GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Fundamentals of Control Engineering I, PG_00053200		
Field of study	Automation, Robotics and Control Systems		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2023/2024
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 Intelligent and Decision Support Systems -> Faculty of Electrical and Control Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Rafał Łangowski	
	Teachers	dr inż. Rafał Łangowski mgr inż. Mateusz Czyżniewski dr hab. inż. Robert Piotrowski mgr inż. Krzysztof Laddach	

Lesson types and methods of instruction	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 main module objectives are: a) to acquire knowledge needed for modelling and analysis of dynamic systems of low order, b) to design of regulatory controllers for such systems.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W07] has basic knowledge related to control and automation systems	On successful completion of this course, the student will be able to: - Explain structures and properties of P, PI and PID controllers and experimentally determine their parameters by applying Ziegler - Nichols methods to lower order processes; - Explain structures of state-feedback controllers, also in the case of unmeasured state variables to lower order processes; - Design by pole placement the basic controller systems meeting the performance specifications in time domain and state observers.	[SW1] Assessment of factual knowledge
	[K6_U07] can build and analyze models of systems and systems in the field related to control systems and automation	On successful completion of this course, the student will be able to: - Derive the first principle dynamic models of the low complexity systems such as R, L, C electrical circuits, DC electrical motors, heat transfer and fluid flow systems; - Analyse basic properties of single input - single output (SISO) linear time invariant dynamic systems based on zeros and poles nad to analytically calculate their responses to typical input signals; - Investigate stability of SISO systems based on the poles by applying the algebraic Routh-Hurwitz criterion - Investigate stability of feedback systems by applying the frequency domain based Nyquist stability criterion - Assess stability robustness of feedback systems based on the open loop system phase and gain margins.	[SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	**LECTURES:** Modelling the continuous time system dynamics for the SISO systems in time an frequency domain; linear differential equations, transfer function and frequency response function. Applications of the frequency response function to a low pass filter design. Calculating the linear system responses to the impulse, step and sinewave input signals. Calculating response of a linear system to an arbitrary input signal by applying convolution of the system impulse response and the input signal. Zeros and poles and their links with basic properties of a linear time invariant dynamic system. Algebraic Routh Hurwitz stability criterion. System structures: cascade and with feedback, Phase and gain margins. Performance measures in time domain of the control systems and their relationships with location of zeros and poles for the second order system dynamics. The P, PI and PID controllers: analysis and applicability conditions. Tuning the controller parameters by placement of poles and zeros and by Ziegler Nichols experimental rules. Structures of state-feedback controllers, also in the case of unmeasured state variables. Tuning the state observers gains by placement of poles. Illustration by applications to the R, L, C electrical circuits, simple mass-spring-damper mechanical systems, heat transfer and hydraulic systems. **TUTORIALS:** Modelling of control system elements and an overall control system, block diagram models of systems and their equivalent transformations, linearity versus nonlinearity of system dynamics, linearization of nonlinear system dynamics model, Laplace transforms in control systems, transfer function and frequency response function, Bode plots, Routh, Hurwitz and Nyquist stability criteria and application to feedback control systems, steady state errors in tracking control systems; P, PI and PID controller: structures, performance, applicability limits and parameter tuning.
Prerequisites and co-requisites	Fundamentals of electrical circuits, DC motors and physics of simple mechanical, heat transfer and hydraulic systems. Linear time invariant and scalar differential equations, Laplace transforms, complex numbers. The Pre-Requisites: Mathematics terms 1,2; Physics term 1, Elektrotechnics term 1.

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Exam	50.0%	50.0%
	Tests	50.0%	30.0%
	Midterm colloquium	50.0%	20.0%

Recommended reading	Basic literature	1. Dorf C.D., Bishop R. H.: Modern control systems. Eleventh Edition. Pearson Prentice Hall, Upper Saddle River, NI 07458, 2008. 2. Kaczorek T. Teoria układów regulacji automatycznej, Wydawnictwa Naukowo-Techniczne, Warszawa, 1974. 3. Kabziński J. Teoria sterowania Projektowanie układów regulacji, Wydawnictwo Naukowe PWN, Warszawa, 2021. 4. Ogata K.: Modern Control Engineering. Fifth Edition, Pearson Prentice Hall, Upper Saddle River, NI 07458, 2010. 5. Nise N.S. Control System Engineering. 3th edition. John Wiley & Sons, 2000. 6. Ljung L., Glad T.: Modelling of Dynamic Systems, Prentice Hall, 1994.
	Supplementary literature	1. Ogata K. Designing Linear Control Systems with MATLAB. Prentice Hall, 2002. 2. Franklin G.E., Powell J.D., Emami-Naeini E. Feedback Control of Dynamic Systems. Addison Wesley Publishing Company, 1994. 3. Dutton K., Thompson S., Barraclough B. The Art of Control Engineering. Pearson, Prentice Hall, 1997.
	eResources addresses	Adresy na platformie eNauczanie: Podstawy inżynierii sterowania I [2023/24] - Moodle ID: 30766 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30766
Example issues/ example questions/ tasks being completed	1) Linearity and nonlinearty; 2) Hurwitz, Routh and Nyquist stabiluity criteria; 3) PID controller design; 4) State-feedback gains design; 5) State observer design;	
Work placement	Not applicable	

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