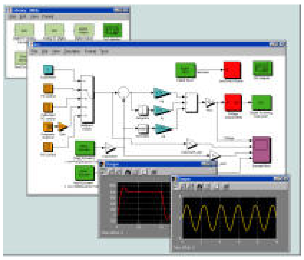

Control Laboratory

a.a. 2017-2018

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, sampling 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) Labs (10:30-14:30)**	**TUESDAY (Labs 8:30-12:30)**	**WEDNESDAY (12:30-14:15 room De)**	**THURSDAY (12:30-14:15 room Ce)**
1 (26/02-1/03)	Introduction to the course (Lecture 1)		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)
2 (5-8/03)	**NO LECTURE**		Frequency domain design and PID controllers (Lecture 6,Lecture 7)	**MATLAB(laboratorio): Part I Control Toolbox (Eng. Riccardo Antonello) Room Ue**
3 (12-15/03)	Modeling of DC motor with friction, (Lecture 8, Lecture 9, Lecture 10)		Estimation of Friction Parameters of DC motor	**SIMULINK (laboratorio): DC motor + friction/inertia estimatio (Eng. Riccardo Antonello) Room Ue**
4 (19-22/03)	**LAB 0: HW & SW Apparatus 10:30-14:15 (shift 1)**	**LAB 0: HW & SW Apparatus 8:30-12:15 (shift 2)**	**NO LECTURE**	**NO LECTURE**
5 (26-	Antiwindup		Fundamentals of Modern Control Theory:	**NO LECTURE**

29/03)	(Lecture 10), Feedforward Control		reachability and controllability(Lecture 11, Lecture 12) State feedback control desing: nominal tracking and robust tracking (Lecture 13)	
6 (2-5/04)	**NO LECTURE**		Internal model principle (Lecture 14,Lecture 15)	Observer design (Lecture 16)
7 (9-12/04)	**LAB 1: PID & State-space control design (shift 1)**	**LAB 1: PID & State-space control design(shift 2)**	Reduced order observer and pole placement considerations (see Lecture 13 and 16)	Discrete time systems: representations and design via emulation (Lecture 17, Lecture 18 (corrected)) Exact discretization and control design Practical consideration of digital control (Lecture 19) Modeling of flexible joint
8 (16-19/04)	LQ Control: problem formulation and example (Lecture 20, Lecture 21)		LQ control: Hamiltonian and properties (Lecture 22, Lecture 23)	
9 (23-26/04)	**LAB 2: digital control (shift 1)**	**LAB 2: digital control (shift 2)**	**NO LECTURE**	LQ control:derivation of Root Locus (Lecture 24)
10 (30/04-3/05)	**NO LECTURE**		LQ control: Root Locus examples (Lecture 25)	LQ control: Weight design (Lecture 26, Lecture 27, Lecture 28)
11 (7-10/05)	**LAB 3: LQ control of flexible joint**	**LAB 3: LQ control of flexible joint**	Segway modeling: mechanical dynamics	Segway modeling: electric dynamics and sensors
12 (14-17/05)	**Intro to Segway apparatus**: 10:30-12:30	**Intro to Segway apparatus**: 10:30-12:30	**[nbsp]**Industrial guest lecture: SALVAGNINI	**Industrial guest lecture: Maschio-Gaspardo**
13 (21-24/05)	**LAB 4: LQ control of a Segway**	**LAB 4: LQ control of a Segway**		
14 (28-29/05)	**Make-up LAB**	**Make-up LAB**		

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. Guide to Segway
7. 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