FRTN10 Multivariable Control, fall 2015

Administration

Responsible for the course are Anton Cervin (anton@control.lth.se, 046-222 44 75, M:5145) and Anders Robertsson (andersro@control.lth.se, 046-222 87 90, M:2426). Course administrator is Mika Nishimura (mika@control.lth.se, 046-222 87 85, M:5141). Their offices are on the 5th (AC and MN) and 2nd (ARo) floor of the Mechanical Engineering building.

Prerequisites

FRT010 Automatic Control, Basic Course or FRTN25 Automatic Process Control is required prior knowledge. It is assumed that you have taken the compulsory courses in mathematics, including linear algebra, calculus in several variables, and systems & transforms or linear systems.

Course material

All course material is available in English. Most lectures are covered by the following textbook 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)

Lecture notes, lecture slides, excercise problems, and laboratory assignments are provided on the **course homepage**: `http://www.control.lth.se/course/FRTN10`

Lectures

The lectures (30 hours) are given by AC and ARo as follows:

Mondays		M:B	8.15–10.00
Wednesdays	until Oct 7	MA:2	8.15–10.00
Thursdays	Sep 3 and Sep 10	M:B	8.15–10.00

Exercise sessions

The exercise sessions (28 hours) are arranged in three groups:

Group	*Times*	*Room*	*Teaching assistant*
1	Mon 13–15, Thu 13–15	Lab A	Mattias Fält (mattiasf@control.lth.se)
2	Mon 13–15, Thu 13–15	Lab B	Gabriel Ingesson (gabriel@control.lth.se)
3	Mon 15–17, Fri 13–15	Lab A	Jonas Dürango (jonas@control.lth.se)

Booking lists for the exercise groups are available on the homepage. All sessions are held in the course lab of Automatic Control LTH, located on the ground floor in the south-west part of the Mechanical Engineering building.

Laboratory experiments

The laboratory experiments (12 hours) are mandatory. Booking lists are posted on the course homepage. Before each lab session some home assignments have to be completed. No reports are required after the labs.

Lab	*Weeks*	*Booking opens*	*Room*	*Responsible*	*Process*
1	38–39	Aug 31	Lab C	Jonas Dürango	Flexible servo
2	40–41	Sep 14	Lab B	Gabriel Ingesson	Quadruple tank
3	42–43	Sep 28	Lab B	Mattias Fält	Crane

Exam

The exam is given on Thursday Oct 29 at 14.00–19.00. A second occasion is on January 8, 2016. Lecture notes, lecture slides, and the textbook are allowed on the exam, but no exercise materials or hand-written notes.

Weekly plan, fall 2015

Week	*Date*		*Content*	*Relevant book sections*
36	Aug 31	**L1:**	**Introduction**	secs 1.1-1.5
		E1:	Control in Matlab	
	Sep 2	**L2:**	**Stability and robustness**	secs 1.6, 2.1-2.5, 3.1, 3.4, 3.5
	Sep 3	**L3:**	**Disturbance models**	secs 5.1-5.6, 6.1-6.3
	Sep 3-4	E2:	System representations and stability	
37	Sep 7	**L4:**	**Control synthesis in frequency domain**	secs 6.4-6.6 8.1-8.2
		E3:	Disturbance models and robustness	
	Sep 9	**L5:**	**Case study**	
	Sep 10	**L6:**	**Multivariable zeros, singular values,**	
	Sep 10-11	E4:	Loop shaping. Prepare lab. 1	
38	Sep 14	**L7:**	**Fundamental limitations**	secs 7.2-7.9
			controllability/observability	secs 3.2-3.3, 3.5-3.6
		E5:	Controllability/observability, multivariable zeros	
	Sep 16	**L8:**	**Decentralized control**	secs 8.3, 8.5
	Sep 17-18	E6:	Fundamental limitations	
38-39	*LAB SESSION 1: Loop shaping for resonant system*			
39	Sep 21	**L9:**	**Linear quadratic optimal control**	secs 5.7 and 9.1-9.4
		E7:	Controller structures, Prepare lab. 2	
	Sep 23	**L10:**	**Optimal observer based feedback**	same as L9
	Sep 24-25	E8:	Linear quadratic optimal control	
40	*LAB SESSION 2: Multivariable tank process*			
40	Sep 28	**L11:**	**More on LQG**	sec 10.2
		E9:	Optimal Kalman filtering	
	Sept 30	**L12:**	**Youla parametrization, dead-time compensation**	sec 8.4
	Oct 1-2	E10:	LQG control. Prepare lab. 3	
41	Oct 5	**L13:**	**Synthesis by convex optimization**	handout
		E11:	Youla parametrization, dead-time compensation	
	Oct 7	**L14:**	**Controller simplification**	sec 3.6
	Oct 8-9	E12:	Synthesis by convex optimization.	
42	*LAB SESSION 3: Crane with rotating load*			
42	Oct 12	**L15:**	**Overview of the course**	
		E13:	Controller simplification	
	Oct 15-16	E14:	Old exam	
43	Oct 29		EXAM	