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 Diofantine 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