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 2022	Academic year of realisation of subject	2021/2022
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. Bartosz Puchalski	

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

Metody optymalizacji [IIst] [WEiA 2021/22] - 920 - Moodle ID: 16631
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=16631

Additional information:
Lecture - online/remote working

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_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_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_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_U07	Students know and can select an appropriate optimization method and algorithm for advanced problems in engineering practice	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools

<table>
<tr><td>Subject contents</td><td>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).</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Ability to mathematically describe physical and technical processes. Knowledge of the fundamentals of Mathematics and Optimization.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>laboratory</td><td>50.0%</td><td>30.0%</td></tr>
<tr><td>project</td><td>50.0%</td><td>30.0%</td></tr>
<tr><td>egzam</td><td>50.0%</td><td>40.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>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.</td></tr>
<tr><td>Supplementary literature</td><td>Cite this chapter as: 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</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Find the conditional minimum of function f by using the method of penalty function.
2. Optimize the parameters of PID controller, using the MNK, MiniMax or AG method for selected control system.
3. Select parameters of the nonlinear function f, based on the measured inputs and outputs data, by using matlab tools.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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