GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Detection of Optical Signals, PG_00048684						
Field of study	Electronics and Telecommunications						
Date of commencement of studies	February 2025		Academic year of realisation of subject	2024/2025			
Education level	second-cycle studies		Subject group	Optional subject group Specialty 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	1		Language of instruction	Polish Subject is offered in the Polish language. Can be offered in English when a group of students has been formed. Subject is not offered to individual students.			
Semester of study	1		ECTS credits	2.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Department of Metrology and Optoelectronics -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Paweł Wierzba					
	Teachers	dr hab. inż. Paweł Wierzba					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	0.0	30
	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	30		4.0	16.0	50	
Subject objectives	Provision of knowledge on advanced detectors of optical radiation. Further extension of analysis and design abilities of circuits working with discussed detectors.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W10] knows and understands, to an increased extent, the basic processes occurring in the life cycle of equipment, objects and technical systems, as well as methods of supporting processes and functions, specific to the field of study	Student knows and understands the processes taking place in selected detectors of optical radiation subjected to relevant adverse factors.	[SW1] Assessment of factual knowledge
[K7_U03] can design, according to required specifications, and make a complex device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment	Student can design electronic and optoelectronic circuits working with detectors of optical radiation and implementing selected measurement and control functions.	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[K7_W02] knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the field of study	Student knows and understands external and internal photoelectric effect, avalanche multiplication. Student knows and understands the operation of thermal and photon detectors. Student knows and understands the operation of single-photon detectors.	[SW1] Assessment of factual knowledge
[K7_W03] knows and understands, to an increased extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum	Student knows and understands the operation of selected circuits for analog signal processing.	[SW1] Assessment of factual knowledge

Subject contents

1. Schottky photodiodes internal structures, characteristics, applications
2. Photodiodes with heterostructures and quantum wells internal struc-tures and characteristics
3. Typical structures of Avalanche Photodiodes (APDs), materials used in their manufacturing
4. Characteristics of APDs, requirements for application circuits
5. Operation of APDs in linear mode. Noise model Geiger mode operation of APDs.
6. Passive quenching of APDs, circuits, multi-pixel APDs
7. Active quenching of APDs, circuits
8. Operation principles of thermal detectors. Spectral characteristics of responsivity
9. Bolometers classification, characteristics, internal structures
10. Thermopiles classification, internal structures
11. Photomultiplier Tubes (PMTs). Basic configuration, principles of op-eration. Photocathode types and their spectral characteristics of responsivity
12. Review of specific PMT configurations
13. Characteristics of PMTs
14. CCD detector matrices, charge transfer, detectors architectures
15. Read-out circuits and signal processing techniques
16. CMOS detector matrices. Internal structures and characteristics
17. Mid-infrared detector matrices
18. Advanced detection techniques: correlated double sampling, the use of integrators
19. Methodology of optoelectronic circuits design
20. Estimation of received power level
21. Design considerations for printed circuit boards of optoelectronic equipment
22. Maximization of signal-to-noise ratio in detector preamplifiers
23. Maximization of bandwidth in detector preamplifiers
24. Design of preamplifiers for bolometer detectors
25. Design of preamplifiers for thermopile detectors
26. Noise analysis of circuits using bolometer and thermopile detectors
27. Selection of operation amplifiers for circuits interfacing to thermal detectors
28. Design of preamplifiers for photomultiplier tubes
29. Design of preamplifiers for avalanche photodiodes
30. Requirements for applying phase sensitive detection
31. Example solutions of detection circuits

Prerequisites and co-requisites

No requirements

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Midterm colloquium	51.0%	50.0%
Project	51.0%	50.0%

Recommended reading	Basic literature	1. T. H. Wilmshurst, Signal recovery from noise in electronic instrumentation, Taylor and Francis, 1990 2. P.Horowitz, W. Hill, The art of electronics, 3rd ed, Cambridge university press, 2015 3. S.O. Kasap, Optoelectronics and Photonics, Pearson Education, 2nd ed., 2013 4. Photomultiplier Handbook. Burle Industries 1989 5. Z. Bielecki, A. Rogalski, Detekcja sygnałów optycznych, WNT Warszawa 2019
	Supplementary literature	No requirements
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	Discuss the structure of an avalanche photodiode Discuss the operation of an avalanche photodiode in the Geiger mode with active quenching Estimate the input-referred signal-to-noise ratio of a current-to-voltage converter	
Work placement	Not applicable	

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