SYLLABUS

Name: ***Control fundamentals (MakAu>SI5CF18)***
Name in Polish:
Name in English: ***Control fundamentals***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

EGZ

Language:

English

Course homepage:

https://platforma2.polsl.pl/rau1/course/view.php?id=422

Short description:

The objective of the lectures is to give basic control knowledge in the fields of analysis and design of linear control systems, continuous and discrete-time, single and multivariable. The objective of classes and laboratory exercises is to acquire some practice in control system analysis and design using advanced CAD environment, like MATLAB-SIMULINK

Description:

ECTS: 6
Total workload: 150 hours (85 contact hours, 65 students' own work hours) Forms of contact hours:
Lecture 45h
Tutorials 30h
Other (e.g. test and reports revision and discussion) 10h
Students' own work: preparation for classes, elaboration results from classes, writing reports, preparation for partial tests, preparation for theoretical part of the exam, preparation for practical part of the exam

Lectures:
Introduction to the course. Watt centrifugal governor Feedback Control Systems-basic notions, dynamic and static elements, block diagrams. Control system classification.
Models of physical systems. Differential equations, state space models, linearization, transfer function for single – and multivariable elements. State space versus transfer function description. Frequency responses: Nyquist, Bode plots.
Basic elements and their responses. Time and frequency responses of the basic elements: first order lag, second order, ideal integrator and differentiator, system with delay.
Dynamic system properties. Fundamental matrix derivation. Canonical form. Controllability – definition, conditions. Observability – definition conditions. Stability, Hurwitz criterion.
Feedback control systems. Voltage stabilization system. Closed-loop (CL) system description. CL frequency response – Nichols chart. Feedback system properties. Control system structure. Block diagrams transformation.
Closed-Loop system stability. Characteristic equation of the CL system. Applying of Hurwitz criterion. Nyquist criterion, derivation and calculation usage. Stability analysis using Bode plots. Stability of the systems with delay.
Quality of the control. Steady-state analysis – system of type 0 and type I. Account of nonlinearities. Method based on root placement. Root locus method. Methods based on integral indices. Methods based on frequency responses.
Compensators and controllers. Lead, lag, lead-lag compensators. Recommendation for compensator choice. PID controller. Regulator implementations. Regulator parameters tuning. Ziegler-Nichols rules.
Multivariable systems. Matrix transfer function. Stability analysis. Characteristic equation using state space and transfer function models. Applying of Hurwitz criterion. Design using the method of successive closing of control loops.
Discrete-time systems. Z-transform. Sampling data system. Digital control systems. Discrete-time transfer function. Ideal sampler, zero-order hold, first order hold. CL system description. Stability analysis. Design.

Class exercises:
Dynamic systems description
Frequency responses
Hurwitz stability criterion
Nyquist stability criterion
Nyquist stability criterion - systems with time delay
Steady state analysis
Root locus method
Stability degree and resonance degree
Systems quality - frequency domain methods
Sampled data systems

Teaching methods, including distance learning:
the lecture is given in traditional way using multimedia materials;
form and criteria for semester completion, including retake tests, as well as conditions for admission to the examination:
the lecture part of the course is evaluated by four written tests;
course organisation and rules of participation in the course, with an indication whether a student‘s attendance is obligatory;

Bibliography:

Primary sources:
1. Gessing R.: Control Fundamentals, Wydawnictwo Politechniki Śl., Gliwice 2004.
2. Franklin G.F, J.D. Powell and Emani-Naeini: Feedback control of Dynamic Systems, (Third Edition) Addison-Wesley, 1994
3. de Oliveira, M. C. Fundamentals of Linear Control: A Concise Approach. Cambridge: Cambridge University Press, 2017.
Secondary sources:
1. Phillips CL., Harbor R.D.: Feedback Control Systems (Third Edition) Prentice Hall, 1996.
2. Goodwin G.C., Graebe S.F., Salgado M.E.: Control Systems Design, Prentice Hall, 2001

Learning outcomes:

The student knows how to create of mathematical models of dynamic systems and processes based on differential equations and operator calculus, together with their time, operator and frequency analysis K1A_W08

The student knows how to describe, design, and analyze simple automation, taking into account issues of stability and quality of control in regulation systems. K1A_W15

The student is able to develop a mathematical model of a simple dynamic control system, select an appropriate control structure and types of controllers, adjust their parameters, and evaluate the quality of control. K1A_U18

Assessment methods and assessment criteria:

The credit points are awarded if a student meets the credit conditions for the exercise classes and final exam.
Exercise classes
1. To get credit students write partial tests, lasting approximately 20 –30 minutes each,
2. The tests grading scale is: 0 – 5 points.
3. Results of all tests are taken into account to award the credit for the exercise classes.

The finel exam consists of two parts: theoretical (on the lecture content) and practical (excercise classes content). Theoretical part consists of four or five theoretical questions, practical part consists of four or five problems to solve. The exam is passed if the student scores at least 50% of points in both parts.

The syllabus is valid from winter semester / academic year 2025/2026 and its content is not subject to change during the semester.

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	6	2020/2021-Z	