GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Optimal Process Control, PG_00049214		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Optional subject group 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	2	Language of instruction	English
Semester of study	3	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Krystyna Rudzińska-Kormańska	
	Teachers	dr inż. Krystyna Rudzińska-Kormańska	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	0.0	0.0	0.0	45

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	45	6.0	24.0	75

Subject objectives

The aim of the course is to acquaint students with the theory of optimal control of continuous and discrete dynamic processes and the ensuing computational methods for solving practical tasks, as well as determining the optimal control of production processes.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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 the tasks of optimal process control by analytical and numerical methods.	[SU4] Assessment of ability to use methods and tools
[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	Solves the tasks of optimal process control by analytical and numerical methods.	[SU3] Assessment of ability to use knowledge gained from the subject
[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 optimal process control in mathematical form.	[SU2] Assessment of ability to analyse information

Subject contents	Treści przedmiotu Concepts: system - model - process. Continuous and discrete processes. Discretization in time. Event-driven processes and the multistage processes. Processes in continuous and discrete dynamical systems. The mathematical description of dynamic processes. Multistage decision-making processes. Compounds with dynamic optimization. Optimal control - practical examples. Mathematical basis of optimal control with and without constraints. Variations and minimization of functionals. Necessary and sufficient conditions of a minimum of the functional. The theory of optimal control for continuous systems (linear, nonlinear, stationary and non-stationary). Necessary and sufficient conditions for the problem without additional constraints on the control and state variables. The influence of boundary conditions on the solution. The use of an iterative decision-making process for determining the optimal controls. Optimal control with constrains. The necessary conditions for an extreme of the performance index. Pontryagin's Principle. Conditions for optimal control with indefinite process time. The minimum time problems. The processes described by discrete differential equations. Markov's property. The principle of optimality. Dynamic programming algorithm. Problems solving with the dynamic programming (DP) method. Transformation of continuous dynamic optimization tasks and static optimization tasks to DP ones. Practical application of DP in technical and economic process engineering. Discrete processes and decision-making processes in production systems. The computer-controlled production processes - characteristics. Functional structure of flexible manufacturing systems (FMS). FMS subsystems. Classification of multi-stage scheduling problems and production planning. Serial production processes. Principles of SPT and EDD. Johnson's algorithm. Scheduling operations described by the graph. Lawler's algorithm. The parallel processes in production. Bellmann's programming. Calculating the optimal routings. The optimal allocation of tasks to machines. The zero-one problems. Hungarian Algorithm - balanced and unbalanced tasks. Optimal control of mobile robots. The use of Dijkstra's algorithm to determine the minimum-cost, collision-free paths.
Prerequisites and co-requisites	
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
100% exam	50.0%	100.0%

Recommended reading	Basic literature	1. D. Kirk, Optimal Control Theory. An Introduction. (Prentice Hall INC., 1970, and Dover Edition, 2004). 2. H.A. Taha Operation Research. (Macmillian International Editions, 1992)
	Supplementary literature	1. I.M. Gelfand and S. V. Fomin, Calculus of Variations, (Dover, New York, 2000).
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	