



## Subject card

Subject name and code	Optics and laser technique, PG_00037289						
Field of study	Technical Physics						
Date of commencement of studies	October 2024		Academic year of realisation of subject		2026/2027		
Education level	first-cycle studies		Subject group		Optional subject group 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	3		Language of instruction		Polish		
Semester of study	5		ECTS credits		4.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Division of Atomic Molecular and Optical Physics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr Mykola Shopa				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	15.0	30.0	0.0	0.0	60
	E-learning hours included: 0.0						
	eNauczanie source address: <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=7717">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=7717</a>						
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		5.0		35.0	100
Subject objectives	Introduction to the design, operation and use of lasers and optical elements applied in laser technique. The study of basic properties and applications of laser light.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K6_W08] has knowledge of planning and conducting physical experiments, and critical analysis of its results		The student explains the stages of experimental process and knows the standards of research reliability: documentation of procedure, data management, reproducibility.		[SW1] Assessment of factual knowledge		
	[K6_W02] has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics		Student is able to describe the physical laws of wave optics, electromagnetism and solid state physics, necessary to understand the principles of operation of lasers and their interaction with matter.		[SW1] Assessment of factual knowledge		
	[K6_U04] plans and conduct experiments, critically analyzes their results, draw conclusions and forms opinions, has laboratory work experience		The student is able to prepare and calibrate a experimental setup, conduct the experiment according to the instructions, process data, identify sources of error and uncertainty, and prepare a report with the experimental results.		[SU3] Assessment of ability to use knowledge gained from the subject		
	[K6_W07] has knowledge of the construction and operation of physical instruments, measurement and research equipment		Student classifies laser devices and explains their construction and operating principles. Student can describe the basic interactions of laser radiation with matter.		[SW1] Assessment of factual knowledge		

Subject contents	<p>Course content – lecture</p> <p><b>LECTURE</b></p> <p>Laser classes (safety)</p> <p>Properties of laser light (with the description of the following concepts: coherence, polarization, divergence angle)</p> <p>The Einstein coefficients</p> <p>The two-level system: laser rate equations, their solutions, conclusions</p> <p>Why is population inversion necessary in a laser?</p> <p>Line broadening mechanisms, what causes them? the profiles</p> <p>The three-level system: laser rate equations, their solutions,</p> <p>The four-level system: laser rate equations. Why the four-level system may be more efficient than the three level system?</p> <p>The laser resonator (cavity) and its role.</p> <p>The longitudinal modes of a resonator, free spectral range</p> <p>The transversal modes, the patterns</p> <p>The Gaussian beam, description, parameters</p> <p>Fabry-Perot resonator, the finesse</p> <p>Solid state lasers, operating principle, examples</p> <p>Gas lasers, operating principle, the CO<sub>2</sub> laser</p> <p>The Brewster window and its role</p> <p>Semiconductor laser, operating principle, differences between them and the LEDs (diodes)</p> <p>Q-switching</p> <p>Mode-locking</p> <p>Physical phenomena used in Q-switching and mode-locking</p> <p>Lasers in medicine</p> <p>Lasers in holography</p> <p>Other applications</p>		
	<p>Course content – exercises</p> <p>Solutions to selected problems related to optics and laser technology. For example:</p> <ul style="list-style-type: none"> <li>- Properties of electromagnetic waves and their behavior when passing through the medium boundaries</li> <li>- Problems using the Fresnel equations</li> <li>- Calculations of the degree of polarization</li> <li>- Problems involving the calculation of light dispersion in media</li> </ul>		
	<p>Course content – laboratory</p> <p><b>LABORATORY EXERCISES</b></p> <ol style="list-style-type: none"> <li>1) Measurement of laser-excited emission spectra of dye solutions.</li> <li>2) Investigation of diffraction and interference of laser light.</li> <li>3) Investigation of the Debye-Sears effect (diffraction of the laser light on acoustic standing wave).</li> <li>4) Investigation of the electro-optic effect</li> <li>5) Laser beam profile investigation</li> <li>6) Investigation of the laser beam polarization state</li> </ol>		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Written test of knowledge (exam)	50.0%	34.0%
	Completing all laboratory exercises, reports, oral presentations	100.0%	33.0%
	Written test (tutorials)	50.0%	33.0%
Recommended reading	Basic literature	<ol style="list-style-type: none"> <li>1. K. Tyagarajan, A. Ghatak, Lasers fundamentals and applications.</li> <li>2. F. Trager (Ed.), Springer Handbook of Lasers and Optics</li> </ol>	

	Supplementary literature	1. W. Demtroder, Laser spectroscopy 2. W. M. Steen, J. Mazumder, Laser material processing, Springer, 2010.
	eResources addresses	
Example issues/ example questions/ tasks being completed	1. Properties of the laser light. 2. Methods of creation of short laser pulses. 3. Line broadening mechanisms, the profiles 4. Applications of lasers in medicine 5. The Fabry-Perot resonator, the finesse 6. Description of the mechanism for creating the necessary lasing conditions 7. Types of active media and methods of pumping 8. Light polarization, birefringence, waveplates	
Practical activities within the subject	Not applicable	

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