ME-524

Advanced control systems

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Cursus	Sem.	Type
Energy Management and Sustainability	MA2, MA4	Opt.
Energy Science and Technology	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA2, MA4	Opt.
Systems Engineering minor	E	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Project	1 weekly
Number of positions	

Summary

This course covers some theoretical and practical aspects of robust and adaptive control. This includes H-2 and H-infinity control in model-based and data-driven framework by convex optimization, direct, indirect and switching adaptive control. The methods are implemented in a hands-on lab.

Content

Stability, performance and robustness of closed-loop control systems. Robust controller design by convex optimization. Model-based H-2 and H-infinity control. Data-driven fixed structure controller design with loopshaping, H2 and H-infinity performance.
Two-degree of freedom RST digital polynomial controller. Pole placement technique. Robust pole placement with Q parameterization. Parameter adaptation algorithms. Direct and Indirect adaptive control. Switching adaptive control. Gain-scheduled controller design.

Keywords

Adaptive control, robust control, digital RST controller.

Learning Prerequisites

Required courses

Control systems + Lab
Commande numeriques des systèmes dynamiques

Recommended courses

1. System Identification
2. Multivariable systems

Important concepts to start the course

• Analyze a linear dynamical system (both time and frequency responses)
• Represent a linear system by a transfer function
• Identify a dynamic system using experimental data
• Design a PID controller
• Design a simple controller for a dynamic system

Learning Outcomes

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

- Design an advanced controller for a dynamic system, A11
- Assess / Evaluate the stability, performance and robustness of a closed-loop system, A12
- Define (specifications) the adequate control performance for dynamic systems, A13
- Propose several control solutions, formulate the trade-offs, choose the options, A14
- Justify methodological choices and validate the results with respect to the specifications, A19

Transversal skills

- Write a scientific or technical report.

Teaching methods

Ex cathedra course, integrated demos and case studies, Hands-on laboratory.

Expected student activities

Hands-on laboratory in groups of two students.

Assessment methods

Hands-on lab reports (30%) and written test (70%).

Supervision

Office hours	Yes
Assistants	Yes
Forum	No

Resources

Bibliography

1. Feedback Control Theory by Doyle, Francis and Tannenbaum; Maxwell Macmillan, 1992.
2. Adaptive Control by Landau, Lozano, M'Saad and Karimi, Springer, 2011.

Ressources en bibliothèque

- Adaptive Control / Landau
- Feedback Control Theory / Doyle

Notes/Handbook

Robust and Adaptive Control, Course-notes by Alireza Karimi

Moodle Link

- https://moodle.epfl.ch/course/view.php?id=15024