ME-422

Multivariable control

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Cursus	Sem.	Type
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course covers methods for the analysis and control of systems with multiple inputs and outputs, which are ubiquitous in modern technology and industry. Special emphasis will be given to discrete-time systems, due to their relevance for digital and embedded control architectures.

Content

Several industries across engineering (e.g. manufacturing, energy, chemical, and transportation) rely on the simultaneous utilization of multiple sensing and actuation channels. Multivariable systems are also relevant for emerging technologies, such as the internet of things, and for fields beyond engineering, such as biology or finance. The first part of this course will provide methods for analyzing multi-input multi-output dynamical systems in the state-space form. The focus will be on linear discrete-time models which offer a reference framework for digital control architectures. To this purpose, several concept of basic system theory will be recalled and developed in detail. The second part will cover popular methods for designing multivariable controllers and illustrate their application to various classes of systems.

Structure

- Basics of discrete-time models in the state space
- Stability analysis
- Controllability and observability
- Sampled-data systems
- State-feedback control based on eigenvalue assignment
- State observers
- Optimal control: the Linear Quadratic Regulator (LQR)
- The Kalman filter
- The Linear Quadratic Gaussian (LQG) regulator

Keywords

Multivariable systems, feedback control, state-space models, optimal control, LQR, Kalman filtering, LQG

Learning Prerequisites

Required courses

Linear algebra, Control systems

Important concepts to start the course

- State-space models
- Linear systems in continuous and discrete time
- Basic concepts of stability
- Feedback control

Learning Outcomes

By the end of the course, the student must be able to:

- Construct and analyse a discrete-time model for a dynamic system, A5
- Analyze a multivariable dynamic system and design an appropriate controller for the system, A10
- Assess / Evaluate the stability, performance and robustness of a closed-loop system, A12
- Propose several control solutions, formulate the trade-offs, choose the options, A14

Transversal skills

- Use a work methodology appropriate to the task.
- Demonstrate the capacity for critical thinking

Teaching methods

Ex-cathedra, exercises

Assessment methods

Written final exam

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Bibliography

- Course slides on Moodle

Ressources en bibliothèque

- Linear optimal control systems / Kwakernaak