The Kerr Effect in Electro-Optical Ceramics (PLZT), Master's thesis, University of Gdańsk, 2008. 6. B.D. Cullity, Fundamentals of X-Ray Diffraction, PWN, Warsaw 1964. 7. J. Sobelman, Atomic Spectra and Radiative Transitions, Springer, 1979. 8. K. Hermbecker, Handbook of Physics X-Ray Experiments, Phywe Serie of Publication, 2010. 9. Physicochemical Guides. 10. Tables of Physical Quantities. 11. Mathematical Guides. A.2. Study by the student independently: 1. A. Barbacki, Electron Microscopy, Poznań University of Technology Publishing House, 2007. 2. A. Chełkowski, Dielectric Physics, PWN, Warsaw 1993. 3. A. K. Wróblewski, J. A. Zakrzewski, Introduction to Physics. Vol. 1 and 2, PWN, Warsaw 1990. 4. A. Kawski, Photoluminescence of Solutions, PWN, 1992. 5. A. Kopystyńska, Lectures on Atomic Physics, PWN, Warsaw 1989. 6. A. Kujawski, P. Szczepański, Lasers. Physical Foundations, Warsaw University of Technology Publishing House, Warsaw 1999. 7. A. Peres, Quantum Theory: Concepts and Methods, Kluwer Academic Publishers, 1993. 8. A. Śliwiński, Ultrasound and Its Applications, Wydawnictwo Naukowo Techniczne, Warsaw 1993. 9. A.N. Matwiejew, Molecular Physics, PWN, Warsaw 1989. 10. B. Ziętek, Lasers, Nicolaus Copernicus University Press, Toruń 2009. 11. B. Ziętek, Optoelectronics, Nicolaus Copernicus University Press, Toruń 2005. 12. C. Kittel, Introduction to Solid State Physics, PWN, Warsaw 1999. 13. Cz. Bobrowski, Physics Short Course, Wydawnictwo Naukowo Techniczne, Warsaw 1998. 14. D. Dehlinger, M.W. Mitchell, Entangled photon apparatus for the undergraduate laboratory, Am. J. Phys. 70, 989 901 (2002). 15. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, PWN, Warsaw 2003. 16. E. Klugman, E. Klugmann, Radziemska, Photovoltaic Cells and Modules and Other Unconventional Energy Sources, Wydawnictwo Ekonomia i Środowisko, Białystok 2005. 17. F. Kaczmarek, Laboratory Exercises in Physics for Advanced Students, PWN, Warsaw 1986. 18. F. Wolańczyk, Thermodynamics, Publishing House of the Rzeszów University of Technology, 2007. 19. G. Barrow, Physical Chemistry, PWN, Warsaw 1978. 20. G. Johnson, A Shortcut Through Time: The Path to the Quantum Computer, Knopf, N.Y. 2003. 21. H. A. Enge, M. R. Wehr, J. A. Richards, Introduction to Atomic Physics, PWN, Warsaw 1983. 22. H. Abramczyk, Introduction to Laser Spectroscopy, Elsevier Science, Amsterdam 2005. 23. H. Haken, H. C. Wolf, Molecular Physics with Elements of Quantum Chemistry, PWN, Warsaw 2010. 24. H. Haken, H. Chr. Wolf, Atoms and Quanta: An Introduction to Modern Atomic Spectroscopy, PWN, Warsaw 1998. 25. H. Ibach, H. Luth, Solid State Physics, PWN, Warsaw 1996. 26. H. Paul, Introduction to Quantum Optics from Light Quanta to Teleportation, Cambridge University Press, Cambridge 2004. 27. H. Szydłowski, Computer-Aided Physics Laboratory, PWN, Warsaw 2003. 28. Handbook Laboratory Experiments Physics, Phywe System GmbH & Co. K.G. 29. I. W. Sawieliew, Lectures on Physics, Vol. 1-3, PWN, Warsaw 2002. 30. J. A. Buck, Fundamentals of Optical Fibers, NJ: Wiley Interscience, Hoboken, 2004. 31. J. A. Weil, J.R. Bolton, Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, Wiley, New York 2001. 32. J. Ginter, Wave Physics, Volume Waves in Homogeneous Media, PWN, Warsaw 1993. 33. J. Ginter, Introduction to the Physics of the Atom, Molecule, and Solid State, PWN, Warsaw 1986. 34. J. H. Moore, Ch. C. Davies, M.A. Coplan, Building Scientific Apparatus, Westview Press, 2003. 35. J. Kączkowski, Fundamentals of Biochemistry, Wydawnictwo Naukowo-Techniczne, Warsaw 1999. 36. J. Laminie, A. Dicks, Fuel Cell Systems Explained, Wiley, 2003.

		37. J. Młochowski, Fundamentals of Chemistry, Publishing House of the Wrocław University of Science and Technology, 1999. 38. J. Orear Physics, Vol. 1 and 2, Wydawnictwo Naukowo-Techniczne, Warsaw 1998. 39. J. P. Simons, Photochemistry and Spectroscopy, PWN, Warsaw 1982. 40. J. R. Ferraro, K. Nakamoto, C. W. Brown, Introductory Raman Spectroscopy, Elsevier, 2003. 41. J. Stankowski, Introduction to Magnetic Resonance Spectroscopy, PWN, Warsaw 2005. 42. K. Booth, M. Kathryn, Optoelectronics, Wyd. Komun. i Łączności, Warsaw 2001. 43. K. Joon, Fuel Cells and a 21st-Century Power System, Journal of Power Sources, 1998, 71. 44. K. Pigoń, Z. Ruziewicz, Physical Chemistry, PWN, Warsaw 2005. 45. K. Shimoda, Introduction to Laser Physics, PWN, Warsaw 1993. 46. K. W. Szalimowa, Physics of Semiconductors, PWN, Warsaw 1974. 47. L. Andrèn, Solar Installations. Practical Applications for the Built Environment, James & James Science Publishers, London 2003. 48. L. Mandel, E. Wolf, Optical Coherence and Quantum Optics, Cambridge 1995. 49. M. Alicka, R. Alicki Information Workshop
	Supplementary literature	Literature provided on an ongoing basis by the instructor, taking into account the specificity of the physical problem under consideration and the individual needs and abilities of the Student.
	eResources addresses	
Example issues/ example questions/ tasks being completed	as in the subject content	
Work placement	Not applicable	

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