COURSE DETAILS

"CONTROLLI AUTOMATICI"

SSD ING-INF/04

DEGREE PROGRAMME: BACHELOR DEGREE IN COMPUTER ENGINEERING

ACADEMIC YEAR: 2023-2024

GENERAL INFORMATION – TEACHER REFERENCES

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE (IF APPLICABLE): N.A.

MODULE (IF APPLICABLE): N.A.

CHANNEL (IF APPLICABLE): N.A.

YEAR OF THE DEGREE PROGRAMME (I, II, III): III

SEMESTER (I, II): II

CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Teoria dei sistemi, Metodi matematici per l'ingegneria.

PREREQUISITES (IF APPLICABLE)

Basic knowledge of analysis of linear dynamical systems with continuous time and discrete time. Use of Laplace, Zeta and Fourier transforms and software tools for the analysis and simulation of dynamical systems.

LEARNING GOALS

The course aims to introduce students to the design of feedback control laws for dynamical systems and illustrate their possible applications. In particular, the main methodologies for the synthesis of linear control systems, both analog and digital, are deepened. At the end of the course the student will be able to design linear controllers, also with the help of software tools for the analysis, design and simulation of control systems.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Il percorso formativo intende fornire gli strumenti metodologici per comprendere i principi fondamentali del controllo automatico e gli effetti della retroazione sulle caratteristiche dinamiche dei sistemi lineari o resi tali dopo linearizzazione. Verranno introdotte le principali metodologie di progettazione di controllo in retroazione, sia analogico che digitale, nel dominio del tempo e nei domini trasformati. Tali conoscenze consentiranno agli studenti di comprendere le principali problematiche connesse all'utilizzo dei diversi metodi di sintesi, in dipendenza dei requisiti richiesti e delle caratteristiche dei processi da controllare.

Applying knowledge and understanding

The acquired knowledge will allow students to formalize the specific requirements of a control system in the time domain and in the transformed domains. On the basis of these specifications and the characteristics of the process to be controlled, students will be able to make design choices, i.e. to design the control law using different synthesis methods. Matlab/Simulink software will be used to support controller synthesis and performance verification.

COURSE CONTENT/SYLLABUS

- Fundamental properties of feedback control systems: specific to a time-domain control system .
- Reachability and controllability in continuous time and discrete time. Checking to a state of balance with state feedback . Output adjustment with assignment of eigenvalues and profit.
- Notes on the analog realization and on the digital realization of a control system. Sampled data system. Output regulator with integral action and status feedback in continuous time and discrete time.
- Observability in continuous time and discrete time. State observer . Eigenvalue separation and output feedback control .
- Analysis of systems with output feedback: accuracy at steady state and type of a system, response in transitory.
- Analysis of the closed loop by the method of the place of the roots. Design of control systems with place of roots in continuous time and discrete time. Typical regulator structures. Control of unstable processes.
- Frequency-domain analysis of continuous-time systems : stability and robustness with the Nyquist criterion. Margins of stability.
- Sensitivity functions. Links between the time-domain response, the open-loop harmonic response function, and sensitivity functions.
- Design of frequency domain control systems with the ring function method. Correcting networks.
- Design of digital controllers for discretization and directly in the discrete-time domain with the The method of assigning the model.
- Problems of realization of the digital control: structuring of the control algorithm, anti-aliasing filtering, considerations on the choice of the sampling period.

- PID controllers: performance analysis in the frequency domain and notes on experimental calibration methods.
- Advanced control systems: Smith predictor, cascade control, mixed control schemes with feedback and feedforward.

READINGS/BIBLIOGRAPHY

- G. Celentano, L. Celentano, "*Elementi di Controlli Automatici vol. III*", Edises, 2015
- P. Bolzern, R. Scattolini, N. Schiavoni, "*Fondamenti di Controlli Automatici*", McGraw-Hill, 4/ed, 2015

Notes and video recordings of the lessons

TEACHING METHODS

a) Lectures for 70% of the total hours, b) Classroom exercises , also through the use of software MATLAB/SIMULINK (https:www.mathworks.com/) for approximately 30% of total hours .

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to:	**Multiple choice answers**	
	Open answers	
	Numerical exercises	X

b) Evaluation pattern: