Fundamentals of Automation
6 Credits
Lecturer: Prof. Antonio Bicchi

Course description

The student will acquire the basic notions and means for analyzing dynamic mechanical systems and for the design of devices which can be utilized to control such dynamics so as to fulfill given requirements.
Particular attention will be paid to the applications where the control of mechanical systems by means of electronic and/or digital devices is a fundamental aspect, such as industrial automation, robotics, smart components for vehicles and machines in general.

Course Objectives

By the end of the course, students should be able to:
- define and analyze simple mathematical models of dynamic mechanical systems;
- determine the fundamental characteristics of such models (stability, controllability, observability, output to typical inputs)
- understand and express the functional specifications of a dynamical system in its different forms
- know the techniques to analyze linear systems in the field of frequency (transfer functions, Bode and Nyquist diagrams, root locus)
- elaborate a simulation algorithm for dynamic systems by means of explicit or graphic programming, using SW commercial instruments
- project a stable, precise and ready regulator for a given system
- realize a digital implementation for a continuous-time control system

Lessons

During the lessons schematic notes will be projected and made available to the students online. Exercitations will be carried on by means of various informatics instruments (analysis and simulation software – MATLAB), available in faculty structures and of a telelab with real experiments available online without hour limitations

Prerequisites

Mathematics: differential equations, matrix algebra, basic geometry;
Phisics: mechanics and electromagnetism

Course Contents

1.Introduction
Course presentation. Dynamic Mechanical systems, regulation and control systems in industrial automation and in modern machines.
2. Definition and basic notions.
Discrete and continuous dynamical systems, physical interpretation of input, output, states, block systems, system properties: linearity, stationarity, physical realizability
3. Linear systems.
Representations of Linear Systems (ordinary equations, state form, transformed and transfer functions). Solutions of Linear Systems: free, forced, temporary and permanent output. Harmonic output of Linear Systems. Diagrams of harmonic output (Bode, Nyquist)
4. Functional specifications of regulated systems.
Concept and definitions of stability. Motivations for feedback: disturbance rejection, insensitivity to modeling errors, modifications in dynamic behavior. Stability specifications. Verification of the specifications of an open-loop system.

5. State and output feedback.
Feedback effects on the fundamental properties. State and output feedback. Corrective actions and networks. Root locus
6. Sampled data systems.
Sampled signals and discretization of continuous dynamical systems: applications to simulation and digital realization of regulators.
7. Computer-assisted data analysis.
Computer assisted analysis and synthesis. Use of SW commercial packets for analysis and simulation of dinamical systems (Matlab, Simulink)

Hours of explanation of new topics: 34
Hours of laboratory exercitations and examples: 21
Total: 55

Required reading

- P. Bolzern, R. Scattolini, N. Schiavoni: “Fondamenti di Controlli Automatici”, McGraw Hill
- G. Marro, “Controlli Automatici”,Zanichelli
- notes of the lecturer