



Subject card

Subject name and code	Control Structures and Algorithms, PG_00038316						
Field of study	Automation, Robotics and Control Systems						
Date of commencement of studies	February 2026		Academic year of realisation of subject		2026/2027		
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	2		ECTS credits		4.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Control Systems Engineering -> Faculty of Electrical and Control Engineering -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Tomasz Rutkowski				
	Teachers		dr inż. Tomasz Rutkowski				
Lesson types	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						
	eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=917						
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		10.0		45.0	100
Subject objectives	Acquiring a knowledge related to advanced control methods and algorithms enabling the construction of such control structures that will allow for effective control of linear/nonlinear objects, both single and multidimensional.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_U10] is able to apply the known mathematical tools and methods and computer techniques to analyse and evaluate automation and robotics components, devices, systems and systems		The student can conduct the synthesis of the known advanced control algorithms for a given object specification. The student designs and implements control structures using the known advanced control methods and algorithms.		[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment [SU5] Assessment of ability to present the results of task		
	[K7_K04] is able to react in abnormal and emergency situations, health and life-threatening when use of automation and robotics components and systems		Student is able to propose basic actions in emergency situations related to the operation of the control structures used, in accordance with safety principles and applicable procedures.		[SK3] Assessment of ability to organize work [SK1] Assessment of group work skills		
	[K7_W06] has an extended knowledge of the design of automation components and devices, control and decision support systems control and decision support systems and complex mechatronic systems		The student uses known (learned during the classes) methods and advanced control algorithms in the projects of control systems.		[SW1] Assessment of factual knowledge		

Subject contents	Course content – lecture Control structures, methods and algorithms for control and state estimation: Kalman filters (assumptions, disturbances and measurement noise, a recursive form of the estimator); predictive control algorithms DMC, QDMC, GPC (problem formulation, a model for prediction, stability, implementation aspects); linearization by feedback (input-state linearization, input-output): differential-integral calculus of fractional orders (definitions of fractional-order operators, approximations of fractional-order operators, fractional-order PID controllers); variable structure control, sliding mode control (stability of sliding motion and conditions of its existence, control law, consideration of various aspects of uncertainty, a continuous approximation of the control law); intelligent adaptive neural and object fuzzy control with nonlinear dynamics with unavailable state and uncertainty in object model dynamics. Application of Linear Matrix Inequalities (LMI) in the synthesis of control systems.		
	Course content – exercises		
	Tutorials cover the practical implementation of the following topics:		
	• Estimation of the linear state of an object with distortions and measurement noise with a temporal structure using the Kalman Filter method, • Synthesis of follow-up manipulator control (robot arm) realizing the reference movement trajectory by linearization method by feedback with nonlinearity leakage compensation in conditions of viscous friction and additive disturbances, • Synthesis, implementation and verification of fractional-orders PID controllers for selected linear objects, • Implementation and verification of DMC and QDMC predictive control algorithms for selected single and multidimensional linear objects, • Implementation and verification of the sliding mode control algorithm enabling the stabilization of a nonlinear object with disturbances in internal dynamics.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Tutorial reports	50.0%	50.0%
	Class tests	50.0%	50.0%
Recommended reading	Basic literature	1. Franklin G. F., Powell J.D., Abbas Emami-Naeini: Feedback Control Dynamic Systems. Sixth Edition, Pearson, Upper Saddle River, 2010. 2. Slotine Jean Jacques E., W. Li: Applied Nonlinear Control. Prentice Hall, Englewood Cliffs, New Jersey 07632, 1991. 3. Brdys Mietek A., Tatjewski P.: Iterative Algorithms for Multilayer Optimizing Control, Imperial College Press, World Scientific Publishing Co. Pte. Ltd., 2005. 4. Rawlings J.B., Mayne D.Q.: Model Predictive Control: Theory and Design. Nob-Hill Publishing, 1st edition, 2009.	
	Supplementary literature	1. Khail Hassan K.: Nonlinear Systems. Prentice Hall, Englewood Cliffs, New Jersey 07632, 2002. 2. Maciejowski J.M.: Multivariable Feedback Design. Addison Wesley, 1989 3. Byrski W.: Obserwacja i Sterowanie w Systemach Dynamicznych. Uczelniane Wydawnictwa Naukowo Dydaktyczne Akademii Górniczo Hutniczej w Krakowie, 2007 (<i>Control and Estimation in Dynamical Systems</i>) 4. Tatjewski P.: Sterowanie Zaawansowane Obiektów Przemysłowych struktury i algorytmy. Warszawa, Akad. Oficyna Wyd. EXIT, 2002. (<i>Advanced Control of Industrial Processes Structures and Algorithms</i>) 5. Duda J. T.: Modele Matematyczne, Struktury i Algorytmy Nadrzędnego Sterowania Komputerowego. Uczelniane Wydawnictwa Naukowo Dydaktyczne Akademii Górniczo-Hutniczej w Krakowie, Kraków, 2003. (<i>Mathematical Models, Structures and Algorithms for Supervisory Computer Control</i>)	
	eResources addresses		
Example issues/ example questions/ tasks being completed	• Present the structure of the Kalman Filter and describe its properties. • Describe the concept of linearization by feedback methodology. • Introduce the concepts of the predictive control algorithm. • Identify the similarities and differences between the DMC and QDMC predictive control algorithms. • Identify the similarities and differences between GPC and QDMC predictive control algorithms. • Describe the concept of sliding mode control. • Describe the chosen method of approximating the fractional-order operators.		
Practical activities within the subject	Not applicable		

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