FRT041 System Identification, Spring 2011

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 Meike Stemmann (`Meike.Stemmann@control.lth.se`, phone 046-222 9745) and Andreas Stolt (`Andreas.Stolt@control.lth.se`, phone 046-222 9745). Laboratory sessions will be held by Marzia Cescon, (phone 046-222 8784, `Marzia.Cescon@control.lth.se`) and Maria Henningsson (`Maria.Henningsson@control.lth.se`, phone 046-222 3270).

Office hours are Monday 4-5pm (RJ), Wednesdays 1-2pm (MS), Fridays 10.30am-12 (AS).

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 8.15-10a.m. and Thursdays at 8.15-10a.m. the Seminar Room, Dept. Automatic Control, on Wednesday, Jan 19, at 10.15-12am; on Wednesdays, Feb 2, Feb 9 at 1.15-3p.m.; M:M1 on Wednesday, Jan 26 at 1.15-3p.m. according to the following schedule:

Week & Date			N^o	Contents
3	Jan	18	L1:	Introduction. Transient response analysis (RJ Chap. 1-2);
	Jan	19	L2:	Frequency response analysis (RJ Chap. 2);
4	Jan	25	L3:	Spectrum analysis (RJ Chap. 3-4). Interactive software;
	Jan	26	L4:	Linear regression. Least-squares method. (RJ Chap. 5);
	Jan	27	L5:	Model parametrizations (RJ Chap. 6);
5	Feb	1	L6:	Maximum-likelihood methods (RJ Chap. 6);
	Feb	2	L7:	Prediction error methods. Algorithms. (RJ Chap. 6);
	Feb	3	L8:	Modeling (RJ Chap. 7);
6	Feb	8	L9:	The experimental procedure (RJ Chap. 8);
	Feb	9	L10:	Model validation (RJ Chap. 9);
	Feb	10	L11:	Model approximation (RJ Chap. 10);
7	Feb	15	L12:	State-space models. Subspace model identification. (RJ Chap. 13);
	Feb	17	L13:	Real-time identification. Continuous-time models. (RJ Chap. 12);
9	Mar	3	L14:	Nonlinear system identification and 2D methods (RJ Chap. 14-15).

Tutorials

Tutorials will be held on Fridays 13.15-1500 (1.15pm-3pm) in MX2a. Exercises denoted 'x' are found on our web server.

Week	Date	Contents	Class	Home work
3	Jan 21	**E1:** Frequency response analysis	2.3, 2.4, 8.2,8.3	x1, 2.5, 8.4, x2
4	Jan 28	**E2:** Spectral Analysis	2.6, 8.5, 8.6, x3	x4
5	Feb 4	**E3:** Linear regression	5.12, 6.3, 5.11	x5
6	Feb 11	**E4:** Time-Series Analysis	8.7, x6, x7	6.1, 6.10, x8
7	Feb 18	**E5:** Model validation	x9, x10,	
		Model reduction	10.1, x11	10.2, x12
8	Feb 25	**E6:** Real-time identification	x15, x16, x13	
		Continuous-time models	12.1	11.1
9	Mar 4	**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 4, 6 and 7 with deadlines on January 29, February 12 and February 19.

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.4	Lab A	Meike Stemmann	222 9745	Frequency response analysis
Lab PI2	w.5-6	Lab A	Marzia Cescon	222 8784	Interactive identification
Lab PI3	w.8	Lab A	Maria Henningsson	222 3270	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 12**. The project should be finished and reported during the Spring semester 2011. Oral reports will take place on **Tuesday, April 29, 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 21 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 **Monday, March 7 at 14.00-19.00 (2pm-7pm** 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 2011

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, Meike Stemmann, Andreas Stolt.

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.