GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Optimization Methods, PG_00057475		
Field of study	Automation, Robotics and Control Systems		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2023/2024
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
Semester of study	1	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Control Engineering -> Faculty of Electrical and Control Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Anna Witkowska	
	Teachers	dr hab. Anna Witkowska dr inż. Krzysztof Armiński	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	15.0	15.0	0.0	60

E-learning hours included: 0.0

Address on the e-learning platform: https://enauczanie.pg.edu.pl/moodle/course/view.php?id=16631

Additional information:
Lecture - stationary/ at the building room

Labolatory and Project - stationary/ at the building room

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	10.0	55.0	125

Subject objectives

The aim of the course is to familiarize students with numerical optimization algorithms and prepare them to solve optimization problems independently, using computer software.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_K06	Students know and can select an appropriate method and algorithm to solve optimization tasks for advanced problems in engineering practice.	[SK5] Assessment of ability to solve problems that arise in practice
K7_W14	Students will be familiar with analytical and numerical algorithms for solving optimization tasks; they will be able to determine the objective function, decision variables, constraints, and boundary conditions.	[SW1] Assessment of factual knowledge
K7_W04	Students gain skills in formulating optimization tasks, building mathematical models of the optimized task. Students are able to evaluate and correctly interpret the obtained solutions	[SW1] Assessment of factual knowledge
K7_U07	Students know and can select an appropriate optimization method and algorithm for advanced problems in engineering practice	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment

Subject contents	Basics of optimization, repetition of the scope of 1st degree studies. Introduction to Matlab Optimization Toolbox. Numerical optimization methods, classification of optimization methods. Algorithms for finding the minimum function of one variable (Fibonacci, golden ratio,). The method of least squares and MiniMax in optimization tasks. Non-gradient methods (including Nelder Mead, Powell). Gradient methods of improvement directions. Methods of conjugate directions. Problems of non-linear programming with limitations. Direct and indirect methods. Random search. Sequential linear programming. Transformation technique. Methods of the penalty function. Multicriteria and methods of searching for solutions for multicriteria optimization problems (including Metakryterium, Pareto). Random search - Genetic algorithms, formic and swarm algorithms. Solving complex optimization problems - static and dynamic. Problem of dynamic positioning of the ship. Methods of optimal allocation of forces in issues of dynamic positioning of a ship (direct, indirect, numerical methods of optimal allocation, predictive method). The issues to be carried out will be accompanied by examples of the use of known methods to optimize the control system, including tuning of regulators, identification of the control object (eg optimization of PID controller parameters, identification of ship model parameters).
Prerequisites and co-requisites	Ability to mathematically describe physical and technical processes. Knowledge of the fundamentals of Mathematics, Numerical Methods, Modeling and Identification, Computer Control Systems, Optimization (within the scope of undergraduate studies). Fundamentals of programming in MATLAB/SIMULINK, Python

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
project	50.0%	30.0%
laboratory	50.0%	30.0%
egzam	50.0%	40.0%

Recommended reading

Basic literature	1. K. Amborski, Podstawy metod optymalizacji, Oficyna Wydawnicza Politechniki Warszawskiej, 2001 2. Arabas G.: Wyklad z algorytmow ewolucyjnych, PWN, Warszawa 2003. 3. Optymalizacja. Wybrane metody z przykładami zastosowań. Kusiak Jan , Danielewska-Tułecka Anna , Oprocha Piotr . Wydawnictwo Naukowe PWN 2009. 4. Kochenderfer, Mykel J., and Tim A. Wheeler. *Algorithms for optimization*. Mit Press, 2019. 5. Tony Gaddis. *Starting out with Python, 5th Edition*. Pearson, 2021. 6. Marek Gągolewski, Maciej Bartoszuk oraz Anna Cena. *Przetwarzanie i analiza danych w języku Python*. Wydawnictwo Naukowe PWN, 2016.
Supplementary literature	Rothlauf F. (2011) Optimization Methods. In: Design of Modern Heuristics. Natural Computing Series. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-72962-4_3
eResources addresses	Adresy na platformie eNauczanie: Metody optymalizacji [2023/24] - Nowy - Moodle ID: 35142 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=35142

Example issues/ example questions/ tasks being completed	1. Optimal allocation of controllers in DP system. 2. Optimization of PID controller parameters using metaheuristic algorithms vs. application of classical methods. 3. Parametric identification of the ship model by numerical optimization methods.
Work placement	Not applicable

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