Foundations of control engineering - course description

General information

Course name	Foundations of control engineering
Course ID	06.9-WE-ELEKTP-FounContrEng-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Electrical Engineering
Education profile	academic
Level of studies	First-cycle Erasmus programme
Beginning semester	winter term 2019/2020

Course information

Semester	3
ECTS credits to win	6
Course type	obligatory
Teaching language	english
Author of syllabus	• dr hab. inż. Andrzej Janczak, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Credit with grade
Laboratory	30	2	-	-	Credit with grade

Aim of the course

Basic knowledge of analysis and synthesis of continuous and discrete control systems in the time and frequency domains, engineering skills in designing linear control systems, choice of controller type, tuning a control loop, analysis and synthesis of nonlinear control systems.

Prerequisites

Mathematical analysis, Numerical methods, Mathematical foundations of engineering.

Scope

Introduction. Control loop basics. Open-loop control, closed-loop control, disturbance compensation. Control tasks, classification of control systems.

Linear continuous control systems. Characterization of systems dynamics in the time and frequency domains. State space representation of system dynamics. Equilibrium points, state trajectories, phase portraits. Basic dynamic elements. Interconnection of subsystems.

Analysis of linear continuous control systems. Stability of linear continuous systems. Stability definitions. Stability criteria. Control specifications. Measures of control system performance. Methods of improving system performance. PID controllers. Choice of controller type. Tuning PID control systems. Controllability and observability. State observers. State feedback control systems.

Discrete-time control systems. Computer control systems. Digital control. Signal sampling and quantization. Discrete-time models of continuous-time systems. Characterization of discrete-time systems dynamics in the time and frequency domains. State space representation of discrete-time system. Stability of discrete-time systems. Discrete PID controllers.

Nonlinear control systems. Basic nonlinear elements. Linearization. Describing function method. Phase plane method. Stability of nonlinear continuous control systems. First Lyapunov method. Second Lyapunov method. Nonlinear controllers. On-off control.

Computer-aided analysis and synthesis of control systems. Control System Toolbox. Simulink. Fuzzy Logic Toolbox.

Teaching methods

Lecture, laboratory exercises.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Knows control systems classification		• a test	• Lecture • Laboratory
Is able to design control continuous systems using PID controllers and state-space feedback controllers		• a test	• Lecture • Laboratory
Knows stability analysis methods and control performance evaluation methods		• a test	• Lecture • Laboratory

Outcome description	Outcome symbols	Methods of verification	The class form
Knows mathematical representations of nonlinear systems, and their stability analysis methods		• a test	• Lecture • Laboratory
Knows mathematical representations of discrete linear systems and their stability analysis methods		• a test	• Lecture • Laboratory
Is able to design control systems using discrete PID controllers and discrete state-space feedback controllers		• a test	• Lecture • Laboratory

Assignment conditions

Lecture – the main condition to get a pass are sufficient marks in written tests.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises

to be planned during the semester.

Calculation of the final Grade: lecture 50% + laboratory 50%

Recommended reading

1. Nise N. S., *Control Systems Engineering*, John Wiley & Sons, Holboken, 2003
2. Ogata K., *Modern Control Engineering*, Prentice Hall, Upper Saddle River, 2002.
3. Sontag E. D. *Mathematical Control Theory*, Springer, Berlin, 1998

Further reading

1. Control System Toolbox™ User's Guide, The MathWorks, Inc., 2015.
2. Simulink® User's Guide, The MathWorks, Inc., 2015.

Notes

Modified by dr hab. inż. Radosław Kłosiński, prof. UZ (last modification: 31-10-2019 23:45)