Advanced Control Engineering

Special Subjects
Elective 2 credit

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1. Course Description

Since the industrial revolution, control theory and engineering have been developed to operate mechanical, electrical, or communication systems accurately and automatically. The classical control theory, mainly for single-input single-output systems, was matured around 1960. After that, "modern control theory" using state-feedback, the main contents of the course, has been developed for large-scale and/or complicated systems.
This course consists of lectures in the classroom with exercises dealing with practical problems, and laboratory work in Computer Laboratory (CL).
In this course, students are expected to achieve the knowledge and technical methods with respect to DP1.

2. Course Objectives

The first objective is to understand PID control technology, which is the leading method in classical control, and to design and adjust PID controllers.
The second objective is to understand the concept of state-feedback control technology and to design and adjust pole-placement control and optimal control. They are the leading methods in modern control.
The third objective is to master Scilab/Scicos in the design, adjustment and simulation of control systems.

3. Grading Policy

Grading policy is based on the results of exercise answers (50%) and reports of laboratory work (50%).

4. Textbook and Reference

Textbook
Y. Hashimoto, C. Ishii, et al. (橋本 洋志, 石井 千春,他) Basics of systems control learned with Scilab (Scilabで学ぶシステム制御の基礎) Ohm publishing Co. ISBN978-4-274-20388-6（オーム社）
Y. Hashimoto, C. Ishii. (橋本 洋志, 石井 千春) Basics of simulations learned with Scilab/Scicos (Scilab/Scicosで学ぶシミュレーションの基礎) Ohm publishing Co. ISBN978-4-274-20487-6（オーム社）
Reference
H. Kimura (木村 英紀)
Principles of control engineering（制御工学の考え方） Koudansya Blue Backs, ISBN978-4062573962 (講談社ブルーバックス)
K. Sato, K. Hiramoto, K. Hirata (佐藤 和也,平元 和彦,平田 研二） Control engineering from the start (はじめての制御工学) Koudansya, ISBN978-4065137475 (講談社)

5. Requirements(Assignments)

This course is the extension of classical single-input, single-output control theory and engineering lectured in undergraduate course. Students are required to have the basic understanding on these fields.
Students are required to spend at least 30 hours for preparation study, review, and reports to assignments and to laboratory works.

6. Note

The concepts and principles of modern control theory and engineering are strongly related to systems engineering, especially to investigation or optimization of large/complicated systems.

7. Schedule

[1] Introduction to systems control: feedback control, classical and modern control
[2] Review of basic control engineering: Laplace transformation, differential equations, and transfer functions
[3] Introduction to Scilab/Scicos
[4] System responses in the time domain
[5] Stability of the system, PID control
[6] Mastering Scicos, PID control simulation
[7] Laboratory work: PID control
[8] State equation 1: state space, derivation of state equation
[9] State equation 2: characteristic equation and stability, controllability and observability
[10] Pole placement and state observer
[11] Optimal regulator (LQ optimal control), cost function, weighing matrices
[12] Optimal servo system 1: augmented system, disturbance suppression, robustness
[13] Optimal servo system 2, simulation of optimal regulator with the observer
[14] Laboratory work: Optimal servo system
[15] Review and exercises