FRTF05 Automatic Control Basic Course (D E)

Course Program Autumn 2021

Due to the Corona pandemic, this year's course will differ in several ways from previous years of the course. Canvas is used to handle the contact between teachers and students. The lectures will be given in the form of pre-recorded videos. The exercises will take place in classrooms, but teachers will not walk around in the room but stay at the board and teach from there. The labs will be carried out individually instead of in pairs and preparation tasks have to be handed in in advance via Canvas. More information will be given at the first lecture.

Canvas

All information about the course, and communication between teachers and students are handled using the Canvas page

https://canvas.education.lu.se/courses/14208

1. Lectures

Lectures (30 hours) are pre-recorded and can be viewed in Canvas at any time. The following schedule would have been used if the lectures were presented at campus. It is presented to simplify synchronization with other parts of the course.

Mondays	week 1–7	15.15–17.00
Tuesdays	week 1–6	15.15–17.00
Thursdays	week 1–2	15.15–17.00

Tore Hägglund is lecturer and course responsible.

2. Exercises

Exercises (30 hours) are held in four groups. Times and places are given below. Detailed program for exercises are given on the last page. Exercise 7 is a computer exercise that is not provided in classrooms this year. Support will be given using zoom at times presented in Canvas.

Group D1	Wed 15–17	E:3316	Thu 13–15	E:3336	Johanna Gustafson
Group D2	Thu 10–12	E:3319	Fri 8–10	E:3316	Max Nyberg Carlsson
Group E1	Wed 13–15	E:3315	Fri 10–12	E:3319	Christian Rosdahl
Group E2	Thu 13–15	E:1144	Fri 13–15	E:3315	Julia Adlercreutz

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. Except for the first lab, there are mandatory home problems, which must be solved and handed in using Canvas at least 4 days before your lab session for you to be allowed to participate in the laboration. Note that you are not allowed to bring used lab manuals with notes from previous users. No laboratory reports need to be written.

The lab facilities are on the bottom floor in the KC4-building. You need to sign up to do the lab. Signup lists are available in Canvas.

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 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.

Lab	**When**	**Signup**	**Responsible**
1	week 2–3	30 Aug – 5 Sept	Olle Kjellqvist
2	week 4–5	6 Sept – 13 Sept	Christian Rosdahl
3	week 6–7	20 Sept – 27 Sept	Max Nyberg Carlsson

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

`arm.ual.es/ilm/`

The module *Modeling* is suitable for studying model descriptions. In Exercise 7, this model is used. This exercise is not given on campus, there will be zoom support at several occasions during the third course week.

5. 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 compendia are also available for free download in Canvas. 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) or Åström & Murray: *Feedback Systems: An Introduction for Scientists and Engineers* (Princeton 2008), available for free at `www.cds.caltech.edu/~murray/amwiki`.

6. 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, and 5.

The exam is on Monday October 25, 14–19, hopefully on campus. However, due to the Corona pandemic, we may be forced to have a remote exam.

Weekly Program

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

Vecka	Datum	Aktivitet	
35	30 aug	F1:	Kursöversikt. Introduktion. PID-regulatorn. Lab 1.
	31 aug	F2:	Processmodeller. Linjärisering. Blockschema.
	2 sep	F3:	Impuls- och stegsvarsanalys.
		Ö1:	Processmodeller. Linjärisering.
		Ö2:	Systemrepresentationer. Blockschema.
36	6 sep	F4:	Frekvensanalys. Samband mellan modellbeskrivningar.
	7 sep	F5:	Återkoppling. Stabilitet.
	9 sep	F6:	Nyquistkriteriet. Stabilitetsmarginaler.
		Ö3:	Poler, nollställen, steg- och impulssvar.
		Ö4:	Frekvensanalys. Bode- och Nyquistdiagram.
	LABORATION 1: Empirisk undersökning av två enkla reglerkretsar.		
37	13 sep	F7:	Känslighet. Stationära fel. Lab 2.
	14 sep	F8:	Tillståndsåterkoppling.
		Ö5:	PID-reglering. Lab 2.
		Ö6:	Nyquistkriteriet. Stabilitetsmarginaler.
		Ö7:	Datorhjälpmedel.
38	20 sep	F9:	Kalmanfiltrering.
	21 sep	F10:	Utsignalåterkoppling. Pol/nollställe-förkortning. Lab 3.
		Ö8:	Stationära fel. Känslighet.
		Ö9:	Tillståndsåterkoppling.
	LABORATION 2: Modellbygge och beräkning av PID-inställning.		
39	27 sep	F11:	Kompensering i frekvensplanet.
	28 sep	F12:	PID-reglering.
		Ö10:	Kalmanfiltrering.
		Ö11:	Kompensering i frekvensplanet.
40	4 okt	F13:	Regulatorstrukturer. Implementering.
	5 okt	F14:	Syntesexempel.
		Ö12:	PID-reglering.
		Ö13:	Regulatorstrukturer.
	LABORATION 3: Reglering av flexibelt servo.		
41	11 okt	F15:	Repetition.
		Ö14:	Syntes.
		Ö15:	Repetition.
43	25 okt	14–19	TENTAMEN

Department Offices

The Department offices are located in the KC4-building, on the third floor. The course lab is on the bottom floor northeast wing.

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More information about the department are available on the home page
`http://www.control.lth.se`

Exercises

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

Ö1 Processmodeller. Linjärisering.
Ö: 1.1, 1.2, 1.7
H: 1.5a-c, 1.6, 1.9

Ö2 Systemrepresentationer. Blockschema.
Ö: 2.1, 2.14ab, 2.15
H: 2.2ab, 2.16ab

Ö3 Poler, nollställen, steg- och impulssvar.
Ö: 2.5, 2.9, 2.11, 2.13
H: 2.6

Ö4 Frekvensanalys. Bodediagram. Nyquistdiagram.
Ö: 3.1, 3.2, 3.4bd, 3.5b, 3.7
H: 3.4ac, 3.5a, 3.6

Ö5 PID-reglering. Lab 2.
Ö: 4.1, Förberedelseuppgifter 3.1 och 3.6 i Lab 2, 4.9
H: 6.3, 6.4

Ö6 Nyquistkriteriet. Stabilitetsmarginaler.
Ö: 4.15, 4.13, 4.17, 4.18
H: 4.12, 4.14, 4.19

Ö7 Datorhjälpmedel.
Ö: 9.1, 9.2, 9.3

Ö8 Stationära fel. Känslighet.
Ö: 4.11, 4.2, 4.6, 4.7, 4.4
H: 4.3, 4.5

Ö9 Tillståndsåterkoppling. Styrbarhet.
Ö: 5.5, 5.6, 5.8, 5.10, 5.11
H: 5.2

Ö10 Kalmanfiltrering. Observerbarhet. Lab3.
Ö: 5.3, 5.12, 5.9
H: 5.13

Ö11 Kompensering i frekvensplanet.
Ö: 6.11, 6.12, 6.13, 6.14
H: 6.15

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

Ö13 Regulatorstrukturer.
Ö: 7.1, 7.6, 7.8, 7.9ab
H: 7.2, 7.5, 7.9c

Ö14 Syntes.
Ö: 8.1
H: 8.2

Ö15 Gammal tenta.