GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modern Control Engineering and Robotics, PG_00061798		
Field of study	Automation, Robotics and Control Systems		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	4	Language of instruction	Polish
Semester of study	7	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Intelligent and Decision Support Systems -> Faculty of Electrical and Control Engineering -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Michał Grochowski	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	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	5.0	40.0	75

Subject objectives

The aim of the course is to present modern technologies and tools currently operating in the field of automation, control and decision support systems and robotics. The course will also present the latest trends in this field and the prospects for its development, with particular emphasis on intelligent and digital technologies.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U01] can obtain information from literature, databases and other sources; integrate the information obtained, interpret it and draw conclusions, formulate and justify opinions	Efficiently obtains information from literature, databases and other sources; to integrate information obtained, interpret and draw conclusions, formulate and justify opinions	[SU2] Assessment of ability to analyse information
[K6_W06] knows the structure of computers and microprocessors and the tasks of operating systems, has basic knowledge of the basics of computer software, drivers, microprocessor technology, design of simple algorithms and the operation of information networks	Is able to propose an ICT system architecture and appropriate software for the implementation of control and decision-support algorithms.	[SW3] Assessment of knowledge contained in written work and projects
[K6_W10] has basic knowledge related to mechatronics and robotics systems	Is able to explain the operation, application conditions, and limitations of selected control engineering and robotics systems	[SW3] Assessment of knowledge contained in written work and projects
[K6_U03] can prepare and present a presentation on the problems and results of an engineering task	Is able to prepare and deliver a presentation on the problems and results of an engineering task.	[SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture
Following the initial delivery of knowledge on a given topic, they will take the form of a focused and Instructor-inspired discussion with Students on the engineering problem undertaken, as well as important, current and forward-looking issues for automation, decision support and robotics professionals.

Topics covered in Lectures:- Methods of obtaining the best quality and efficiency of control of complex objects - intelligent control methods, technologies of optimal, predictive, adaptive, hierarchical control; - Application of intelligent data analysis methods in modern decision-making systems - methods of artificial intelligence and machine learning (including deep learning technologies, evolutionary algorithms, computer vision algorithms) - e.g. analysis and exploration of knowledge from big data sets (Big data), object detection and classification, black box modelling;- Use of decision support methods in distributed, hierarchical, discrete systems and multi-criteria issues - multi-agent control, group decisions (e.g. decentralised control of extensive control objects, e.g. IT, energy, water supply networks);- Methods of determining the optimal trajectory of movement and its realisation (control) of dynamic objects in a known or unknown environment - e.g. control of autonomous vehicles, control of robot formations, exploration of an unknown environment and its mapping;- Modern methods of process monitoring and diagnostics - parameter estimation, reconstruction of state variables, detection and finding the causes of process anomalies using methods based on measurement data.

Course content – laboratory
The classes will be conducted in the form of workshops, during which groups (56 students) will work together to solve a task defined by the instructor. Particular attention will be paid to students creativity, the ability to use modern engineering tools and technologies, and the ability to cooperate within a team.

Example topics covered during laboratory classes:
Optimal control of nonlinear systems/processes (e.g., predictive control, adaptive control);
Decision support in distributed systems multi-agent control, group decision-making (e.g., robot formation control, cooperation of computational agents implemented on Raspberry Pi platforms, Matlab/Simulink);
Use of modern algorithms and IT tools for data analysis, including large-scale and uncertain data.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratory	50.0%	50.0%
Colloquium	50.0%	50.0%

Recommended reading

Basic literature

- Bonaccorso, G. Algorytmy uczenia maszynowego. Zaawansowane techniki implementacji. Helion, 2019;
- Szeliga, M. Data Science i uczenie maszynowe. Wydawnictwo Naukowe PWN, 2017.
- Grus, J. Data science od podstaw. Analiza danych w Pythonie. Helion, 2019.
- Rawlings J.B., D.Q. Mayne (2009). Model Predictive Control: Theory and Design. Nob-Hill Publishing.
- Grega W. (2004). Metody i algorytmy sterowania cyfrowego w układach scentralizowanych i rozproszonych. Wydawnictwa AGH, Kraków.
- Michalewicz Z. (1996). Genetic Algorithms + Data Structures = Evolution Programs. Springer-Verlag, Berlin, third edition.

Supplementary literature

- Bengio, Y., Courville A., Goodfellow I. Deep Learning. Systemy uczące się. Wydawnictwo Naukowe PWN, 2018.
- Tatjewski T (2002). Sterowanie zaawansowane obiektów przemysłowych. Akademicka Oficyna Wydawnicza EXIT, Warszawa.
- ROS, Robot Operating System (2024): https://www.ros.org/blog/getting-started/
- Matlab/Simulink ROS Toolbox (2024): https://www.mathworks.com/products/ros.html
- Slotine J.-J. E., Li W. (1991). Applied Nonlinear Control. Prentice Hall, Englewood Cliffs, New Jersey, US.
- Maciejowski J. M. (1989). Multivariable Feedback Design. Addison Wesley.
- Byrski W. (2007). Obserwacja i Sterowanie w Systemach Dynamicznych. Uczelniane Wydawnictwa Naukowo Dydaktyczne Akademii Górniczo Hutniczej w Krakowie.

eResources addresses

Example issues/ example questions/ tasks being completed	• Choose measurement and control algorithms for an autonomous vehicle to navigate in an unknown environment - implementation in ROS (Robot Operating System) - Gazebo simulator • Analyse the measurement data set for patterns of interest • Determine the parameters of the optimal control system for the selected object (INTECO family objects)
Practical activites within the subject	Not applicable

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