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# Digital Control Systems

## Finalità

The course is designed to give the fundamentals of control theory based on digital systems with sampled data. Discrete systems are analysed and the main digital feedback-based control techniques are studied. The theoretical program is completed by laboratory lectures.

## Programma

**Control devices**: sensors, actuators.

**Preliminary mathematical notions**: linear difference equations, z-transform and its properties.

**Sampled-data systems**: data sampling, choice of sampling rate, hold devices, discrete-time transfer functions, poles and zeroes for discrete-time transfer functions, relationship between s and z planes, constant damping-ratio and constant natural frequency loci, block diagrams and their composition.

**Problems of discrete regulators**: discretization, quantization, aliasing.

**Discrete systems stability**: External stability (BIBO), bilinear transformation and Routh-Hurwitz criterion, Jury criterion, Nyquist criterion, root locus.

**Design specifications**: steady state errors for standard input signals, time-domain specifications, rise time, settling time, maximum overshoot, frequency-domain specifications, gain and phase margins.

**Design of discrete regulators**:

a) Discretization-based design: backward transform, forward transform, bilinear transform, matched pole-zero method, impulse response invariance and step response invariance methods.

b) Analytical design: Diophantine equation, unitary feedback controller through the Diophantine equation, deadbeat and modified deadbeat methods.

c) Standard discrete regulators: PID-controllers and their tuning, effects of signal saturation, forward compensation.

## Attività d'esercitazione

The course includes some laboratory lectures in which the discrete systems analysis techniques are applied and some of the regulators proposed in the theoretical lectures are simulated. The programs used are Matlab and Simulink.

## Modalità d'esame

The exam is written and is divided into two parts, the first part includes some exercises, the second some theoretical questions. A couple of mid-term tests are scheduled during the class period.

## Propedeuticità

Controlli Automatici

## Testi consigliati

G. F. Franklin, J. D. Powell, M. L. Workman, "Digital Control of Dynamic Systems", Addison Wesley

C. Bonivento, C. Melchiorri, R. Zanasi, "Sistemi di Controllo Digitale", Progetto Leonardo, Bologna