



Subject card

Subject name and code	Computational Optimization Methods, PG_00064530						
Field of study	Automatic Control, Cybernetics and Robotics						
Date of commencement of studies	February 2027		Academic year of realisation of subject			2026/2027	
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	1		ECTS credits			3.0	
Learning profile	general academic profile		Assessment form			assessment	
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr Magdalena Musielak				
	Teachers		dr Magdalena Musielak				
Lesson types	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	6.0		39.0		75
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_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		
	[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_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		Can formulate the problem of optimization in mathematical form.		[SU2] Assessment of ability to analyse information		

## Subject contents

Course content – lecture

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
	test	50.0%	80.0%
	activity	50.0%	20.0%
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		
Example issues/ example questions/ tasks being completed			
Practical activities within the subject	Not applicable		

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