GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Control Theory, PG_00067501		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
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 Signals and Systems -> Faculty of Electronics Telecommunications and Informatics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Piotr Kaczmarek	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	0.0	0.0	0.0	45
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	45	7.0	23.0	75

Subject objectives

The aim of the course is to develop skills in modeling, analysis, and design of control systems, which form the foundation for further applications in automation and robotics engineering. The course covers advanced methods for analyzing and designing dynamic systems in state space, as well as topics related to nonlinear systems. The lectures focus on state-space models of linear systems, controllability and observability analysis, system diagonalization, and the design of state feedback controllers and state observers. Basic issues of nonlinear systems are also discussed, including methods for studying stability using Lyapunov functions. The computational exercises will enable students to practically apply mathematical methods such as linearization, stability analysis, and determination of state trajectories.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W21] knows and understands the basic methods of decision making as well as methods and techniques of design and operation of automatic regulation and control systems, computer applications for controlling and monitoring dynamic systems.	The student can analyze control system performance based on selected criteria.	[SW1] Assessment of factual knowledge
	[K6_U03] can design, according to required specifications, and make a simple device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment	The student can design control systems based on state variable feedback.	[SU5] Assessment of ability to present the results of task
	[K6_W01] knows and understands, to an advanced extent, mathematics necessary to formulate and solve simple issues related to the field of study	"The student can use mathematical tools from mathematical analysis and linear algebra to design control systems.	[SW1] Assessment of factual knowledge
	[K6_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study and perform tasks, in an innovative way, in not entirely predictable conditions, by:n- appropriate selection of sources and information obtained from them, assessment, critical analysis and synthesis of this information,n- selection and application of appropriate methods and toolsn	The student can design control systems for both linear and nonlinear systems using modern control theory methods.	[SU2] Assessment of ability to analyse information

Subject contents

LECTURE:
- Introduction to state-space control theory
- Mathematical descriptions of dynamic systems inputoutput models vs. state-space models
- State-space concepts definitions, notation, and basic principles
- State equations of linear systems
- Solving linear systems matrix exponential and time response
- Controllability of dynamic systems
- Observability of dynamic systems
- Diagonalization of dynamic systems
- Coordinate transformations state feedback and system structure
- State-feedback controller design using pole placement
- State observer design (Luenberger observer)
- Dynamic systems with observercontroller feedback
- Modeling and analysis of nonlinear systems
- Linearization of nonlinear systems around equilibrium points
- Stability analysis of dynamic systems
- Stability of nonlinear systems Lyapunov functions
- Nonlinear control design basic approaches and limitations
- Modeling state trajectories phase-space analysis of system motion
- Applying the describing function method to determine limit cycle parameters
- Practical topics modeling technical systems (robot, motor, positioning system)
- Lecture summary knowledge integration and engineering applications

EXERCISES:
- Transformation of inputoutput models into state-space form
- Determination of the time response of linear systems
- Controllability and observability analysis of systems
- Diagonalization of the state matrix and transformation into diagonal form
- State feedback design using pole placement method
- Design of a Luenberger observer
- Integration of controller and observer combined (closed-loop) system
- Linearization of a nonlinear system around an equilibrium point
- Local and global stability analysis of a nonlinear system using Lyapunov methods
- Determination of state trajectories and phase-plane analysis of a dynamic system
- Estimation of limit cycle parameters using the describing function method

Prerequisites and co-requisites

Knowledge in the fields of: Linear Algebra, Fundamentals of Automation

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
"Theoretical exam	60.0%	50.0%
Computational exercises	60.0%	50.0%

Recommended reading	Basic literature	Katsuhiko Ogata Modern Control Engineering
	Supplementary literature	Karl Aström, Richard Murray Feedback Systems An Introduction for Scientists and Engineers
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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