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Politecnico di Torino

Academic Year 2010/11 (first time established in A.Y.2007/08)

02MBOJA

System and control theory

1st degree and Bachelor-level of the Bologna process in Electronic And Computer Engineering - Vercelli (III FACOLTA' DI INGEGNERIA)

Teacher	Status	SSD	Les	Ex	Lab	Years Stability
Carlucci Donato	AC	ING-INF/04	5	2	1	1

SSD	CFU	Activities	Area context
ING-INF/04	8	B - Caratterizzanti	Ingegneria informatica

Objectives of the course

The first part of this course provides the students with the basic notions of dynamical systems theory, both linear and nonlinear, using state variables techniques. Topics range from physical modelling to numerical simulation, analysis of stability, reachability and observability, and design of state observers and feedback regulators. A second part of the course focuses on the frequency-domain representation of linear time invariant systems, and provides the student with the ability of analyzing classical specifications for automatic control systems (such as Bode plots, Nyquist stability criterion, time domain characteristics, reference following, disturbance rejection, robustness, etc.) and the skills for designing simple feedback controllers.

Expected skills

The student will acquire abilities to model simple dynamical systems (of different natures, such as mechanical, electrical, electro-mechanical, thermal, hydraulic, etc.) into state-space or frequency-domain form, and understand the qualitative and quantitative behaviour of such systems. The student will acquire the basic techniques to control the behaviour of dynamical systems by designing appropriate 'automatic control laws,' that is rules for automatically tuning the manipulable input signals of the system from output measurements, with the objective of obtaining desirable behaviour in terms of reference following, disturbance rejections, bandwidth, etc.

Prerequisites

Calculus, Linear Algebra, Signals and transforms, basic notions of physics and electrical circuits.

Syllabus

Dynamical systems models:
examples of mechanical structures, electrical networks, electro-mechanical systems, thermal exchange, etc.
Continuos and discrete time signals and their transforms
State variable representation and system classification
Numerical simulations for nonlinear systems
Linearization of state equations
Lyapunov stability theory
Linear systems
Reachabiliy and observability of linear systems
Design of state-feedback regulators
Design of state observers
Regulation via dynamic output feedback
Analysis of LTI systems in the complex domain.
Transfer functions and frequency response
Bode diagrams, Polar plots and Nyquist diagrams
Stability analysis for feedback systems, the Nyquist criterion
Robustness margins
The classical control loop
Reference signals, outputs, disturbances, measurement noise, tracking errors and the relative closed loop transfer functions
Sensitivity S, complementary sensitivity T and control effort CS
Stationary and low frequency de sign specifications
Frequency-domain specifications on S, T and CS
Time-domain specifications on transient response
Structural limits of control architectures
Synthesis of lead, lag and lead-lag compensators
Synthesis of notch filters
Standard PID regulators
Examples and case studies of complete control designs.

Laboratories and/or exercises

The course includes practise sessions and lab activity for numerical simulations and computer aided design using Matlab and Simulink.

Bibliography

Textbooks
Franklin, Powell, Emami-Naeini, Feedback Control of Dynamic Systems, Prentice-Hall.
G. Calafiore, Elementi di Automatica, Seconda edizione; CLUT, Torino, 2007.
G. Calafiore, Appunti di Controlli Automatici; CLUT, Torino, 2005.

Revisions / Exam

Written examination. Students may consult the textbooks and personal notes, and may use a scientific calculator. An oral examination may follow the written one, upon instructor's request.

Programma definitivo per l'A.A.2010/11

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