University of Gdańsk

Subject card

Subject name and code	Laboratory of Optics and Wave Phenomena, PG_00182304					
Field of study	Physics					
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028	
Education level	Bachelor'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	2		Language of instruction		Polish	
Semester of study	4		ECTS credits		3.0	
Learning profile	academic		Assessment form		credit	
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector					
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Sebastian Mahlik				
	Teachers					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	45.0	0.0	0.0	45
	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	45	0.0	30.0	75	
Subject objectives	The aim of the course is to provide students with practical skills in performing experiments in optics and wave phenomena and in analyzing the obtained results. Students will become familiar with measurement methods used in studying the properties of mechanical and electromagnetic waves, geometrical and wave optics phenomena, as well as photometry. The course develops the ability to design and conduct experiments, critically analyze experimental data, assess uncertainties, and formulate conclusions based on observations.					

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZL3_W14] knows the principles of ergonomics and occupational health and safety	The student knows the principles of ergonomics and occupational health and safety in the physics laboratory, particularly when conducting experiments in optics and wave phenomena. They understand the necessity of applying safe practices when working with optical systems (including light sources and lasers), measuring instruments, and in teamwork. The student can identify potential hazards related to optical and wave experiments and knows how to minimize these risks.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZL3_W13] knows measuring instruments, their construction and principle of operation as well as the use of simple electronic systems	The student knows the measuring instruments used in the study of wave and optical phenomena, understands their construction, operating principles, and measurement limitations. They can identify the applications of simple electronic circuits in optical experiments, e.g. in light detection, wave signal recording, photometric measurements, or controlling light sources. The student is familiar with the basic components of measurement setups, such as photodiodes, amplifiers, oscilloscopes, or data acquisition systems, and understands their role in the analysis of wave and optical phenomena.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZL3_W02] understands the role of physical experiments, mathematical theoretical models that bring reality closer and computer simulations in the methodology of scientific research; is aware of technological, instrumental and methodological limitations in scientific research	The student understands the role of physical experiments in the study of wave and optical phenomena, as well as the importance of mathematical theoretical models—such as the wave equation, Fourier analysis, Maxwell’s equations, and models of geometrical and wave optics—which provide approximate descriptions of reality. They know the applications of computer simulations in analyzing wave propagation, interference, diffraction, polarization, and photometry. The student is aware of the technological, instrumental, and methodological limitations of measurements in optics and waves, and understands the sources of errors as well as the impact of modeling assumptions on the obtained results.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZL3_U07] has the ability to quantitatively analyze vibrating and wave motion and describe optical and acoustic phenomena and the interaction of light with matter	The student is able to perform quantitative analysis of oscillatory and wave motion, including the harmonic oscillator (damped and driven), plane and spherical waves, dispersion, and phase and group velocity. They can describe and interpret optical phenomena in geometrical optics (reflection, refraction, lenses, optical systems) and wave optics (interference, diffraction, polarization, coherence, holography). The student is able to analyze the interaction of light with matter, particularly absorption, dispersion, and scattering phenomena. They can also apply mathematical methods, including Fourier analysis, to the quantitative description of wave and optical phenomena and draw qualitative conclusions based on these analyses.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report

	Course outcome	Subject outcome	Method of verification
	[FIZL3_W08] has advanced knowledge in the field of phenomena and laws of geometric, wave and photometry optics	The student possesses advanced knowledge of the phenomena and laws of geometrical optics, wave optics, and photometry. They know the principles of reflection and refraction of light, can explain the operation of lenses and mirrors, and understand the construction of optical systems (including magnifying glass, microscope, telescope, and refracting telescope). The student understands the fundamental laws governing interference and diffraction of light, the Rayleigh criterion for the resolution of optical systems, and the different types of light polarization, including in anisotropic media. They are familiar with the definitions, units, and laws of photometry (inverse square law, Lambert's law) and their applications in optical measurements.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZL3_W03] knows how to plan and perform a physical experiment and analyze the results obtained; knows the elements of the theory of measurement uncertainty in application to advanced physics experiments, knows the basic units of the SI system and its most important derived units; knows other systems of units of measurement	The student knows how to plan and carry out a physical experiment in the field of waves and optics, including experiments on the harmonic oscillator, standing waves, interference, diffraction, polarization of light, and photometric measurements. They understand the principles of processing and analyzing experimental results, including the application of measurement uncertainty theory, can identify sources of errors, and assess their impact on the reliability of the results. The student is familiar with the fundamental SI units and the most important derived units used in the description of wave and optical phenomena (e.g., Hz, N, Pa, W, lm, cd), and is also aware of other systems of measurement units.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
	[FIZL3_K07] has a sense of responsibility for jointly performed tasks	The student has a strong sense of responsibility for jointly performed tasks related to the analysis and interpretation of wave and optical phenomena. In teamwork, they are able to share responsibilities when addressing topics such as wave theory (harmonic oscillator, wave equation, dispersion, standing waves), propagation of electromagnetic waves (Maxwell's equations, polarization), as well as phenomena of geometrical optics (Fermat's principle, lenses, optical systems) and wave optics (interference, diffraction, coherence, holography). The student ensures the accuracy and reliability of results and the correct interpretation of photometric laws in measurement contexts.	[SK1] oral statement/conversation/ discussion [SK2] presentation/project/paper/ report

	Course outcome	Subject outcome	Method of verification
	[FIZL3_U02] has the ability to perform measurements of basic physical quantities; is able to develop, describe and present the results of physics experiments and computer simulations; is able to perform quantitative analyses and formulate qualitative conclusions on this basis; can estimate measurement uncertainties	The student is able to perform measurements of basic physical quantities related to wave and optical phenomena, such as wavelength, frequency, amplitude, phase and group velocity, light intensity, and photometric quantities. They can carry out and document experiments involving the harmonic oscillator, mechanical and electromagnetic waves, as well as experiments in geometrical and wave optics (reflection, refraction, interference, diffraction, polarization). The student is able to process and describe measurement results, apply quantitative analysis (e.g. Fourier analysis), and formulate qualitative conclusions on this basis. They can estimate measurement uncertainties and evaluate the reliability of results obtained both in laboratory experiments and in computer simulations.	[SU1] oral statement/conversation/discussion [SU2] presentation/project/paper/report
	[FIZL3_U15] can work in a team, plan and organize his/her own work and in a team	The student is able to work in a team on solving problems and carrying out tasks related to optics and waves. They can plan and organize both their own work and group activities while analyzing topics such as the harmonic oscillator, electromagnetic waves, interference, diffraction, polarization, and photometry. In collaboration with others, the student is able to share responsibilities, coordinate the workflow, support team members in achieving objectives, and ensure the reliability and timeliness of the obtained results.	[SU1] oral statement/conversation/discussion [SU2] presentation/project/paper/report

<table>
<tr><td>Subject contents</td><td colspan="3">The laboratory classes cover classical physics measurement methods using electronic techniques, with particular emphasis on planning measurements, constructing measurement systems, conducting experiments, and evaluating uncertainties. The aim is to verify fundamental laws of physics and to observe wave and optical phenomena.

Example laboratory exercises:
• Determination of the grating constant and measurement of the wavelength of light.
• Diffraction and interference of laser light.
• Determination of focal lengths of thin lenses.
• Determination of the radius of curvature of a lens using Newtons rings.
• Determination of the refractive index of light (various methods: minimum deviation angle in a prism, magnification of a microscope objective).
• Investigation of a photoresistor.
• Measurement of extinction using a spectrophotometer.
• Determination of the specific rotation of a sugar solution using a polarimeter.
• Polarization of light through a polaroid verification of Malus law.
• Examination of local thickness variations of planeparallel plates using a Haidinger interferometer.
• Determination of changes in the refractive index of air using a Jamin interferometer.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Assessment methods and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>not applicable</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>not applicable</td><td>51.0%</td><td>60.0%</td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">David H. Loyd, Physics Laboratory Manual (3rd Edition) a classic collection of physics experiments, including optics, wave phenomena, measurement methods, and error analysis.

John R. Taylor, An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements the standard reference on experimental measurements and uncertainties.

Introductory Physics Laboratory Manual commonly used in undergraduate physics/engineering programs; includes experiments on diffraction, interference, wavelength measurements, and error analysis.

Physics 131 Laboratory Manual (Simon Fraser University) covers basic experiments in optics and wave phenomena such as Brewsters angle, light polarization, and optical interference.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">not applicable</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">not applicable</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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