Multivariable Control, FRTN10, autumn 2013

Administration

Responsible for the course is professor Anders Rantzer (046-222 87 78). Course administrator is Lizette Borgeram (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 excercises 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 by Anders Rantzer and Per Hagander as follows:

Mondays Sep 2, 9, 16, 23 and Oct 14	8.15–10.00 in MH:A except 2/9 in M:B
Wednesdays Sep 4, 11, 18 and Oct 2, 9, 16	8.15–10.00 in M:B
Thursdays Sep 5, 19, 26 and Oct 3	15.15–17.00 in M:B

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, Ola Johnsson, Fredrik Magnusson och Jerker Nordh. 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 11	Lab C	Josefin Berner	222 9745	Flex-servo
2	40	Sept 23	Lab C	Josefin Berner	222 9745	Quad-tank
3	42	Oct 7	Lab B	Fredrik Magnusson	222 1570	Crane

Exam

The exam is given on Wednesday Oct 23. A second occasion is on January 8, 2014. Lecture slides and the text book are allowed on the exam, but no exercise materials or extra hand-written notes.

Weekly plan, autumn 2013

Week	*Date*		*Content*	*Relevant book sections*
36	Sep 2	**L1:**	**Introduction**	sections 1.1-1.5
		E1:	Control in Matlab	
	Sep 4	**L2:**	**Stability and robustness**	sections 1.6, 2.1-2.5, 3.1, 3.4, 3.5
	Sep 5	**L3:**	**Disturbance models**	sections 5.1-5.6, 6.1-6.3
	Sep 5-6	E2:	System representations and stability	
37	Sep 9	**L4:**	**Control synthesis in frequency domain**	sections 6.4-6.6 8.1-8.2
		E3:	Disturbance models and robustness	
	Sep 11	**L5:**	**Case study**	
	Sep 12-13	E4:	Loop shaping. Prepare lab. 1	
38	Sep 16	**L6:**	**Multivariable zeros, singular values, controllability/observability**	sections 3.2-3.3, 3.5-3.6
		E5:	Controllability/observability, multivariable zeros	
	Sep 18	**L7:**	**Fundamental limitations**	sections 7.2-7.9
	Sep 19	**L8:**	**Decentralized control**	sections 8.3, 8.5
	Sep 19-20	E6:	Fundamental limitations	
38-39	*LAB SESSION 1: Loop shaping for resonant system*			
39	Sep 23	**L9:**	**Linear quadratic optimal control**	sections 5.7 and 9.1-9.4
		E7:	Controller structures, Prepare lab. 2	
	Sep 26	**L10:**	**Optimal observer based feedback**	same as L9
	Sep 26-27	E8:	Linear quadratic optimal control	
40	*LAB SESSION 2: Multivariable tank process*			
40	Sep 30	E9:	Optimal Kalman filtering	
	Oct 2	**L11:**	**More on LQG**	section 10.2
	Oct 3	**L12:**	**Youla parametrization, dead-time compensation**	section 8.4
	Oct 3-4	E10:	LQG control. Prepare lab. 3	
41	Oct 7	E11:	Youla parametrization, dead-time compensation	
	Oct 9	**L13:**	**Synthesis by convex optimization**	handout
	Oct 10-11	E12:	Synthesis by convex optimization.	
42	*LAB SESSION 3: Crane with rotating load*			
42	Oct 14	**L14:**	**Controller simplification**	section 3.6
		E13:	Controller simplification	
	Oct 16	**L15:**	**Overview of the course**	
	Oct 17-18	E14:	Old exam	
43	Oct 23		EXAMINATION	