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

Course Program Spring 2024
Updated Jan 9, 2024

1 Lectures

The course consists of 15 lectures (30 hours). All lectures are held in M:A (Ole Römers väg 1).

Lectures are held in Swedish. We will mainly use the whiteboard, but any additional materials such as compendia, exercises and lab manuals are available on Canvas.

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

Course responsible: Bo Bernhardsson is lecturer and course responsible.
E-mail: bo.bernhardsson@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 try to avoid overcrowding. Times and places are given below. A detailed program for what is planned for each exercise is given on the last page.

Exercise 7 is a computer exercise which is held at lab facilities at the department.

Group	**Time 1**	**Room**	**Time 2**	**Room**
Alba	Tue 10–12	MH:229	Tue 13 –15	MH:362A
Rasmus	Tue 15–17	MH:362A	Wed 10–12	MH:362A
Toni	Wed 15–17	MH:362A	Thu 15–17	MH:362A
Max	Thu 8–10	MH:362A	Fri 8–10	MH:331

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 (and an already used manual can, for obvious reasons, not be used).

Location. The labs are performed in Lab C, 2nd floor in the M-building, above the eastwards entrance.

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. You can still do the exam if you miss or fail a lab. If you miss a lab you can redo lab1 and lab2 in any study period, and lab3 in any study period except lp4.

Lab	Held	Sign-up opens and closes	Responsible for sign-up
1	Course weeks 2–3	Course week 1, Jan 15 - Jan 19	Alba Gurbegui
2	Course weeks 4–5	Course week 3, Jan 29 - Feb 2	Anton Åkerman
3	Course weeks 6–7	Course week 5, Feb 12 - Feb 16	Sebastiano Fregnan

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, or 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	Max 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. The grades are: Fail, 3, 4 or 5. 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 exam is on Thursday March 14, 08:00–13:00 at Victoriahallen. Please be there in good time.

7 Department Offices

The Department offices are located in the M-building, 2nd and 3rd floor. `http://www.control.lth.se`

Contact information

Mika Nishimura	Ladok etc	mika.nishimura@control.lth.se
Bo Bernhardsson	Course responsible	bo.bernhardsson@control.lth.se
Alba Gurbegui	Lab 1+Exercises	alba.gurpegui_ramon@control.lth.se
Anton Åkerman	Lab 2	anton.akerman@control.lth.se
Sebasiano Fregnan	Lab 3	sebastiano.fregnan@control.lth.se
Max Nilsson	Exercises	max.nilsson@control.lth.se
Toni Carrillo	Exercises	carrillotoni@gmail.com
Rasmus Kovacs	Exercises	rasmus.kovacs@gmail.com

Interested in more control theory ?

We offer the 3 ECTS credit course "FRTF15 Control Theory" in parallel to this course. It starts on Wed January 17 at 10.15 in M:M. It is given by Richard Pates.

Weekly Program

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

Week	Date	Activity	
1	15 Jan	F1:	Course overview and introduction to control. PID control.
	16 Jan	F2:	Process models. Linearization. Block diagrams.
	17 Jan	F3:	Impulse and step response analysis
	*	E1:	Process models. Linearization.
	*	E2:	System representations. Block diagrams.
2	22 Jan	F4:	Frequency analysis. Connections between model descriptions.
	23 Jan	F5:	Feedback. Stability.
	24 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	30 Jan	F7:	Sensitivity. Stationary errors. Lab 2.
	31 Jan	F8:	State feedback control.
	*	E5:	PID-control. Lab 2.
	*	E6:	Nyquist criterion. Stability margins.
	*	E7:	Computer exercise (not in TimeEdit, check Canvas)
4	5 Feb	F9:	Kalman filtering.
	7 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	13 Feb	F11:	Compensation in the frequency domain.
	14 Feb	F12:	PID-control.
	*	E10:	Kalman filtering. Observability. Lab 3.
	*	E11:	Compensation in the frequency domain.
6	20 Feb	F13:	Controller architectures. Implementation.
	21 Feb	F14:	Synthesis example.
	*	E12:	PID-control.
	*	E13:	Controller architectures.
	LAB 3: Control of flexible servo.		
7	27 Feb	Extra	Probably not used spare time, check Canvas
	28 Feb	F15:	Repetition.
	*	E14:	Synthesis.
	*	E15:	Repetition.
8	*	Extra	Exercise if requested, check Canvas
9	14 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.