

# Multivariable Control, FRTN10, autumn 2014

## Administration

Responsible for the course is professor Anders Rantzer (046-222 87 78). Course administrator is Mika Nishimura (046-222 87 85). Their offices are on the 5th floor of the Mechanical Engineering building, respectively.

## Prerequisites

Recommended courses are Mathematics, Basic Course (FMA012), Complex and Linear Analysis (FMA030 or FMA035), Automatic Control, Basic Course (FRT010).

## Course material

All course material is available in English. Most lectures are covered by the following book sold by KFS AB:

Torkel Glad and Lennart Ljung (2003), *Reglerteori — Flervariabla och olinjära metoder* (2nd ed.), Studentlitteratur, ISBN 9789144030036.

English edition: Torkel Glad and Lennart Ljung (2000), *Control Theory — Multivariable and Nonlinear Methods*, Taylor and Frances, ISBN 0748408789 (paperback)

Notes for the remaining lectures as well as exercises and laboratory assignments are provided on the course home page

<http://www.control.lth.se/Education/EngineeringProgram/FRTN10.html>

## Lectures

The lectures (30 hours) are given in M:B by Anders Rantzer as follows:

Mondays	8.15–10.00
Wednesdays until Oct 8	8.15–10.00
Thursdays Sep 4 and Sep 11	8.15–10.00

## Exercise sessions

There are two exercise sessions each week, each with two alternative time slots:

First session	Monday 13–15	Monday 15–17	lab A and B
Second session	Thursday 13–15	Friday 13–15	lab A and B

The teaching assistants are Josefin Berner, Anders Mannesson and Olof Sörnmo. All sessions are held in labs of Automatic Control LTH, located on the ground floor in the south-west part of the Mechanical Engineering building.

## Laboratory experiments

The three laboratory experiments are mandatory and are given in connection to the different parts of the course. Booking lists where you need to sign up are posted on the course home page. Before the lab sessions some home assignments have to be completed. No reports are required after the labs.

Lab	Week	Booking	Room	Responsible	Phone	Content
1	38-39	Sept 8	Lab C	Josefin Berner	222 9745	Flex-servo
2	40	Sept 22	Lab B	Anders Mannesson	222 8796	Quad-tank
3	42	Oct 6	Lab B	Jonas Dürango	222 8760	Crane

## Exam

The exam is given on Thursday Oct 30. A second occasion is on January 9, 2015. Lecture slides and the text book are allowed on the exam, but no exercise materials or extra hand-written notes.

## Weekly plan, autumn 2014

<i>Week</i>	<i>Date</i>	<i>Content</i>	<i>Relevant book sections</i>
36	Sep 1	<b>L1: Introduction</b> E1: Control in Matlab	sections 1.1-1.5
	Sep 3	<b>L2: Stability and robustness</b>	sections 1.6, 2.1-2.5, 3.1, 3.4, 3.5
	Sep 4	<b>L3: Disturbance models</b>	sections 5.1-5.6, 6.1-6.3
	Sep 4-5	E2: System representations and stability	
37	Sep 8	<b>L4: Control synthesis in frequency domain</b> E3: Disturbance models and robustness	sections 6.4-6.6 8.1-8.2
	Sep 10	<b>L5: Case study</b>	
	Sep 11	<b>L6: Multivariable zeros, singular values,</b>	
	Sep 11-12	E4: Loop shaping. Prepare lab. 1	
38	Sep 15	<b>L7: Fundamental limitations</b> <b>controllability/observability</b> E5: Controllability/observability, multivariable zeros	sections 7.2-7.9 sections 3.2-3.3, 3.5-3.6
	Sep 17	<b>L8: Decentralized control</b>	sections 8.3, 8.5
	Sep 18-19	E6: Fundamental limitations	
38-39	<i>LAB SESSION 1: Loop shaping for resonant system</i>		
39	Sep 22	<b>L9: Linear quadratic optimal control</b> E7: Controller structures, Prepare lab. 2	sections 5.7 and 9.1-9.4
	Sep 24	<b>L10: Optimal observer based feedback</b>	same as L9
	Sep 25-26	E8: Linear quadratic optimal control	
40	<i>LAB SESSION 2: Multivariable tank process</i>		
40	Sep 29	<b>L11: More on LQG</b> E9: Optimal Kalman filtering	section 10.2
	Oct 1	<b>L12: Youla parametrization, dead-time compensation</b>	section 8.4
	Oct 2-3	E10: LQG control. Prepare lab. 3	
41	Oct 6	<b>L13: Synthesis by convex optimization</b> E11: Youla parametrization, dead-time compensation	handout
	Oct 8	<b>L14: Controller simplification</b>	section 3.6
	Oct 9-10	E12: Synthesis by convex optimization.	
42	<i>LAB SESSION 3: Crane with rotating load</i>		
42	Oct 13	<b>L15: Overview of the course</b> E13: Controller simplification	
	Oct 16-17	E14: Old exam	
43	Oct 30	EXAMINATION	