FRTN10 Multivariable Control, fall 2017

Administration

Course responsible is Anton Cervin (anton@control.lth.se, 046-222 44 75, M:5145). Course administrator is Mika Nishimura (mika@control.lth.se, 046-222 87 85, M:5141). Their offices are on the 5th floor of the M building.

Prerequisites

FRT010 Automatic Control, Basic Course or FRTN25 Automatic Process Control is required prior knowledge. It is assumed that you have taken the basic courses in mathematics, including linear algebra and calculus in several variables, and preferably also 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* (2 uppl.), Studentlitteratur, ISBN 9789144030036.
English edition: Torkel Glad and Lennart Ljung (2000), *Control Theory — Multivariable and Nonlinear Methods*, CRC Press/Taylor & Francis, ISBN 9780748408788.

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

Lectures

The lectures (30 hours in total) are given by Anton Cervin on Mondays (w. 35–39, 41), Tuesdays (w. 35–36), and Thursdays (w. 35–41). See the LTH schedule generator for details.

Exercise sessions

The exercise sessions (28 hours in total) are arranged in two groups (free choice). See the LTH schedule generator for details.

Group	*Times*	*Room*
1	Wednesdays 10–12, Fridays 10–12	Lab A
2	Wednesdays 13–15, Fridays 13–15	Lab A

The 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 three laboratory sessions (12 hours in total) are mandatory. Booking lists are posted on the course homepage. You must sign up before the first session starts. Before each session there are pre-lab assignments that must be completed. No reports are required afterwards.

Lab	*Weeks*	*Booking opens*	*Room*	*Responsible*	*Process*
1	37–38	Aug 30	Lab C	Hamed Sedaghi	Flexible linear servo
2	39–40	Sep 13	Lab C	Olof Troeng	Quadruple tank
3	41–42	Sep 27	Lab B	Mattias Fält	Rotating crane

Exam

The exam is given on October 27 at 14:00–19:00. Retake exams are offered in April and August, 2018. The textbook, lecture notes, and lecture slides (with markings/notes) are allowed on the exam. You may also bring an *Automatic Control—Collection of Formulae*, standard mathematical tables (TEFYMA), and a pocket calculator.

Weekly plan, fall 2017

Week	*Date*		*Content*	*Relevant book sections*
35	Aug 28	**L1:**	**Introduction, systems and signals**	secs 1.1-1.5
	Aug 29	**L2:**	**Stability and robustness**	secs 1.6, 2.1–2.5, 3.1, 3.4, 3.5
	Aug 30	E1:	Control in Matlab	
	Aug 31	**L3:**	**Specifications and disturbance models**	secs 5.1–5.6, 6.1–6.3
	Sep 1	E2:	System representations and stability	
36	Sep 4	**L4:**	**Control synthesis in frequency domain**	secs 6.4–6.6 8.1–8.2
	Sep 5	**L5:**	**Case study: DVD player**	
	Sep 6	E3:	Disturbance models and robustness	
	Sep 7	**L6:**	**Controllability/observability, multivariable poles/zeros, realizations**	secs 3.2–3.3, 3.5–3.6
	Sep 8	E4:	Loop shaping, preparations for Lab 1	
37	Sep 11	**L7:**	**Fundamental limitations**	secs 7.2–7.9
	Sep 13	E5:	Multivariable zeros, singular values and controllability/observability	
	Sep 14	**L8:**	**Multivariable and decentralized control**	secs 8.3, 8.5
	Sep 14,15	E6:	Fundamental limitations	
37–38	*LAB SESSION 1: Loop shaping for a flexible linear servo*			
38	Sep 18	**L9:**	**Linear-quadratic control**	secs 5.7 and 9.1–9.4
	Sep 20	E7:	Controller structures, preparations for Lab 2	
	Sep 21	**L10:**	**Kalman filtering, LQG**	same as L9
	Sep 22	E8:	Linear-quadratic optimal control	
39	Sep 25	**L11:**	**More on LQG**	sec 10.2
	Sep 27	E9:	Kalman filtering, LQG	
	Sep 28	**L12:**	**Youla parametrization, internal model control**	sec 8.4
	Sep 29	E10:	LQG, preparations for Lab 3	
39–40	*LAB SESSION 2: Decentralized control of quadruple tank*			
40	Oct 4	E11:	Youla parametrization, internal model control	
	Oct 5	**L13:**	**Synthesis by convex optimization**	handout
	Oct 6	E12:	Synthesis by convex optimization.	
41	Oct 9	**L14:**	**Controller simplification, course review**	sec 3.6
	Oct 11	E13:	Controller simplification	
	Oct 12	**L15:**	**Course review**	
	Oct 13	E14:	Old exam	
41–42	*LAB SESSION 3: LQG control of rotating crane*			
43	Oct 27		EXAM	