GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Identification of Changes in Signals, PG_00048474						
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	1			Language of instruction		Polish	
Semester of study	2			ECTS credits		1.0	
Learning profile	general academic profile			Assessment form		assessment	
Conducting unit	Department of Decision Systems and Robotics -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Janusz Kozłowski				
	Teachers		dr inż. Janusz Kozłowski				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	15.0	0.0	0.0	0.0	15
	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	15		2.0	8.0		25
Subject objectives	Expanding knowledge on change detection and parameter identification algorithms. Practical implementations of selected procedures. Application of different methods of mathematical modelling of systems.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W21] Knows and understands, to an advanced extent, methods and techniques of design and operation of automatic control systems, control and robotics systems, as well as the use of computers in the control and monitoring of dynamic objects	Student got fundamental knowledge on diagnostics of automation systems. Student got prepared to practically apply the robust to outliers identification methods in diagnostic procedures.	[SW1] Assessment of factual knowledge
	[K7_W03] Knows and understands, to an increased extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum.	Student got practical knowledge on applications of the on-line detection and identification algorithms. Student got familiar with analytical methods for examination of algorithms.	[SW1] Assessment of factual knowledge
	[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	Student got general knowledge on digital processing of measurement signals. Student applied the identification algorithms to monitor the dynamics of automation systems.	[SU4] Assessment of ability to use methods and tools
	[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.	Student got engineering knowledge on implementation of mathematical methods of multiple integration. Student applied suitable methods for numerical approximation of continuous models.	[SW1] Assessment of factual knowledge
	[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	Student got expert knowledge on mathematical modelling of automation systems. Student implemented the parameter identification procedures with utility weighting mechanisms (i.e. with simple and directional forgetting).	[SU4] Assessment of ability to use methods and tools

Subject contents	
	Determination of basic characteristics of stochastic processes. Discrete-time approximation of continuous-time representations. Numerical integration of signals using splines. The least-squares method – transformation of continuous-time and discrete-time formulae. Examination of asymptotic properties of the least-squares method. Practical implementation. Modification of the least-squares method using a vector of instrumental variables. Examination of asymptotic properties of the instrumental variable method. Comparison of different realizations of instrumental variables. Implementation of algorithms with an adaptive weighting mechanism. Implementation of robust to measurement outliers algorithms. Numerical examples. Transformation of continuous-time models using linear integrating filters and Poisson moment functionals. Simulation tests. Direct and indirect identification of continuous-time models. Numerical comparison of estimation quality.

<table>
<tr><td>Prerequisites
and co-requisites</td><td colspan="2">The required knowledge and skills:

Deterministic and stochastic modeling, frequency domain representations and state-space descriptions.

Methods of discretization of continuous-time models using linear integrating filters and Poisson moment functionals in discrete-time approximations of continuous systems.

Recursive least-squares method, its implementation and practical applications.

Robust to measurement faults parameter identification algorithms derived from minimization of non-quadratic criteria and their applications in diagnostic procedures.

Direct method of continuous-time system identification and its application in identification of delay systems, systems with nonlinearities and distributed parameter systems.

The lecture on Detection of Changes in Signals in the preceding semester must be accomplished successfully.</td></tr>
<tr><td>Assessment methods
and criteria</td><td colspan="2"><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Colloquiums. It is necessary to score at least 10 out of total amount of 20 pts. for each colloquium. Number of colloquiums: 1.</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Basseville M., Nikiforov I.V.: Detection of abrupt changes: theory and application. Prentice-Hall Inc., 1993.

Ljung L.: System identification. Theory for the user. Prentice-Hall Inc., 1987.

Korbicz J., Kościelny J.M., Kowalczuk Z., Cholewa W. (Editors): Fault diagnosis: models, artificial intelligence, applications. Springer, Berlin New York, 2004.</td></tr>
<tr><td>Supplementary literature</td><td>Anderson B.D.O., Moore J.B.: Optimal filtering. Information and System Sciences Series. Prentice-Hall Inc., 1979.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/
example questions/
tasks being completed</td><td colspan="2">1. Enumerate and describe in brief common performance indices used for evaluation of quality of change detection.

2. Compare the Kalman approach and the Wiener approach to optimal filtering. Indicate situations where Kalman filter demonstrates its supremacy.

3. Compare the so-called direct and indirect approaches to identification of continuous-time systems. Enumerate the benefits and drawbacks of both concepts.

4. Describe the direct method of identification of continuous-time systems based on the method of linear integral filtering (LIF). Introduce the transfer function of the LIF operator and derive the ultimate formula for the numerical LIF realization using the bilinear operator. Formulate and justify the rule of thumb for proper selection of the integration horizon.

5. Specify in brief possible applications of change detection algorithms. Explain why abrupt changes do not necessarily mean changes large in magnitude.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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