



Subject card

Subject name and code	Selected methods of state estimation, PG_00071142						
Field of study	Automation, Robotics and Control Systems						
Date of commencement of studies	February 2025	Academic year of realisation of subject			2025/2026		
Education level	second-cycle studies	Subject group					
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	2	Language of instruction			Polish		
Semester of study	3	ECTS credits			2.0		
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 inż. Rafał Łangowski				
	Teachers						
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		0.0		0.0	30
Subject objectives	The aim of the course is to present selected methods for estimating the state of linear and non-linear dynamic systems, including in the presence of various types of uncertainty modelled in both deterministic and stochastic ways.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_K06] is aware of the impact of engineering activities on the quality of applied solutions and the environment		The student analyses and interprets the impact of the information provided by the designed state observatories on the quality and effectiveness of the monitoring and control systems implemented at a given facility.		[SK5] Assessment of ability to solve problems that arise in practice		
	[K7_U01] is able to obtain information from literature, databases and other sources, to integrate information obtained information, interpret and draw conclusions and substantiate opinions in a comprehensive manner		The student reviews the literature on state estimation, extracts and interprets the knowledge contained in the relevant publications. The student presents their own research objectives in the context of the literature review and in relation to the specific application.		[SU2] Assessment of ability to analyse information		
	[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods		The student uses mathematical language to describe plants, processes and systems, enabling the analysis of their crucial properties, particularly with regard to state estimation. Based on those descriptions, the student derives models for state observer synthesis. The student designs state observers based on the derived models and available measurement data, including in the presence of model and measuring uncertainties.		[SW1] Assessment of factual knowledge		

Subject contents	<p>Course content – lecture The lecture includes the following topics:</p> <ol style="list-style-type: none"> <li>1. Preparation for the synthesis of state observers deriving models for observer design, analysing observability and detectability, primarily of non-linear models, using tools from differential geometry and the method of indistinguishable dynamics (indistinguishable state trajectories), modelling uncertainty in both dynamics (unstructured and parametric) and measurements.</li> <li>2. Synthesis of deterministic state observers various types of Luenberger observers, high-gain observers, first- and higher-order sliding mode observers, and interval observers.</li> <li>3. Synthesis of stochastic state observers various types of Kalman filters.</li> </ol>								
Prerequisites and co-requisites	<p>Basic knowledge of control theory and control engineering, particularly in relation to:</p> <ul style="list-style-type: none"> <li>- classical state estimation methods based on the Luenberger observer and the Kalman filter,</li> <li>- the derivation of mechanistic models,</li> <li>- the analysis of the properties of plants and systems, particularly with regard to stability and observability.</li> </ul>								
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>Final test</td> <td>50.0%</td> <td>100.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Final test	50.0%	100.0%
Subject passing criteria	Passing threshold	Percentage of the final grade							
Final test	50.0%	100.0%							
Recommended reading	Basic literature	<ol style="list-style-type: none"> <li>1. Mitkowski W.: Zarys teorii sterowania, Wydawnictwa AGH, Kraków, 2019.</li> <li>2. Khalil H.K.: Nonlinear Systems, Prentice Hall, 2002.</li> <li>3. Bastin G., Dochain D.: On-line Estimation and Adaptive Control of Bioreactors. Elsevier, 1990.</li> <li>4. Veluvolu K. C.: Nonlinear Sliding Mode State and Unknown Input Estimations, VDM Verlag, 2009.</li> <li>5. Schweppe F.C.: Układy dynamiczne w warunkch losowych, Wydawnictwa Naukowo-Techniczne, 1978.</li> </ol>							
	Supplementary literature	<ol style="list-style-type: none"> <li>1. Moore R. E., Kearfott R.B., Cloud M. J.: Introduction to Interval Analysis. Siam, 2009.</li> <li>2. Boyd S., El Ghaoui L, Feron E., Balakrishnan V.: Linear Matrix Inequalities in System and Control Theory, Siam, 1994.</li> <li>3. Gauthier J.-P., Kupka I.: Deterministic Observation Theory and Applications. Cambridge University Press, 2009.</li> </ol>							
	eResources addresses								
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>1. Steps in the synthesis of a selected observer type;</li> <li>2. Conditions for the applicability of a given observer type;</li> <li>3. Selection of the gain matrix for a high-gain observer;</li> </ol>								
Practical activites within the subject	Not applicable								

Document generated electronically. Does not require a seal or signature.