Design Methods for Control Systems

Dates and time

24-05-2027 FULL day
31-05-2027 FULL day

From 10.15 – 16.00 hrs

Course location

Cursus- en vergadercentrum Domstad, Utrecht

ECTS

3 ECTS if the homework is completed successfully.
1 ECTS for auditing the entire course

Lecturers

Prof.dr.ir. Tom Oomen, Eindhoven University of Technology
Prof.dr.ir. Jan-Willem van Wingerden, Delft University of Technology

Objective

The course covers "classical," "modern" and "postmodern" notions about linear control system design. First the basic principles, potentials, advantages, pitfalls and limitations of feedback control are presented. An effort is made to explain the fundamental design aspects of stability, performance and robustness. Next, various well-known classical single-loop control system design methods are reviewed and their strengths and weaknesses are analyzed. The course includes a survey of design aspects that are characteristic for multivariable systems, such as interaction, decoupling and input-output pairing. Further LQ, LQG and some of their extensions are reviewed. After a presentation of uncertainty, model design methods based on H-infinity-optimization and mu-synthesis are presented.

Contents

1. INTRODUCTION TO FEEDBACK THEORY.
-Basic feedback theory, closed-loop stability,
-Stability robustness, loop shaping, limits of performance.

2. CLASSICAL CONTROL SYSTEM DESIGN.
-Design goals and classical performance criteria, integral control,
-Frequency response analysis, compensator design, classical methods for compensator design.

3. MULTIVARIABLE CONTROL.
-Multivariable poles and zeros, interaction, interaction measures,
-Decoupling, input-output pairing.

4. LQ, LQG AND CONTROL SYSTEM DESIGN.
-LQ basic theory, LQG basic theory.

5. UNCERTAINTY MODELS AND ROBUSTNESS.
Parametric robustness analysis, the small-gain theorem, stability robustness of feedback systems, numerator-denominator, structured singular value robustness analysis, combined performance and stability robustness.

6. H-INFINITY OPTIMIZATION AND MU-SYNTHESIS.
-The mixed sensitivity problem, loop shaping, the standard H-infinity
- Control problem, state space solution, optimal and suboptimal solutions,
-Integral control and HF roll-off, mu-synthesis, application.
A. Appendix on Matrices
B. Appendix on norms of signals and systems.

Course materials
A full set of lecture notes will be made available on the DISC course platform.

Prerequisites
Basic undergraduate courses in systems and control. Some familiarity with MATLAB is helpful for doing the homework exercises.

Homework assignments
Homework sets will be distributed via the course website. Homework is graded on a scale from 1 to 10. Missing sets receive the grade 1. The final grade for the course is a weighted average of the grades for the homework sets.