GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Analog Control, PG_00047575		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2022/2023
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	4	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Automatic Control -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Piotr Kaczmarek	
	Teachers	dr inż. Piotr Kaczmarek	

Lesson types and methods of instruction

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	3.0	42.0	75

Subject objectives

Introduction of linear analysis using state space methods. Introduction of nonlinear system analysis (describing function, phase plane method).

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W05] Knows and understands, to an advanced extent, methods of supporting processes and functions, specific to the field of study	Student can design nonlinear control systems.	[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	Student can design complex control systems based on state space methods	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>1. Introduction to state-space modelling for linear continuous-time dynamic systems. Transfer function versus state-space modelling.
2. State space model - diagonalization.
3. Stability of linear dynamical systems.
4. Controllability. Algebraic criteria for controllability.
5. Non-optimal control. Reachability.
6. Observability. Algebraic criteria for observability. Detectability.
7. Synthesis of state space feedback control: pole assignment. Ackermann method.
8. Tracking (servo) problem.
9. State estimation problem. Ackermann"s formula for observer design. Minimal order observer.
10. Observer-state feedback control systems. A separation rule for designing.. Decoupling.
11. Kalman"s decomposition. Numerical problems of linear control systems.
12. Eigenstructure assignment for control system design.
13. Diagnostic observer design.
14. Optimal control - linear quadratic regulator (LQR) problem.
15. Introduction to non-linear control.
16. Non-linear differential equations. Fixed-point methods.
17. Phase plane analysis of non-linear control systems.
18. Phase-plane method: relay control. Saturation.
19. Phase-plane method: sliding-mode control.
20. Stability of equilibrium points in the sense of Lyapunov.
21. Lyapunov"s linearisation method for stability analysis.
22. Lyapunov"s direct method for stability analysis. Region of attraction.
23. Stability of state trajectory of non-autonomous systems.
24. Input-output (I/O) stability.
25. Relationships between I/O stability and Lyapunov stability. Time-varying and non-linear systems.
26. Approximate analysis methods for non-linear systems. Describing function analysis of non-linear control systems
27. Describing-function method: periodic solutions, limit cycles.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Advanced mathematics, fundamentals of control engineering</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>Oral exam</td><td>60.0%</td><td>50.0%</td></tr>
<tr><td>Written test</td><td>60.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>J. Nowakowski "Podstawy automatyki" tom 2 skrypt PG

Katsuhiko Ogata "Modern Control Engineering"</td></tr>
<tr><td>Supplementary literature</td><td>C.-T. Chen: Control System Design, Saunders College Publishing, 1993</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
</table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td></td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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