GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Optics and laser technique, PG_00037289		
Field of study	Technical Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2028/2029
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

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_W04] has advanced knowledge of the principles of experimental design, experimental methods, measurement techniques and scientific equipment used in physics and related sciences, including their life cycle.	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_U04] is able, individually or in a team, to plan and conduct experiments in physics and related fields, including applied computer science or energy engineering, and to analyse and interpret results and formulate conclusions.	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_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and 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

Subject contents	Course content – lecture LECTURE Laser classes (safety) Properties of laser light (with the description of the following concepts: coherence, polarization, divergence angle) The Einstein coefficients The two-level system: laser rate equations, their solutions, conclusions Why is population inversion necessary in a laser? Line broadening mechanisms, what causes them? the profiles The three-level system: laser rate equations, their solutions, The four-level system: laser rate equations. Why the four-level system may be more efficient than the three level system? The laser resonator (cavity) and its role. The longitudinal modes of a resonator, free spectral range The transversal modes, the patterns The Gaussian beam, description, parameters Fabry-Perot resonator, the finesse Solid state lasers, operating principle, examples Gas lasers, operating principle, the CO2 laser The Brewster window and its role Semiconductor laser, operating principle, differences between them and the LEDs (diodes) Q-switching Mode-locking Physical phenomena used in Q-switching and mode-locking Lasers in medicine Lasers in holography Other applications Course content – exercises Solutions to selected problems related to optics and laser technology. For example: - Properties of electromagnetic waves and their behavior when passing through the medium boundaries - Problems using the Fresnel equations - Calculations of the degree of polarization - Problems involving the calculation of light dispersion in media Course content – laboratory LABORATORY EXERCISES 1) Measurement of laser-excited emission spectra of dye solutions. 2) Investigation of diffraction and interference of laser light. 3) Investigation of the Debye-Sears effect (diffraction of the laser light on acoustic standing wave). 4) Investigation of the electro-optic effect 5) Laser beam profile investigation 6) Investigation of the laser beam polarization state
Prerequisites and co-requisites	
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Completing all laboratory exercises, reports, oral presentations	100.0%	33.0%
Written test (tutorials)	50.0%	33.0%
Written test of knowledge (exam)	50.0%	34.0%

Recommended reading	Basic literature	1. K. Tyagarajan, A. Ghatak, Lasers fundamentals and applications. 2. F. Trager (Ed.), Springer Handbook of Lasers and Optics

	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 activites within the subject	Not applicable	

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