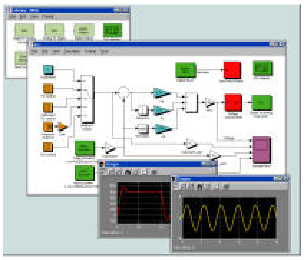

Control Laboratory

a.a. 2016-2017

Laurea Magistrale in Ingegneria dell'Automazione

Instructor and collaborators

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Description

Objective of the course:
The goal of this course is to present to students all possible issues related to modeling and desing of advanced control systems via the implementation in a control laboratory of traditional control systems for industrial automation.
Synopsys:
Modeling of control systems: DC motor, DC motor with flexible joint, segway. Representation of dynamical systems: state space, transfer fucntion, ODEs, impulse response. PID design in frequency domain. Anti-windup. Overview of state-space control design: state feedback, observers, separation principle, regulator design. Feedforward and Integral control. Internal model principle for periodic signal tracking. Discrete time dynamical systems: representation. Digital control and limits: quantization, samplying period, etc. Control design by emulation and by exact discretization. LQ control: formulation, theory and main results. Root locus of LQ control for SISO systems. Design of LQ weights. Extension of LQ control to frequency shaping. The tools presented in the lectures are asked to be implemented into a real CD motor provided with a flexible joint.

Lectures

Each lecture is provided with a link to textbook pages or PDF files.

WEEK	MONDAY (10:30-12:15 room Ee)	WEDNESDAY (10:30-12:15 room Le)	THURSDAY (12:30-14:15 room Le)	FRIDAY (12:30-16:15 Control Lab)
1 (30/02-2/03)	**NO LECTURE**	**NO LECTURE**	Introduction to the course: benefit of control, control design procedure (Lecture 1)	
2 (6-9/03)	Representation of dynamical systems (Lecture 2). Sensor and actuator modeling (Lecture 3)	Dominant pole approximation. Dynamic model reduction (Lecture 4)	Bode and Nyquist plot. Time domain vs frequency domain performance specifications (Lecture 5)	
3 (13-16/03)	**MATLAB(laboratorio): Part I Dominant Pole Approximation (Eng. Riccardo Antonello)**	Frequency domain design and PID controllers (Lecture 6,Lecture 7)	Modeling of DC motor with friction (Lecture 8, Lecture 9, Lecture 10)	

4 (20-23/03)	**SIMULINK (laboratorio): Part II DC Motor (Eng. Riccardo Antonello)**	Estimation of Friction Parameters of DC motor	**LAB 0: HW & SW Apparatus 12:30-14:15**	**LAB 0: HW & SW Apparatus 14:30-16:15**
5 (27-30/03)	**NO LECTURE**	**NO LECTURE**	**NO LECTURE**	
6 (2-6/04)	Antiwindup (Lecture 10), Feedforward Control (Riccardo Antonello)	Fundamentals of Modern Control Theory: reachability and controllability(Lecture 11, Lecture 12) State feedback control desing: nominal tracking and robust tracking (Lecture 13)	Internal model principle (Lecture 14,Lecture 15)	**LAB 1: PID & State-space control design**
7 (10-13/04)	Observer design and reduced order observer (Lecture 16)	**LAB 1: PID & State-space control design**	Discrete time systems: representations and design via emulation Exact discretization and control design Practical consideration of digital control (Lecture 17, Lecture 18, Lecture 19)	
8 (17-20/04)	**NO LECTURE**	**LAB 2: digital control**	Modeling of flexible joint (Ing. Antonello)	**LAB 2: digital control**
9 (24-27/04)	**NO LECTURE**	**[nbsp]**LQ Control: problem formulation and example (Lecture 20, Lecture 21)	LQ control: Hamiltonian and properties (Lecture 22, Lecture 23)	
10 (1-4/05)	**NO LECTURE**	**LAB 3: LQ control of flexible joint**	LQ control: Root Locus (Lecture 24, Lecture 25)	**LAB 3: LQ control of flexible joint**
11 (8-11/05)	LQ control: Weight design (Lecture 26, Lecture 27, Lecture 28)	LQG control: Kalman Filter + LQ control (Extra lecture Notes: Part 1, Part 2, Part 3)	Segway modeling: mechanical dynamics	
12 (15-18/05)	Segway modeling: electric dynamics and sensors	**MATLAB/SIMULINK** lab: Part IV Segway (Eng. Riccardo Antonello). Wednesday Shift 8:30-10:15, Friday Shift 10:30-12:15		
13 (22-25/05)		**LAB 4: LQ control of a Segway**	Industrial guest lecture: SALVAGNINI	**LAB 4: LQ control of a Segway** **LAB 5: extra lab (9/06 and 10/06)**

Material

1. Blackboard lectures
2. PID design in frequency domain [notes in PDF**]**
3. LQ control and Frequency Shaping [notes in PDF]
4. Guide for the laboratory software (MATLAB's Realtimeworshop toolbox) and hardware **[PDF]**
5. Notes on DC motor modeling, flexible joint modeling, segway modeling **[PDF]**
6. Notes on how to write a good technical report [PDF]

Laboratory experiments

1. Parameter identification and PID design for a DC electric motor
2. State-space control desing for a DC electric motor
3. Digital control desing for a DC electric motor
4. LQ control design for a DC electric motor with a flexible joint

Latex templates

1. Templates for Lecture notes
2. Templates for final Techicical report