GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Essentials of Automatics, PG_00047537					
Field of study	Automatic Control, Cybernetics and Robotics					
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028	
Education level	first-cycle studies		Subject group		Obligatory subject group in the field of study 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	2		Language of instruction		Polish	
Semester of study	3		ECTS credits		5.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Department of Automatic Control -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology					
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Piotr Kaczmarek			
	Teachers		dr inż. Piotr Kaczmarek			
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60	5.0	60.0	125	
Subject objectives	The course introduces students to the linear dynamic systems. It covers methods for developing mathematical models based on differential equations and converting them into transfer functions and state-space representations. Special focus is given to the time response of first- and second-order systems, system stability, and control performance. Students learn controller design using the root locus method and frequency response techniques. The course combines theoretical knowledge with practical computational skills, equipping students with the tools necessary for analyzing and designing control systems.					

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W01] knows and understands, to an advanced extent, mathematics necessary to formulate and solve simple issues related to the field of study	Student knows various methods of modeling of dynamic systems and understands how they are related to each other	[SW1] Assessment of factual knowledge
	[K6_W10] knows and understands, to an advanced extent, the parameters, functions, and methods of analysis, design, and optimization of electronic circuits and systems, the definitions of error and measurement uncertainty, measurement methods, including time, frequency, and phase measurements, the properties of converters, and methods of digital signal processing, as well as the basic processes occurring in the life cycle of technical devices, objects, and systems, and methods of supporting processes and functions, specific to the field of study	The student can model linear dynamic systems and shape their characteristics based on feedback control.	[SW1] Assessment of factual knowledge
	[K6_W03] knows and understands, to an advanced 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	The student understands the impact of different controller configurations on the behavior of the control system.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Lecture Program
Basic concepts and classification of control systems
The role of mathematical modeling in control engineering
Differential equations of dynamic systems
Mechanical, electrical, and thermal models formulation of physical equations
Transfer function definition and interpretation
Laplace transform, initial conditions, interpretation of poles and zeros
Construction and reduction of block diagrams, rules for combining elements
State-space modeling
Responses of dynamic systems
Time response of a first-order system
Time response of a second-order system
Characteristics of overshoot, rise time, and settling time
Time-domain performance indices
Dominant poles and their significance in response analysis
Approximation of higher-order models, influence of dominant poles
BIBO stability and asymptotic stability
Routh-Hurwitz stability criteria
Stability conditions for transfer functions and characteristic equations
Steady-state quality error analysis
System type, classification, and steady-state errors
Root locus construction rules and general features
Controller design using the root locus method
Padé approximation of time delays
Frequency response characteristics: Bode and Nyquist plots
Frequency-domain performance indices
Stability margins gain and phase margin
Controller design in the frequency domain
Modification of open-loop and closed-loop characteristics, compensation

Exercise Program
Using the Laplace transform to solve differential equations
Derivation of differential equations for mechanical and electrical systems
Converting differential equations to transfer functions
Building a block diagram from a differential equation
Dynamic system modeling in state-space form
Step response of a first-order system
Step response of a second-order system
Response analysis of second-order systems with varying damping
Determination of time-domain performance indices
BIBO stability analysis based on transfer functions
Stability verification using the Routh-Hurwitz method
Routh array and special cases
Root locus drawing construction rules
Analysis of the effect of gain K on system stability and response
Controller design (P/PD/PI/Lead/Lag) using the root locus method
Determining Bode plots for a given transfer function and analyzing stability
Stability analysis using the Nyquist plot
Evaluation of control quality based on frequency response characteristics</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Calculus, Complex Calculus, Algebra</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Exercices</td><td>60.0%</td><td>50.0%</td></tr><tr><td>Oral exam</td><td>60.0%</td><td>50.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>N.S. Nise, Control Systems Engineering, Wiley, 2010.

R.C. Dorf, R.H. Bishop, Modern Control Systems, Prentice Hall, 2008.

F. Golnaraghi, B.C. Kuo, Automatic Control Systems, Wiley, 2009.</td></tr><tr><td>Supplementary literature</td><td>S. Skogestat, I, Postlethwaite, Multivariable Feedback Control: Analysis and Design, Wiley, 2005.</td></tr><tr><td>eResources addresses</td><td></td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td></td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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