



## 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 2023	Academic year of realisation of subject			2024/2025		
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	dr inż. Mohammad Ghaemi dr inż. Joanna Grochowalska dr hab. inż. Robert Piotrowski dr inż. Rafał Łangowski					
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_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.			[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		
	[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.			[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		

Subject contents	1. Introduction and principal definitions 2. Classification of control systems 3. Modelling of dynamic systems and description of elements of control systems 4. Mathematical model presentation: differential equation, transfer function, block diagram, state and observation equations; model transformation 5. Transient function and time characteristics 6. Feedback control 7. Analysis of control systems in time and frequency domains 8. Stability 9. Controllers and principles of their selection and design 10. Quality of control systems 11. Discrete control systems			
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%	28.0%
	Lab.		50.0%	28.0%
	Written colloquiums, oral examination		56.0%	44.0%
Recommended reading	Basic literature		1. Domachowski Z., Automatyka i robotyka podstawy, Wydawnictwo PG, Gdańsk, 2003. 2. Nise N. S., Control system engineering, John Wiley & 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:	

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 resonance 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.

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

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