GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Fundamentals of automation, PG_00055890		
Field of study	Power Engineering, Power Engineering, Power Engineering		
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	4	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Biuro Praw,Wartości Akademickich i Równego Traktowania -> HR Center		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Mohammad Ghaemi	
	Teachers	mgr inż. Jacek Frost dr inż. Joanna Grochowalska dr inż. Mohammad Ghaemi	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	15.0	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	4.0	36.0	100

Subject objectives

Gaining the knowledge about fundamental concepts of control systems and robotics including system modeling and representation, analysis and synthesis, as well as technical solutions. Ability of implementation and application of control systems in industrial and engineering processes and systems.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W03] knows the basics of automation and automatic regulation, knows the principles of the selection of electrical devices, drive systems and their control	Knows the basics of control systems and automatic regulation, including the necessary rules for the selection of related devices and components.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
[K6_W06] knows classic and developmental energy technologies, rules for the selection and operation of heat and energy devices and installations, basic principles of energy systems operation, basic issues regarding the reliability of energy devices and diagnostics, environmental effects of energy technologies used, methods of using renewable energy sources	The student knows the basic concepts and principles of analysis, synthesis, operation, and evaluation of simple technical automation systems, important for power engineering systems.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents	1. Basic concepts: modeling of dynamic systems (mechanical, electrical, thermal, hydraulic, pneumatic), equivalence of dynamic systems, understanding of feedback, classification of control systems, basic control mechanism, technical problems of designing control systems. 2. Various ways of building mathematical models, including equations of conservation of mass, momentum and energy, Lagrange's equation, Newton's second law of dynamics, Ohm's Law, etc. This includes: equations of basic linear elements, elements causing energy losses, elements storing potential energy, kinetic energy elements, introduction of equations of dynamic systems. 3. Identification and linearization. 4. Static characteristics of dynamic systems, differential equations, dimensionless differential equations. 5. Laplace transform, transfer function. 6. Block diagram and its algebra. 7. Model of the dynamic/control system in state space, equations of state and observations, transfer function matrix. 8. Transition from one form of the mathematical model to other forms. 9. Solution of differential equations, solution of state and observation equations, transfer function, time responses, step and impulse characteristics. 10. Analysis of the most important elements of automation (7 elements). 11. Frequency method for the description and analysis of control systems: spectral transmittance, A-F Nyquist characteristics, logarithmic Bode characteristics, frequency response, resonance pulsation, low- and high-band filters. 12. Regulators: types of operation of regulators, structure and design of regulators, use of feedback in shaping the characteristics of the regulator, shaping the characteristics of the regulator in a parallel system, shaping the characteristics of the regulator in a sensor or amplifier, selection of the regulator due to the condition of stability of the control system. 13. Control error: steady and unsteady error. 14. Stability of control systems: definitions and concepts, stability in the sense of Lyapunov, Hurwitz stability criterion, Nyquist stability criterion, amplitude headroom, phase headroom. 15. Control quality indicators: transient process and quality criteria, such as regulation time, rise time, overshoot, oscillation degree, logarithmic damping decrement, etc. Integral criteria, Ziegler-Nichols method for selecting controller settings.
Prerequisites and co-requisites	Preceding subjects: 1. Mathematics 2. Physics 3. Technical mechanics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
class tests	50.0%	30.0%
Lab.	50.0%	30.0%
Written colloquiums, oral egzamination	50.0%	40.0%

Recommended reading	Basic literature	1. Domachowski Z., Automatyka i robotyka podstawy, Wydawnictwo PG, Gdańsk, 2003. 2. Nise N. S., Control system engineering, John Whiley & Sons Inc., 2000. 3. Próchnicki W., Dzida M., Zbiór zadań z podstaw automatyki, skrypt dla studentów Wydziału Oceanotechniki i Okrętownictwa PG, Gdańsk, 1993.

	Supplementary literature	1. Friedland B., Control System Design, McGraw Hill Co., 1986. 2. Bubnicki Z., Teoria i algorytmy sterowania, Wydawnictwo Naukowe PWN, Warszawa, 2002. 3. Kaczorek T., Teoria sterowania i systemów, Wydawnictwo Naukowe PWN, Warszawa, 1999. 4. Ogata K., Modern Control Engineering, 4th edition, Prentice Hall, 2002. 5. Perycz S., Podstawy automatyki, skrypt dla Instytutu Okrętowego PG, Gdańsk, 1983. 6. Raven, F. H., Automatic control engineering, McGraw Hill Co., 1986.
	eResources addresses	Adresy na platformie eNauczanie: Podstawy automatyki, W/L/C, Energetyka, sem. 04, letni 23/24 (PG_00055890) - Moodle ID: 29126 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=29126

Example issues/ example questions/ tasks being completed	1.Feedback control, the role, function and elements, natural and artificial examples 2. Comparison of open and closed loop control systems, examples. 3.The aim and goal of automatic control system 4.Possibilities of control systems 5. Dynamic system, examples 6. Steady state and dynamic characteristics of control systems, general block diagram of a control system, signals. 7. elements of a control system, their roles. 8. Disturbances and their influence. 9. Definition, block diagram and examples of the following control systems: - constant value, programmed, tracking/tracking point -SISO, MIMO - linear and nonlinear, - time-variant, time-invariant - lumped, distributed - continuous, discrete - optimal - adaptive, - extreme. 10. Building mathematical models of dynamic systems 11. The types of linear mathematical models 12. Equivalency of dynamic systems 13. Relations between differential equations, transfer functions, block diagram, state space model and frequency response 14.Step and impulse responses 15. linearization 16. Transient response

17. Representation of the most important dynamic systems in the form of transfer function

18. Response trajectory

19. Solving the state and observation equations

20. Transition matrix

21. natural frequency and resonanse in control systems

22. Definition:

rise time

settling time

overshoot

oscillation degree.

23. Frequency domain characteristics

24. Relation between time and frequency domain characteristics

25. Nyquist and Bode characteristics

26. Bandwidth and filters

27. Resonance compensation

28.Damping coefficient and its influence

29. Structure of controllers, their block diagrams

30. The elements of controllers

31. General principles for selecting a controller

32. Ideal linear controllers, types, transfer functions

33.Design of structure of controllers

34. Controller characteristics and its influence of the behaviour of control system

35. Design of characteristics of controllers using parallel connection of elements

36. Hydraulic amplifier

37. Stability of control systems, definition based on Lyapunov, examples.

	38. Stability of control systems 39. How stability is affected by the conditions 40. Characteristic equation of a control system 41.Stability checking based on the roots of characteristic equation 42. The reason for which we use stability criteria 43. Routh-Hurwitz stability criterion 44. Nyquista stability criterion 45. Stability margins 46.Steady-state error, way of calculation 47. Relation between the controller parameters and steady state error 48. Optimization of control system 49. Quality of control system 50 General information about discrete control systems
Work placement	Not applicable

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