

FRTF05 Automatic Control Basic Course (F I Pi)

Course Program Spring 2019

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 |

Pontus Giselsson and Anders Robertsson are lecturers and course responsible.

2. Exercises

Exercises (30 hours) are held in 5 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 | S.K. | Thu 10–12 | M:L1-L2 | J.G.A. |
| Group F2.07-12 | Tue 15–17 | M:L1-L2 | M.S. | Fri 10–12 | M:L1-L2 ¹ | M.S. |
| Group I3.01-06 | Tue 13–15 | M:M1-M2 | H.P. | Wed 15–17 | M:M1-M2 | S.K. |
| Group I3.07-12 | Wed 10–12 | M:L1-L2 | J.G.A. | Thu 13–15 | M:M1-M2 | H.P. |
| Group Pi2 | Tue 13–15 | M:R | M.F. | Thu 13–15 | M:R | M.F. |

¹Room changed to M:M1-M2 on Feb. 15.

Initials: M.F. = Mattias Fält, H.P. = Harry Pigot, M.S. = Magnus Svensson, J.G.A. = Jacob Gummesson Atroshi, S.K. = Sverre Knutsen.

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/engineering-program/frtf05-automatic-control-basic-course-for-fipi/>

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 | Claudio Mandrioli |
| 2 | week 4–5 | week 3 | Harry Pigot |
| 3 | week 6–7 | week 5 | Mattias Fält |
| Ex. 7 | week 3 | week 2 | Martina Maggio |

* 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. 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.

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 or 5.

The exam is on Wednesday March 19, 08–13 at MA 10 and MA 9A.

Weekly Program

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

| Vecka | Datum | Aktivitet |
|--|---|---|
| 4 | 21 jan | F1: Course overview and intro to control. PID control. Lab 1. |
| | 22 jan | F2: Process models. Linearization. Block diagrams. |
| | 23 jan | F3: Impuls and stepresponse analysis |
| | | Ö1: Process models. Linearization. |
| | | Ö2: System representations. Block diagrams. |
| 5 | 28 jan | F4: Frequency analysis. Connections between model descriptions. |
| | 29 jan | F5: Feedback. Stability. |
| | 30 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 | 4 feb | F7: Sensitivity. Stationary errors. Lab 2. |
| | 6 feb | F8: State feedback control. |
| | | Ö5: PID-control. Lab 2. |
| | | Ö6: Nyquist criterion. Stability margins. |
| | | Ö7: Computer exercise. |
| 7 | 11 feb | F9: Kalman filtering. |
| | 13 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 | 18 feb | F11: Compensation in the frequency domain. |
| | 20 feb | F12: PID-control. |
| | | Ö10: Kalman filtering. Observability. Lab 3. |
| | | Ö11: Compensation in the frequency domain. |
| 9 | 25 feb | F13: Controller architectures. Implementation. |
| | 27 feb | F14: Synthesis example. |
| | | Ö12: PID-control. |
| | | Ö13: Controller architectures. |
| LABORATION 3: Control of flexible servo. | | |
| 10 | 4 mar | F15: Repetition. |
| | | Ö14: Synthesis. |
| | | Ö15: Repetition. |
| 11 | 19 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 | Ö8 Stationary error. Sensitivity. Ö: 4.11, 4.2, 4.6, 4.7, 4.4 H: 4.3, 4.5 |
| Ö2 System representations. Block diagrams. Ö: 2.1, 2.14ab, 2.15 H: 2.2ab, 2.16ab | Ö9 State feedback. Controllability. Ö: 5.5, 5.8, 5.10, 5.11 H: 5.2, 5.6 |
| Ö3 Poles, zeros, step- and impulse response. Ö: 2.5, 2.9, 2.11, 2.13 H: 2.6 | Ö10 Kalman filtering. Observability. Lab3. Ö: 5.3, 5.12, 5.9 H: 5.13 |
| 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 | Ö11 Compensation in frequency domain. Ö: 6.11, 6.12, 6.13, 6.14 H: 6.15 |
| Ö5 PID-control. Lab 2. Ö: 4.1, Förberedelseuppgifter 3.1 och 3.6 i Lab 2, 4.9 H: 6.3, 6.4 | Ö12 PID-control. Ö: 6.5, 6.2, 6.7, 6.8 H: 6.6, 6.9 |
| Ö6 Nyquist criterion. Stability margins Ö: 4.13, 4.15, 4.17, 4.18 H: 4.12, 4.14, 4.19 | Ö13 Controller architectures. Ö: 7.1, 7.6, 7.8, 7.9 H: 7.2, 7.5 |
| Ö7 Computer exercise. Ö: 9.1, 9.2, 9.3 | Ö14 Synthesis example. Ö: 8.1 H: 8.2 |
| | Ö15 Repetition. |