Digital control algorithms - course description

General information

Course name	Digital control algorithms
Course ID	06.2-WE-AutP-DCA-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Automatic Control and Robotics
Education profile	academic
Level of studies	First-cycle Erasmus programme
Beginning semester	winter term 2019/2020

Course information

Semester	6
ECTS credits to win	3
Course type	optional
Teaching language	english
Author of syllabus	• dr hab. inż. Wojciech Paszke, 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	15	1	-	-	Credit with grade
Laboratory	30	2	-	-	Credit with grade

Aim of the course

1. To familiarize with the basic algorithms of digital control

2. To familiarize with selected methods for designing of digital controllers

3. To understand of the impact of sampling and quantization as well as the ability to select the discretization method and sampling period

Prerequisites

Control engineering. Signals and dynamic systems.

Scope

Introduction to digital control. Digitization. Sampling results. Linear difference equations. Quantization and Quantization errors. Round off error analysis. Word-size effects. Pulse transfer function of discrete systems. Discrete models of sampled systems. The z-transform properties

Sample Rate Selection. Nyquist-Shannon sampling theorem. Time response and smoothness. Limitations on control performance In system with varying inputs or disturbances. Sensitivity to parameter value changes. Measurement noise and anti-aliasing filters.

Sampled signal systems. Sample and hold system analysis. Sampled signal spectrum. Data extrapolation. Analysis of sampled signal system.

Design of digital control systems and algorithms. Design by emulation. Direct digital design by matched pole-zero (MPZ) method. Frequency response and frequency response techniques. Design via direct method of Ragazzini. Design and practical implementation of PID controller and lead-lag compensators.

Design via state spaces. A state feedback method. Observer design. Controller design - combined state feedback control law and a state estimator. Introduction of the reference input; reference signal tracking problem. Integral feedback control and disturbance attenuation. Influence of time delay on control performance. Controllability and observerability.

Teaching methods

Lectures, laboratory exercises.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Can apply and implement selected algorithms for digital controller design		• a quiz • an ongoing monitoring during classes	• Laboratory
Understands the effects of sampling and quantization		• an evaluation test	• Lecture
Can design a digital controller by emulating or placing poles on the Z plane		• a quiz • an ongoing monitoring during classes	• Laboratory
Can choose the parameters of the digital PID controller		• a quiz • an ongoing monitoring during classes	• Laboratory

Assignment conditions

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester.

Recommended reading

1. Franklin G. F., Powell J. D., Workman M. L.: *Digital Control of Dynamic Systems* Addison Wesley;,1998.
2. Ogata K.: *Discrete-Time Control Systems*, Prentice Hall; 1994
3. Shahian B., Hassul M. :*Control System Design Using MATLAB*, Prentice Hall, New Jersey,1993.

Further reading

1. Nise N.S.: *Control Systems Engineering*, 6th Edition International Student Version, John Wiley & Sons, Inc. , 2011.
2. Franklin G.E, Powell J.D. Emami-Naeini A.: *Feedback Control of Dynamics Systems.* Addison-Wesley, Upper Saddle River, New Jersey, 2002

Notes

Modified by dr hab. inż. Wojciech Paszke, prof. UZ (last modification: 29-04-2020 08:33)