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# Automatic control A

## Finalità

The course teaches some elementary aspects of control theory. Focusing on continuous-time linear time-invariant systems some techniques on the analysis and synthesis of scalar feedback control systems will be presented.

## Programma

1) Fundamental concepts: systems and mathematical models. Block diagrams. Feedforward and feedback. Robustness of feedback with respect to feedforward. Mathematical modelling of physical systems: examples from electric networks, mechanical systems, and thermal systems.

2) Analysis methods of LTI (linear time-invariant) systems. Ordinary differential equations and Laplace transform. Inverse Laplace transform of rational functions. Generalized derivatives and elements of impulse function theory. Relations between the initial conditions of a differential equation. First and second order linear systems. The concept of dominant poles.

3) Frequency-domain analysis: the frequency response function. Relation between the impulse response and the frequency response. Bode's diagrams. Nyquist's or polar diagrams. Asymptote of the polar diagrams. Bode's formula and minimum-phase systems.

4) Stability to perturbations and BIBO (bounded-input bounded-output) stability of LTI systems: definitions and theorems. The Routh criterion. Properties of feedback systems. The Nyquist criterion. Phase and magnitude margins: traditional definitions and their extensions. The Padé approximants of the time delay.

5) The root locus of a feedback systems: properties for the plotting. Generalization of the root locus: the "root contour". Examples. Stability degree on the complex plane of a stable systems.

6) Control system design: the approach with fixed-structure controllers. Specification requirements and their compatibility. Phase-lead and phase-lag compensation. Pole-zero cancellations and the internal stability of a feedback connection. The PID regulator. The inversion formulae for the synthesis of lead and lag compensators. Synthesis with Diophantine equations.

## Attività d'esercitazione

Exercises and design projects on feedback control systems.

## Modalità d'esame

Written tests and exercises in the middle of the course lessons. Final written examinations at the end of the course. Optional complementary oral exam.

## Propedeuticità

Analisi Matematica AB, Geometria A, Analisi Matematica C, Fisica Generale AB, Elettrotecnica A, Teoria dei Segnali B.

## Testi consigliati

A. Piazzi, "Controlli Automatici A: lucidi delle lezioni", UniNova, Parma, 200