GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Signal processing in FMCW radars, PG_00069765		
Field of study	Informatics, Electronics and Telecommunications, Biomedical Engineering, Biomedical Engineering, Biomedical Engineering, Space and Satellite Technologies, Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish Polish
Semester of study	2	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Microwave and Antenna Engineering -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Grzegorz Fotyga	
	Teachers	dr hab. inż. Grzegorz Fotyga	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	0.0	0.0	15.0	0.0	0.0	15

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/moodle/

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	15	1.0	9.0	25

Subject objectives

The aim of the course is to provide an in-depth understanding of the theoretical foundations and practical aspects related to signal processing in FMCW (Frequency-Modulated Continuous-Wave) radars.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W01] knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study	Successful completion of this course provides a thorough understanding of the theoretical foundations and practical aspects of signal processing in FMCW (Frequency-Modulated Continuous-Wave) radars.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
[K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by: - appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation, - application of appropriate methods and tools	Based on the acquired knowledge, he can analyze topics such as creating a Range-Doppler Map, determining the velocity and distance of objects, and CFAR (Constant False Alarm Rate) algorithms. The analysis is performed in the Jupyter Notebook and Python environments.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K7_W08] knows and understands, to an increased extent, the fundamental dilemmas of modern civilisation, the main development trends of scientific disciplines relevant to the field of education	The knowledge imparted on the subject is in line with contemporary trends in the arms industry.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
[K7_U09] can carry out a critical analysis of the functioning of existing technical solutions and assess these solutions, as well as apply experience related to the maintenance of advanced technical systems, devices and facilities typical for the field of studies, gained in the professional engineering environment	As part of the course, in addition to laboratory classes at PG, a visit to one of the companies that creates FMCW radar systems is planned.	[SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools

Subject contents

Course content – laboratory
1. Fourier Transform.
2. FMCW Radar Architecture.
3. RD Map Creation.
4. CFAR.
5. Determining the Distance and Velocity of Detected Objects.
6. Kalman Filters and Tracking.

Prerequisites and co-requisites

Requirements: basics of digital signal analysis (e.g. fast Fourier transform), basics of Python programming, basics of electromagnetism (Maxwell's equations, propagation of electromagnetic waves).

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratories - 5 meetings of 3 hours each	50.0%	100.0%

Recommended reading

Basic literature	Jankiraman, Mohinder. *FMCW radar design*. Artech House, 2018. Bi, Ziqian, et al. "Fmcw radar principles and human activity recognition systems: Foundations, techniques, and applications." *arXiv preprint arXiv:2410.08483* (2024).
Supplementary literature	Suleymanov, Suleyman. "Design and implementation of an FMCW radar signal processing module for automotive applications." *University of TWENTE* (2016).
eResources addresses	Basic https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=9024309&fileOId=9024312 - A Radar Signal Processing Study Supplementary https://arxiv.org/pdf/2410.08483 - FMCW Radar Principles and Human Activity Recognition Systems: Foundations, Techniques, and Applications

Example issues/ example questions/ tasks being completed

Practical activites within the subject

Field exercises

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