



## 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		

Subject contents	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.		
Prerequisites and co-requisites	Advanced mathematics, fundamentals of control engineering		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Oral exam	60.0%	50.0%
	Written test	60.0%	50.0%
Recommended reading	Basic literature	J. Nowakowski "Podstawy automatyki" tom 2 skrypt PG  Katsuhiko Ogata "Modern Control Engineering"	
	Supplementary literature	C.-T. Chen: Control System Design, Saunders College Publishing, 1993	
	eResources addresses	Adresy na platformie eNauczanie:	
	Example issues/ example questions/ tasks being completed		
Work placement	Not applicable		