FRTF05 Automatic Control Basic Course (I, Pi)

Course Program Spring 2022
Updated Jan 11, 2022

1 Lectures and lecture seminars

The course consists of 15 lectures (30 hours). The full lectures are pre-recorded and will be available online on the course Canvas page.

Seminars complementing the lectures will be held at the scheduled lecture times on Mondays, Tuesdays and Wednesdays. These will be 45 minutes long and held in two groups[1]:

Group I I (Industriell ekonomi)

Group Pi+ Pi (Teknisk matematik) + students from all other programs.

Prior to the seminar, you are expected to have watched the lecture video, or have read the corresponding chapter in the lecture notes.

The lecture seminars will not cover all course contents. They will, however, highlight important theory, solve example exercises on the board and leave room for discussions. You are strongly encouraged to attend, as this will be a complementary learning opportunity and your best chance to interact with the course responsible.

Schedule: see the weekly program further down, and refer to TimeEdit for the exact schedule.

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

The course format may change subject to COVID restrictions. Any changes will be announced on Canvas.

2 Exercises

We hold 15 exercises (30 hours) in three 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 13–15	KC:M Q	Thu 13–15	KC:M Q	Johanna Gustafson
Teodor	Tue 13–15*	KC:M R	Thu 13–15	KC:M R	Teodor Westholm
Matilda	Tue 15–17	KC:M Q,	Thu 8–10	KC:M Q	Matilda Froste
Johan	Wed 10–12	KC:M Q,	Thu 15–17	KC:M Q	Johan Lindberg

*On Jan 18, this exercise takes place at 10–12 in KC: M R

[1] You are allowed to change groups if you find a peer in the other group to switch places with.

3 Labs

There are three mandatory lab exercises in the course.

Preparing for the labs. The course labs are rather extensive and for them to be meaningful you need to prepare. 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. The second lab exercise also begins with a short test, and you must answer the questions correctly to be allowed to participate in the lab. No laboratory reports need to be written.

Lab manuals. Lab manuals are sold at KF-Sigma. Note that you cannot bring a pre-used lab manual to the lab.

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. There are 6 sessions + 1 backup for each lab. 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!

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.

Lab	Held	Sign-up opens and closes	Responsible for sign-up
1	Course weeks 2–3	Course week 1, Jan 17 - Jan 21	Johan Lindberg
2	Course weeks 4–5	Course week 3, Jan 31 - Feb 4	Fethi Bencherki
3	Course weeks 6–7	Course week 5, Feb 14 - Feb 18	Fethi Bencherki

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 24 - Jan 31	Fethi Bencherki

4 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.

5 Literature and course materials

Course compendia. The course is covered by four compendia:

Reglerteknik AK – Föreläsningar (Lectures)
Reglerteknik AK – Exempelsamling (Exercises and solutions)

Reglerteknik AK – Laborationer (Lab manual)
Reglerteknik – Formelsamling (Collection of formulae)

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.

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 17, 14–19 at MA:10 D–J .

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

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Weekly Program

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

Note: Lecture seminars are held in two groups. The scheduled lecture times are divided as follows:

- Course week 1 (17-21 Jan) Group I first hour, Group Pi+ second hour
- Course week 2 (24-28 Jan) Group Pi+ first hour, Group I second hour
- Course weeks 3-7 TBD, check Canvas!

Example: In course week 1, a lecture is scheduled for Tuesday, Jan 18 8:00-10:00. Group I starts at 8:15, Group Pi+ starts at 9:15.

You are allowed to change groups if you find a peer in the other group to switch places with.

Week	**Date**	**Activity**	
1	17 Jan	F1:	Course overview and introduction to control. PID control. Lab 1.
	18 Jan	F2:	Process models. Linearization. Block diagrams.
	19 Jan	F3:	Impulse and step response analysis
		E1:	Process models. Linearization.
		E2:	System representations. Block diagrams.
2	24 Jan	F4:	Frequency analysis. Connections between model descriptions.
	25 Jan	F5:	Feedback. Stability.
	26 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.
	2 Feb	F8:	State feedback control.
		E5:	PID-control. Lab 2.
		E6:	Nyquist criterion. Stability margins.
		E7:	Computer exercise.
4	7 Feb	F9:	Kalman filtering.
	9 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	15 Feb	F11:	Compensation in the frequency domain.
	16 Feb	F12:	PID-control.
		E10:	Kalman filtering. Observability. Lab 3.
		E11:	Compensation in the frequency domain.
6	22 Feb	F13:	Controller architectures. Implementation.
	23 Feb	F14:	Synthesis example.
		E12:	PID-control.
		E13:	Controller architectures.
	LAB 3: Control of flexible servo.		
7	2 mar	F15:	Repetition.
		E14:	Synthesis.
		E15:	Repetition.
8	17 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.