FRT010 Automatic Control Basic Course (F I Pi)

Course Program Spring 2017

1. Lectures

Lectures (30 hours) are held at:

Mondays		15.15–17.00	M:A
Tuesdays	week 1–2	8.15–10.00	M:A
Wednesdays	week 1–6	13.15–15.00	M:A

Bo Bernhardsson is lecturer and course responsible.

2. Exercises

Exercises (30 hours) are held in 6 groups. You can choose group freely. Time and place are given below. Detailed program for exercises are given on the last page. Exercise 7 (computer exercise) is held at lab facilities at the department.

Group F2.01-06	Tue 10–12	M:L1-L2	Thu 10–12	M:L1-L2	Gustav Nilsson
Group F2.07-12	Tue 15–17	M:L1-L2	Fri 10–12	M:L1-L2	Christine Sjölander
Group I3.01-04	Wed 15–17	M:X1ab	Thu 13–15	M:M1-M2	Johan Lindberg
Group I3.05-08	Tue 13–15	M:M1-M2	Wed 10–12	M:X1ab	Tove Jungenfeldt
Group I3.09-12	Tue 10–12	M:M1-M2	Thu 8–10	M:L1-L2	Jacob Mejvik
Group Pi2	Tue 13–15	M:R	Thu 13–15	M:R	Hamed Sadeghi

3. Lab Exercises

In the course there are three mandatory lab exercises. These labs are rather extensive and for them to be meaningful you need to prepare. For Lab2 and Lab3 there are mandatory home problems, which you must be able to present at the start of the laboration. The second lab exercise also starts with a short test, and you must answer the questions correctly to be allowed to participate in the laboration. Lab manuals are sold at KF-Sigma. No laboratory reports need to be written. The lab facilities are on the bottom floor in the M-building.

The labs are performed during the hours 8.15–12.00, 13.15–17.00. They are not included in the schedule from the LTH schedule generator. You need to sign up to do the labs. Signup lists are available on the course home page, see

`http://www.control.lth.se/Education/EngineeringProgram/FRT010_FIPi.html`

The signup lists are open during the week before the lab starts. 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. Persons that have missed signing up in time or been absent from a lab without proper cause will have to do the lab the next time the course is

given. This is however often already in the next study period, since the same labs are used for most other programs.

Exercise 7 is a computer exercise and booked in the same way as the labs. This exercise is not mandatory, though highly recommended, and the booking is only to even out the load between the groups.

Lab	**When**	**Signup**	**Responsible**
1	week 2–3*	week 1	Gustav Nilsson
2	week 4–5	week 3	Jacob Mejvik
3	week 6–7	week 5	Hamed Sadhegi
Ex. 7	week 3	week 2	Bo Bernhardsson

* week stands for course week, not week of the year

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 for free download from

`aer.ual.es/ilm/`

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

5. Piazza.com

We will use the tool Piazza during the course, mainly for online discussion, questions and answers. The signup link is `piazza.com/lu.se/spring2017/frt010`

6. Literature

The course is covered by 4 compendia sold by KF:

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

The last three compendia are also available for free download at `www.control.lth.se.` You are allowed to use the 'Formelsamling' on the exam.

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

7. Exam

The written exam is 5 hours long. You may use 'Formelsamling', standard tables and calculators (not preprogrammed with e.g. Bode diagrams though). The grades are: fail, 3, 4 or 5.

The exam is on Wednesday March 15, 08–13 at MatteAnnexet MA9A+10

Weekly Program

Here is a weekly program with lectures=föreläsningar (F), exercises=Övningar (Ö), and labs.

Vecka	Datum	Aktivitet	
4	16 jan	F1:	Course overview and intro to control. PID control. Lab 1.
	17 jan	F2:	Process models. Linearization. Block diagrams.
	18 jan	F3:	Impuls and stepresponse analysis
		Ö1:	Process models. Linearization.
		Ö2:	System representations. Block diagrams.
5	23 jan	F4:	Frequency analysis. Connections between model descriptions.
	24 jan	F5:	Feedback. Stability.
	25 jan	F6:	Nyquist criterion. Stability margins.
		Ö3:	Poles, zero, step- and impulse-response.
		Ö4:	Frequency analysis. Bode- and Nyquist diagrams.
	LABORATION 1: Empirical investigation of two simple control problems.		
6	30 jan	F7:	Sensitivity. Stationary errors. Lab 2.
	1 feb	F8:	State feedback control.
		Ö5:	PID-control. Lab 2.
		Ö6:	Nyquist criterion. Stability margins.
		Ö7:	Computer exercise.
7	6 feb	F9:	Kalman filtering.
	8 feb	F10:	Output Feedback Control. Pol/zero-cancellation. Lab 3.
		Ö8:	Stationary error. Sensitivity.
		Ö9:	State feedback control. Controllability.
	LABORATION 2: Modeling and calculation of PID-controller parameters.		
8	13 feb	F11:	Compensation in the frequency domain.
	15 feb	F12:	PID-control.
		Ö10:	Kalman filtering. Observability. Lab 3.
		Ö11:	Compensation in the frequency domain.
9	22 feb	F13:	Controller architectures. Implementation.
	24 feb	F14:	Synthesis example.
		Ö12:	PID-control.
		Ö13:	Controller architectures.
	LABORATION 3: Control of flexible servo.		
10	2 mar	F15:	Repetition.
		Ö14:	Synthesis.
		Ö15:	Repetition.
11	15 mar	8–13	EXAM

Department Offices

The Department offices are located in the M-building. Administrators are on the 5th floor. The course lab is on the bottom floor southwest wing. We also have facilities on floor 2, 3, and 5. For more information about the department see `http://www.control.lth.se`

Phone and addresses

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Exercises

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

Ö1 Process models. Linearization.
E: 1.1, 1.2, 1.7
H: 1.5a-c, 1.6, 1.9

Ö2 System representations. Block diagrams.
Ö: 2.1, 2.14ab, 2.15
H: 2.2ab, 2.16ab

Ö3 Poles, zeros, step- and impulse response.
Ö: 2.5, 2.9, 2.11, 2.13
H: 2.6

Ö4 Frequency analysis. Bode- and Nyquist diagrams.
Ö: 3.1, 3.2, 3.4bd, 3.5b, 3.7
H: 3.4ac, 3.5a, 3.6

Ö5 PID-control. Lab 2.
Ö: 4.1, Fï¿½rberedelseuppgifter 3.1 och 3.6 i Lab 2, 4.9
H: 6.3, 6.4

Ö6 Nyquist criterion. Stability margins
Ö: 4.13, 4.15, 4.17, 4.18
H: 4.12, 4.14, 4.19

Ö7 Computer exercise.
Ö: 9.1, 9.2, 9.3

Ö8 Stationary error. Sensitivity.
Ö: 4.11, 4.2, 4.6, 4.7, 4.4
H: 4.3, 4.5

Ö9 State feedback. Controllability.
Ö: 5.5, 5.8, 5.10, 5.11
H: 5.2, 5.6

Ö10 Kalman filtering. Observability. Lab3.
Ö: 5.3, 5.12, 5.9
H: 5.13

Ö11 Compensation in frequency domain.
Ö: 6.11, 6.12, 6.13, 6.14
H: 6.15

Ö12 PID-control.
Ö: 6.5, 6.2, 6.7, 6.8
H: 6.6, 6.9

Ö13 Controller architectures.
Ö: 7.1, 7.6, 7.8, 7.9
H: 7.2, 7.5

Ö14 Synthesis example.
Ö: 8.1
H: 8.2

Ö15 Repitition.