FRTF05 Automatic Control Basic Course for F, I, Pi + TFRG95

Course Program Spring 2023
Updated Jan 11, 2023

1 Lectures

The course consists of 15 lectures (30 hours). All lectures are held in *Karhusets hörsal*, John Ericssons väg 3.

Lectures are held in Swedish. We will mainly use the whiteboard, but any additional materials such as exercises will be made available on Canvas.

Schedule: See the weekly program further down. Please refer to TimeEdit for the official schedule.

Course resposible: Emma Tegling is lecturer and course responsible.
E-mail: emma.tegling@control.lth.se

Online lectures: Lecture videos from a previous course round with Tore Hägglund are available on Canvas. While these lecture videos cover the entire course just like the in-person lectures, they should be considered a complementary course material.

2 Exercises

We hold 15 exercises (30 hours) in four groups. You can choose group freely, but avoid overcrowding! Times and places are given below. A detailed program for the exercises is given on the last page.

Exercise 7 is a computer exercise which is held at lab facilities at the department. See Section 3 for sign-up information.

Group	Time 1	Room	Time 2	Room	Teacher
Johanna	Tue 15–17	KC:M Q	Wed 15 –17	KC:M Q	Johanna Gustafson
Johan	Tue 13–15	KC:M Q,	Thu 8–10	KC:M Q	Johan Lindberg
Fredrik	Tue 10–12	KC:M Q	Thu 15–17	KC:M Q	Fredrik Horn
Martin	Wed 10–12	KC:M Q,	Fri 8–10	KC:M Q	Martin Gemborn Nilsson

3 Labs

There are three mandatory lab exercises in the course.

Preparing for the labs. The course labs are rather extensive and preparation is needed. For Lab 2 and Lab 3 there are mandatory homework problems, which you must be able to present at the beginning of the lab exercise.

No laboratory reports need to be written. However, you need to write down your results in the manual during the lab and present orally.

Labs are performed in pairs. Groups of three or more are not allowed. You sign up individually and form pairs at the beginning of the lab.

Lab manuals. Lab manuals are sold at KF-Sigma. They can also be printed from the course homepage.

A printed lab manual is required at the lab to enable examination, but a pre-used manual can (for obvious reasons!) not be used.

Location. The labs are performed in Lab C, in the north-east wing of the KC4 building on the floor -1. Enter through entrance D at the north side of the building, from the parking between KC and Lophtet, and you will find the lab corridor immediately to the left.

Schedule and sign-up. The labs are performed during the hours 8.15–12.00, 13.15–17.00 most days during the lab weeks. Note that lab sessions are *not* included in the TimeEdit schedule from the LTH schedule generator.

You need to sign up (on time!) to do the labs. Sign-up lists will be available through a link on Canvas. The sign-up lists for each of the three labs open during the week preceding the first lab exercise. Note that you must sign up during this week! Choose time carefully – once you have signed up you cannot change times.

Lab	Held	Sign-up opens and closes	Responsible for sign-up
1	Course weeks 2–3	Course week 1, Jan 16 - Jan 20	Johan Lindberg
2	Course weeks 4–5	Course week 3, Jan 30 - Feb 3	Martin Gemborn Nilsson
3	Course weeks 6–7	Course week 5, Feb 13 - Feb 17	Harry Pigot

If you are unable to attend the lab you should report this to the administrators or lab responsible. There is one backup session for each lab. Persons who fail to show up to the lab without a valid reason, forget to sign up for the lab, or fail to submit preparatory exercises, will have to do the lab the next time the course is given. Fortunately, this is usually in the next study period.

Computer exercise. Exercise 7 is a computer exercise held in course week 3 and booked in the same way as the labs. This exercise is not mandatory, though highly recommended.

	Held	Sign-up opens and closes	Responsible for sign-up
Exercise 7	Course week 3	Course week 2, Jan 23 - Jan 30	Martin Gemborn Nilsson

4 Literature and course materials

Course compendia. The course is covered by four compendia:

Reglerteknik AK – Föreläsningar (Lectures), 2021 version
Reglerteknik AK – Exempelsamling (Exercises and solutions), 2022 version
Reglerteknik AK – Laborationer (Lab manual)
Reglerteknik – Formelsamling (Collection of formulae), 2021 version

The Swedish versions are sold by KF. The compendia are also available for free download in both Swedish and English from Canvas.

You are allowed to use the 'Formelsamling' on the exam.

Textbooks. For those interested in more reading we recommend Glad & Ljung: *Reglerteknik — Grundläggande teori* (Studentlitteratur 2006) or Lennartson: *Reglerteknikens grunder* (Studentlitteratur 2002). In English, we recommend Åström & Murray: *Feedback Systems: An Introduction for Scientists and Engineers* (Princeton 2008), available for free at `www.cds.caltech.edu/~murray/amwiki!`.

Additional materials. On the Canvas page, you can find many additional resources. For example, lecture videos, seminar recordings, special topics, and useful links.

5 Interactive Computer Tools

In order to facilitate the learning and understanding of some of the concepts used in the course, there are interactive computer tools available (free!) for download from

`https://arm.ual.es/ilm/`

The module *'Modelling'* is suitable for studying model descriptions. At Exercise 7 you have the opportunity for supervised use of this module in our lab facilities.

6 Exam

The written exam is 5 hours long.

You may use the following aids:

1. Reglerteknik – Formelsamling (Collection of formulae)
2. Standard tables (TEFYMA)
3. Calculator (not pre-programmed with Bode diagrams or similar)

No textbooks, notes, or electronic aids are allowed. If in doubt regarding the above, ask the course responsible during a lecture.

The grades are: Fail, 3, 4 or 5.

The exam is on Thursday March 16, 14:00–19:00 at MA:9 A–E .

7 Department Offices

The Department offices are located in the M-building, temporarily located in KC4 (Kemicentrum), third floor. `http://www.control.lth.se`

Contact information

Mika Nishimura (Ladok etc)	046-222 87 85	mika.nishimura@control.lth.se
Emma Tegling (Course responsible)	046-222 97 43	emma.tegling@control.lth.se
Johan Lindberg		johan.lindberg@control.lth.se
Martin Gemborn Nilsson		martin.gemborn_nilsson@control.lth.se
Harry Pigot		harry.pigot@control.lth.se
Johanna Gustafson		johanna@integer.se
Fredrik Horn		fredrikh981@gmail.com

Weekly Program

Below is a weekly program with lectures (seminars!)=föreläsningar (F), exercises=Övningar (E), and labs.

Week	Date	Activity	
1	16 Jan	F1:	Course overview and introduction to control. PID control.
	17 Jan	F2:	Process models. Linearization. Block diagrams.
	18 Jan	F3:	Impulse and step response analysis
	*	E1:	Process models. Linearization.
	*	E2:	System representations. Block diagrams.
2	23 Jan	F4:	Frequency analysis. Connections between model descriptions.
	24 Jan	F5:	Feedback. Stability.
	25 Jan	F6:	Nyquist criterion. Stability margins.
	*	E3:	Poles, zero, step and impulse responses.
	*	E4:	Frequency analysis. Bode- and Nyquist diagrams.
	LAB 1: Empirical investigation of two simple control problems.		
3	31 Jan	F7:	Sensitivity. Stationary errors. Lab 2.
	1 Feb	F8:	State feedback control.
	*	E5:	PID-control. Lab 2.
	*	E6:	Nyquist criterion. Stability margins.
	*	E7:	Computer exercise.
4	7 Feb	F9:	Kalman filtering.
	8 Feb	F10:	Output Feedback Control. PolE/zero-cancellation. Lab 3.
	*	E8:	Stationary error. Sensitivity.
	*	E9:	State feedback control. Controllability.
	LAB 2: Modeling and calculation of PID-controller parameters.		
5	14 Feb	F11:	Compensation in the frequency domain.
	15 Feb	F12:	PID-control.
	*	E10:	Kalman filtering. Observability. Lab 3.
	*	E11:	Compensation in the frequency domain.
6	21 Feb	F13:	Controller architectures. Implementation.
	22 Feb	F14:	Synthesis example.
	*	E12:	PID-control.
	*	E13:	Controller architectures.
	LAB 3: Control of flexible servo.		
7	1 mar	F15:	Repetition.
	*	E14:	Synthesis.
	*	E15:	Repetition.
8	16 Mar	EXAM	

Exercises

E= Done during exercise. H = Suggested home exercises/repetition for exam

E1 Process models. Linearization.
E: 1.1, 1.2, 1.7
H: 1.5a-c, 1.6, 1.9

E2 System representations. Block diagrams.
E: 2.1, 2.14ab, 2.15
H: 2.2ab, 2.16ab

E3 Poles, zeros, step- and impulse response.
E: 2.5, 2.9, 2.11, 2.13
H: 2.6

E4 Frequency analysis. Bode- and Nyquist diagrams.
E: 3.1, 3.2, 3.4bd, 3.5b, 3.7
H: 3.4ac, 3.5a, 3.6

E5 PID-control. Lab 2.
E: 4.1, **Preparation for lab 2, tasks 3.1 and 3.6 for Lab 2**, 4.9
H: 6.3, 6.4

E6 Nyquist criterion. Stability margins
E: 4.13, 4.15, 4.17, 4.18
H: 4.12, 4.14, 4.19

E7 Computer exercise.
E: 9.1, 9.2, 9.3

E8 Stationary error. Sensitivity.
E: 4.11, 4.2, 4.6, 4.7, 4.4
H: 4.3, 4.5

E9 State feedback. Controllability.
E: 5.5, 5.8, 5.10, 5.11
H: 5.2, 5.6

E10 Kalman filtering. Observability. Lab3.
E: 5.3, 5.12, 5.9
H: 5.13

E11 Compensation in frequency domain.
E: 6.11, 6.12, 6.13, 6.14
H: 6.15

E12 PID-control.
E: 6.5, 6.2, 6.7, 6.8
H: 6.6, 6.9

E13 Controller architectures.
E: 7.1, 7.6, 7.8, 7.9
H: 7.2, 7.5

E14 Synthesis example.
E: 8.1
H: 8.2

E15 Repetition.