



Subject card

Subject name and code	Kalman Filters and Stochastic Control, PG_00064517						
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				Optional subject group Specialty 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	1	Language of instruction				Polish	
Semester of study	1	ECTS credits				2.0	
Learning profile	general academic profile	Assessment form				assessment	
Conducting unit	Department of Signals and Systems -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Artur Gańcza					
	Teachers	dr inż. Piotr Kaczmarek dr inż. Artur Gańcza					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	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	4.0		16.0	50	
Subject objectives	Introducing design methods for regulation systems working in random conditions.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[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	Students understand the minimum-variance estimation, they understand the operating principle of Kalman filter and its selected modifications. Students understand the working principle of minimum-variance control and know its properties. Students understand how Bayesian reasoning can be used to combine results of different algorithms.			[SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge		
	[K7_W02] knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the field of study	Students know basic kinds of random processes and Markow's decision problems. Students understand the principle of Bayesian reasoning.			[SK5] Assessment of ability to solve problems that arise in practice [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SW1] Assessment of factual knowledge		

Subject contents	<p>Course content – lecture</p> <ol style="list-style-type: none"> 1. Principles of minimum variance (MV) control 2. MV regulators for ARMAX systems 3. Stability of MV regulators 4. Diophantine equations and their solutions 5. MV tracking of a reference signal 6. Limitations and drawbacks of MV control 7. Moving average (MA) control 8. Linear quadratic (LQ) control principles 9. Design of LQ regulators 10. Principles of minimum variance estimation 11. Introduction to Kalman filtering conditional densities of Gaussian variables 12. Prediction, filtration and smoothing of stochastic signals 13. Kalman predictor and Kalman filter 14. Properties of Kalman filter 15. Stationary Kalman filter Wiener filter 16. Kalman filter as an optimal state observer 17. Application of Kalman filter to airplane tracking 18. Numerical safeguards used in Kalman filtering 19. Extended Kalman filter (EKF) 20. Application of EKF to localization of an autonomous guided vehicle 21. LQ regulators in state space 22. Separation theorem 23. Robustness of LQ regulators 24. Markov chains 25. Multiple models estimation methods <p>Course content – project</p> <ol style="list-style-type: none"> 1. Kalman filter in state estimation of a stationary object. 2. Kalman filter in state estimation of a stationary nonlinear object. 3. Combining estimation results of multiple Kalman filters. 											
Prerequisites and co-requisites												
Assessment methods and criteria	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 40%;">Subject passing criteria</th> <th style="width: 30%;">Passing threshold</th> <th style="width: 30%;">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>Midterm colloquium</td> <td>52.0%</td> <td>100.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Midterm colloquium	52.0%	100.0%			
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Recommended reading	<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 40%;">Basic literature</td> <td colspan="2" style="width: 60%;">B. D. O. Anderson & Moore J. B., "Optimal Filtering", Dover Publications, 2005</td> </tr> <tr> <td>Supplementary literature</td> <td colspan="2">Blackman S. & Poppoli R., "Design and Analysis of Modern Tracking Systems", Artech House, 1999</td> </tr> <tr> <td>eResources addresses</td> <td colspan="2"></td> </tr> </tbody> </table>			Basic literature	B. D. O. Anderson & Moore J. B., "Optimal Filtering", Dover Publications, 2005		Supplementary literature	Blackman S. & Poppoli R., "Design and Analysis of Modern Tracking Systems", Artech House, 1999		eResources addresses		
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Example issues/ example questions/ tasks being completed												
Practical activities within the subject	Not applicable											

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