GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Computational Optimization Methods, PG_00047422		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2022/2023
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study 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	English
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Henryk Kormański	
	Teachers	dr inż. Henryk Kormański	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	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	8.0	62.0	100

Subject objectives	To familiarize students with the theoretical foundations of mathematical optimization methods for problems without constraints and with constraints. In addition, introduction to the analytical and numerical computational methods.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by:n- appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation,n- application of appropriate methods and toolsn	Can formulate the problem of optimization in mathematical form.	[SU2] Assessment of ability to analyse information
	[K7_U21] can individually carry out an in-depth analysis of controlling, diagnostics and signal processing problems; and, to an advanced extent, is able to individually design, tune and operate automatic regulation, control and robotics systems; and use computers to control and monitor dynamic systems	Solves optimization tasks by analytical and numerical methods.	[SU4] Assessment of ability to use methods and tools
	[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.	Has basic knowledge of static and dynamic optimization.	[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	Is able to use optimization methods when solving problems in various fields.	[SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	Optimal decisions, optimal control and parametric optimization. Basic definitions. Examples of optimization problems. Classification of optimization problems: a) continuous optimal control mathematical description; b) discrete optimal control - mathematical description; c) static optimization - mathematical description. Transformation of optimal control problems to parametric optimization tasks. Convex sets and convex functions properties. Objective criteria, constraints and feasible areas. Function extremum in R^n space. Global and local extrema. Weierstass Theorem. Extremum determination by using analytical and iterative methods. Mathematical programming (linear, quadratic, convex). Static optimization of differential objective function without constraints. Necessary and sufficient conditions for extrema in R^1 space. Necessary and sufficient conditions for extrema in R^n space. Gradient vector and Hessian matrix. Properties of quadratic forms. Sylvester theorem. Static optimization with equality constraints. Lagrange functions. Necessary and sufficient conditions for identifying bordered extrema. Static optimization with inequality constraints. Lagrangean methods. Kuhn-Tucker Theorem. Iterative methods of minimum finding for problems without constraints. Classification of methods: a) one dimensional search methods; b) nongradient local search methods; c) nongradient search methods with R^n orthogonal basis; d) nongradient conjugate vector search methods; e) gradient methods in R^n space: simple gradient and Newton-Raphson method, conjugate gradient methods, Newton and quasi-Newton methods. Iterative methods for optimization problems with constraints. Review of methods: a) variable transformations; b) methods of feasible directions; c) penalty function methods.

Prerequisites and co-requisites	Basic mathematical knowledge
Assessment methods and criteria	Subject passing criteria / Passing threshold / Percentage of the final grade: activity – 50.0% – 20.0% test – 50.0% – 80.0%
Recommended reading	Basic literature: J.Nocedal, S.J.Wright, Numerical Optimization. Supplementary literature: P.E.Gill, W.Murray, M.H.Wright, Practical Optimization. eResources addresses: Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	
Work placement	Not applicable

Subject passing criteria	Passing threshold	Percentage of the final grade
activity	50.0%	20.0%
test	50.0%	80.0%