FRT041 System Identification, Spring 2013

Welcome to the course *System Identification (FRT 041)* at the Department of Automatic Control, Lund University (Internet http://www.control.lth.se).

Responsible academic staff

Lectures will be held by Rolf Johansson (Rolf.Johansson@control.lth.se, phone 046-222 8791). Tutorials will be held by Mahdi Ghazaei, (Mahdi@control.lth.se phone 046-222 8795). Laboratory sessions will be held by Mahdi Ghazaei and Meike Stemmann (phone 046-222 8784, Meike.Stemmann@control.lth.se).

Office hours are Monday 4-5pm (RJ), and Wednesdays 1-2pm (MG)

Prior knowledge required

Control Theory (FRT 010), (Mathematical Statistics—Stochastic Processes (FMS 045)).

Reading list

- R. Johansson, *System Modeling and Identification*, Englewood Cliffs, NJ: Prentice Hall, 1993. ISBN 0-13-482308-7 (hard cover) or ISBN 0-13-145889-2 (paperback) (The book is currently out of stock but a 2nd edition draft is available at KFS).

Other course material such as *Laboratory Exercises* and *System Modeling and Identification—Solutions Manual* are available via our home page `http://www.control.lth.se/course/FRT041/`.

Lectures

Lectures will be held in M:E on Tuesdays 13.15-15. and Thursdays at 8.15-10a.m. the Seminar Room M2498, Dept. Automatic Control, on Wednesdays, Jan 23 and Jan 30, at 13.15-15; according to the following schedule:

Week & Date			N^o	Contents
4	Jan	22	L1:	Introduction. Transient response analysis (RJ Chap. 1-2);
	Jan	23	L2:	Frequency response analysis (RJ Chap. 2);
	Jan	24	L3:	Spectrum analysis (RJ Chap. 3-4). Interactive software;
5	Jan	29	L4:	Linear regression. Least-squares method. (RJ Chap. 5);
	Jan	30	L5:	Model parametrizations (RJ Chap. 6);
	Jan	31	L6:	Maximum-likelihood methods (RJ Chap. 6);
6	Feb	5	L7:	Prediction error methods. Algorithms. (RJ Chap. 6);
	Feb	7	L8:	Modeling (RJ Chap. 7);
7	Feb	12	L9:	The experimental procedure (RJ Chap. 8);
8	Feb	19	L10:	Model validation (RJ Chap. 9);
	Feb	21	L11:	Model approximation (RJ Chap. 10);
9	Feb	26	L12:	State-space models. Subspace model identification. (RJ Chap. 13);
10	Mar	5	L13:	Real-time identification. Continuous-time models. (RJ Chap. 12);
	Mar	7	L14:	Nonlinear system identification and 2D methods (RJ Chap. 14-15).

Tutorials

Tutorials will be held in M:L2 on Fridays at 10.15-1200. Exercises denoted 'x' are found on our web server.

Week	Date	Contents	Class	Home work
4	Jan 25	**E1:** Frequency response analysis	2.3, 2.4, 8.2,8.3	x1, 2.5, 8.4, x2
5	Feb 1	**E2:** Spectrum Analysis	2.6, 8.5, 8.6, x3	x4
6	Feb 8	**E3:** Linear regression	5.12, 6.3, 5.11	x5
7	Feb 15	**E4:** Time-Series Analysis	8.7, x6, x7	6.1, 6.10, x8
8	Feb 22	**E5:** Model validation	x9, x10,	
		Model reduction	10.1, x11	10.2, x12
9	Mar 1	**E6:** Real-time identification	x15, x16, x13	
		Continuous-time models	12.1	11.1
10	Mar 8	**E7:** Subspace-based identification	x18	

Information and course material is also available on `www.control.lth.se`

Homework Assignments

Homework assignments with mandatory hand-in of solutions will be requested during weeks 5, 7 and 8 with deadlines on February 3, February 17 and February 24.

Laboratory Exercises

Laboratory exercises will be held in the course laboratory in the ground floor of the M-building. Booking for the laboratory sessions are to be found via the home page and bookings are accepted two weeks before the first session will be held. Laboratory sessions will be made in groups of three students.

Lab	Time	Place	Responsible	Phone	Contents
Lab PI1	w.5	Lab A	Mahdi Ghazaei	222 8795	Frequency response analysis
Lab PI2	w.6-7	Lab A	Mahdi Ghazaei	222 8795	Interactive identification
Lab PI3	w.9	Lab A	Meike Stemmann	222 8784	Synthesis

Projects

Projects should be made in teams of three students and the subject of study should be chosen in cooperation with the instructor by **February 15**. The project should be finished and reported during the Spring semester 2013. Oral reports will take place on **Friday, April 26, 10.15 a.m.–** or at a time to be decided later. The project laboratory, with computers is available to the students. An entrance card to the laboratory and permissions will be issued at **Friday, January 25 at 10.30-11.30 a.m.**, at the office of Mr. Rolf Braun, Level 2, southern wing, M-building. (Notice that a separate permission is required to enter the M-building. This should be acquired before visiting Mr. Braun.)

Exam and Exam Policy

The final exam is to be given on **Thursday, March 14 at 8.00-13.00 (8am-1pm** in *M:Q*. Course literature (excluding old exams, exercises, and solutions) may be used during the exam. The grade of the exam (3, 4, or 5) will be posted on the notice board at the ground floor of the M-building. The final grade will be issued when the course project has been accepted. A well performed course project may increase the final grade by one unit as compared to the written exam.

Projects in System Identification 2013

A Few Suggested Project Outlines

- Identification of a flexible servo
- Identification of a helicopter model
- Identification and modeling of the ball-and-beam process—The position loop
- Parametric robot identification
- Motor drive with speed and tension control
- A servo with backlash
- Econometric identification
- Friction models for servo mechanisms
- Inverted-pendulum dynamics
- A fan process

Procedure

- Modeling
- Experiment planning
- Identification: At least two 'independent' methods should be used.
- Validation:
  - Statistic criteria
  - Simulation
  - Control (if relevant)
  - Legible, nice, type-written report and a short oral presentation

Organisation

- Three students in each project team
- Instructors: Rolf Johansson, Mahdi Ghazaei, Meike Stemmann.

Examination

An oral report in class should take place on **Friday, April 29, 10.15 a.m.** (or at another time to be decided). Final project reports should be submitted no later than this date.

- Examiner: Rolf Johansson
- It is required that the project is accepted to fulfill course requirements
- A well done project may improve the final grade by one unit

Laboratory and computer resources

- Project laboratories A with computers are available with the following software: Matlab.