COURSE DETAILS

"TEORIA DEI SISTEMI"

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): II

SEMESTER (I, II): II

CFU: 9

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

Fisica Generale II.

PREREQUISITES (IF APPLICABLE)

Basic knowledge of Laplace, Zeta and Fourier transforms.

LEARNING GOALS

Provide the student: the basics of mathematical modeling of natural and / or artificial systems in continuous and discrete time, the techniques of analysis of systems described by mathematical models input-state-output and input-output, with particular reference to linear and stationary systems, the main techniques of analysis of feedback systems. Introduce the student to the use of the main software for the analysis and simulation of systems.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The training course aims to provide students with the methodological tools to describe simple engineering systems using an adequate mathematical model, derive models for small signals of nonlinear systems, and characterize the response over time and the main structural properties of linear systems. To this end, the student will be introduced to the main techniques of analysis of dynamical systems, both in the time domain and in the complex domain. In addition, the analysis of systems in the frequency domain will be treated by presenting the main parameters that, in this context, characterize linear systems.

Applying knowledge and understanding

At the end of the course, students will be able to analyze block patterns, obtaining an overall model, and to evaluate the response of this model to assigned signals. In addition, the student will be able to analyze the structural properties of this model with particular reference to stability. You will also be able to use Matlab/Simulink software for system analysis and simulation.

COURSE CONTENT/SYLLABUS

- References to matrix algebra: elementary operations on matrices and vectors. Eigenvalues and eigenvectors of a matrix. Vector spaces. Banach spaces and Hilbert spaces. P norms of matrices and vectors.
- Dynamical systems: input, state and output variables, state and input-output representations, classification of dynamical systems.
- Elements of modeling, examples of mathematical models.
- Nonlinear systems: equilibrium points of a nonlinear system, linearization around a trajectory and an equilibrium point.
- Analysis of linear and stationary systems in continuous and discrete time: the principle of superposition of effects, free-evolving response and forced response. Calculation of the transition matrix through diagonalization. The natural ways.
- Analysis of linear and stationary systems in continuous time with the aid of the Laplace transform: transfer function, impulsive response and step response, characteristic parameters of step response, response to polynomial and sinusoidal signals, regime and transient response.
- Analysis of linear and stationary discrete-time systems with the help of the Zeta transform: transfer function, pulse response and step response, regime and transient response.
- Stability of equilibrium points: simple and asymptotic stability, instability. Examples of analysis of the stability of equilibrium points of nonlinear systems (pendulum, etc.). Notes on Lyapunov's Theory. Stability of linear systems, Routh criterion, application of Routh's criterion to discrete time systems. Input-output stability of linear systems.

- Interconnected systems and block diagrams: series, parallel and feedback systems. Representation of interconnected systems i. Notes on the stability of interconnected systems.
- Theory of realization for monovariable systems, canonical form of observability and canonical form of reachability.
- Techniques for digitizing a continuous-time system. Sampled data systems: ZOH sampler and filter. Sampled data representation of a finite-dimensional linear system.
- Series and Fourier transform. Frequency response of a linear and stationary system.
- Plotting Bode diagrams.
- Filtering action of dynamic systems: low-pass, high-pass, band-pass, needle filters.
- Analysis of the stability of closed-loop systems: plotting Nyquist diagrams, the Nyquist criterion. Margins of stability.
- Structural properties: reachability, controllability and observability, canonical Kalman forms.

- Matlab and Simulink for simulation and analysis of dynamical systems.

READINGS/BIBLIOGRAPHY

G. Celentano, L. Celentano – *"Modellistica, Simulazione, Analisi, Controllo e Tecnologie dei Sistemi Dinamici - Fondamenti di Dinamica dei Sistemi*", Vol. II, EdiSES, 2010.
Other texts and/or notes suggested by the teacher.

TEACHING METHODS

The teacher will use: a) lectures for 80% of the total hours, b) classroom exercises through the use of the MATLAB/SIMULINK tool (https://www.mathworks.com/) for about 20% of the total hours.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

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

The written test is aimed at verifying thestudent's ability to calculate the response of a linear signal system to draw Bode diagrams, and to analyze the stability properties of interconnected systems.
The oral interview, which follows the written test, consists of a discussion on the theoretical topics covered in the course and on simple papers in Matlab / Simulink, in order to ascertain the acquisition of the concepts and contents covered during the lessons.

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

	Numerical exercises	X

b) Evaluation pattern:

The outcome of the written test is binding for access to the oral test. Overcoming the written test is not sufficient to pass the exam.