Uppsala University
Department of Information Technology
Systems and Control
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September, 2011
www.it.uu.se/research/syscon

Introduction to computer control systems

(1RT485, 5 hp, period 2, 2011)

1.1 About the course

The aim of the course is to introduce you to the analysis, design and implementation of control systems. The course covers the following topics: system model representation in continuous and discrete-time, analysis of system properties in time and frequency domain, as well as the design and implementation of simple controllers.

1.1.1 Structure

The schedule includes lectures, problem solving sessions, computer laboratories, process laboratories and homework assignments.

1.1.2 Teachers

Name	Office	Tel	Course part
Darine Zambrano (darine.zambrano@it.uu.se)	2341	471 2984	Lectures, course responsibility
Margarida Martins da Silva (margarida.silva@it.uu.se)	2303	471 2849	Problem solving sessions
Egi Hidayat (egi.hidayat@it.uu.se)	2339	471 3395	Lab sessions

The Division of Systems and Control is located at Polacksbacken, house 2.

1.1.3 Course homepage

http://www.it.uu.se/edu/course/homepage/regsysintro/ht11

1.2 Course material

1.2.1 Textbook

T. Glad and L.Ljung "Control theory: Multivariable and Nonlinear Methods", Taylor & Francis, London and New York, 2000.

Regarding the textbook

The textbook covers the material for two courses in control engineering, namely the present one and a continuation course Automatic Control II.

You can buy your copy of the textbook (499 SEK) at "Studentbokhandeln" or "Akademibokhandeln (LundeQ)" who have it in stock. Otherwise the textbook can be ordered on-line from, for instance, Bokus with delivery in 5 to 8 workdays.

1.2.2 Course material

Manuals for computer and process labs are available in electronic form on the homepage of the course. List of exercises for each problem solving session are also available on the homepage of the course. Also, additional material will be posted on the homepage of the course.

1.3 Laboratories

1.3.1 Laboratory assignments

There are two types of lab exercises in this course: simulation assignments and process assignments. All of them are mandatory.

Process assignments, (3×4 hours, in 2 groups), are to be carried out at P4404, house 4, Polacksbacken.

The process assignments are based on large chunks of the course material and make use of LEGO NXT. It is important to prepare for the process assignments by reading correspondent chapters of the course book, lecture notes and lab manuals.

Simulation assignments will help you to check your theoretical knowledge before you apply it to LEGO robots in practice. Laboratory reports are written during the lab hours and have to be checked by the lab instructors by the end of the day.

Lab. number	Topic
1	Actuate, measure and close the loop
2	Modeling, analysis and PID-control
3	Model-based control design

Sign-up lists for process labs will be placed on the door of P4404 the week before the first laboratory.

1.3.2 Access rules for computer and process labs

An UpUnet-S account is needed to get access to the lab computers, see the following link for more information: www.student.uu.se/upunets/

The computer labs keep open doors at day time (7:00-17:00) and a valid access card is needed otherwise. It is strictly forbidden to install own software as well as keep all kinds of offensive material (text, images or any other) on the university computers.

1.3.3 Lab rooms

Do be done. A valid access card is needed to enter lab rooms after office hours. Access cards are issued and administered by Janitor Office (by Siegbahnsalen in Ångström).

1.4 Examination

The following is required to pass the course:

1. All the lab assignments have to be performed and the lab reports be approved by the lab instructors
2. A satisfactory grade obtained at the written exam.

For the written exam you are allowed to have with you: a copy of the textbook, copies of the lecture notes and slides from the course, you own hand-written notes made during the lectures and problem solving sessions, a mathematical handbook, a calculator.

1.5 Contents

A formal description of the contents of the course is available in 'Contents' on the homepage of the course. The following list links to the contents of the course with the sections of the textbook.

1. Chap. 1
   (a) 1.3 Discrete and continuous time models and controllers
   (b) 1.4 Some basic concepts in control
   (c) 1.6 Stability of solutions
2. Chap. 2
   (a) 2.1 Impulse response
   (b) 2.2 Transfer function matrices
   (c) 2.3 Transfer operator
   (d) 2.4 Input-output equations
   (e) 2.5 State-space form
   (f) 2.6 Discrete time systems
3. Chap. 3
   (a) 3.1 Solving the system equations
   (b) 3.2 Controllability and observability (not PBH Test)
   (c) 3.3 Poles and zeros (only SISO case)
   (d) 3.4 Stability
   (e) 3.5 Frequency response (only SISO case)

(f) 3.7 Discrete time systems

4. Chap. 4

   (a) 4.1 Approximating continuous time systems
   (b) 4.2 System sampling
   (c) 4.3 Poles and zeros
   (d) 4.4 Controllability and observability
   (e) 4.5 Frequency functions

5. Chap. 5

   (a) 5.1 Disturbances
   (b) 5.7 Observers and Kalman filters (only observers)
   (c) 5.8 Discrete time systems (only observers)
   (d) 5.9 Practical aspects of signal sampling

6. Chap. 6

   (a) 6.1 The transfer functions of the closed loop system (only SISO)
   (b) 6.2 Stability of the closed system
   (c) 6.3 Sensitivity and robustness
   (d) 6.5 Specifications in time domain
   (e) 6.7 Sampled data controllers

7. Chap. 8.

   (a) 8.1 Main ideas
   (b) 8.4 Feedback from reconstructed states

8. Chap. 11

   (a) 11.4 Equilibria and linearization

9. Chap. 15

   (a) 15.2 Nonlinear internal model control (integrator windup)

1.6 Preliminary course plan

The course includes 10 lectures (L), 10 problem solving sessions (Ex), two simulation assignments (CL) and three process assignments (PL).

Week	Event	Contents
43	L1	Introduction and basic notions.
	L2	Representation of linear systems in continuos and discrete-time.
44	L3	Model transformations.
	Ex1	Problems solving for L1 and L2
	L4	PID design
45	PL1	Process assignment 1.
	L5	Frequency domain properties.
	Ex2	Problems solving to L1 and L2
	L6	Time domain properties.
	Ex3	Problem solving for L3 and L4
46	CL1	Simulation assignment 1
	L7	Pole placement and observers.
	Ex4	Problem solving for L3 and L4
	Ex5	Problem solving for L5 and L6
	PL2	Process assignment 2.
47	L8	Closed-loop system. Stability. Specifications in time domain.
	Ex6	Problem solving for L5 and L6
	Ex7	Problem solving for L7 and L8
48	CL2	Simulation assignment 2
	L9	Closed-loop system. Sensitivity and robustness.
	Ex8	Problem solving for L7 and L8
	Ex9	Reserve/repetition
49	PL3	Process assignment 3.
	L10	Practical aspects, implementation.
	Ex10	Typical exam problems
50	Written exam	Wednesday 14/12/2011