FRT041 System Identification, Autumn 2014

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, 046-222 8791). Tutorials will be held by Mahdi Ghazaei, (Mahdi@control.lth.se, 046-222 8795) and Jacob Antonsson (046-2224287, Jacob.Antonsson@control.lth.se). Laboratory sessions will be held by Mahdi Ghazaei and Meike Stemmann (Meike.Stemmann@control.lth.se, 046-222 8784). Office hours are Mondays 4-5pm (RJ), and Wednesdays 4-5pm (MG), and Fridays 1-2pm (JA).

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 8.15-10am; in the Seminar Room M:2112B, Dept. Automatic Control, on Thursdays, Sep 4 and Sep 11, at 15.15-17; according to the following schedule:

Week & Date			N^o	Contents
36	Sep	2	L1:	Introduction. Transient response analysis (RJ Chap. 1-2);
	Sep	4	L2:	Frequency response analysis (RJ Chap. 2);
	Sep	4	L3:	Spectrum analysis (RJ Chap. 3-4). Interactive software;
37	Sep	9	L4:	Linear regression. Least-squares method. (RJ Chap. 5);
	Sep	11	L5:	Model parametrizations (RJ Chap. 6);
	Sep	11	L6:	Maximum-likelihood methods (RJ Chap. 6);
38	Sep	16	L7:	Prediction error methods. Algorithms. (RJ Chap. 6);
	Sep	18	L8:	Modeling (RJ Chap. 7);
39	Sep	23	L9:	The experimental procedure (RJ Chap. 8);
	Sep	25	L10:	Model validation (RJ Chap. 9);
40	Sep	30	L11:	Model approximation (RJ Chap. 10);
	Oct	2	L12:	State-space models. Subspace model identification. (RJ Chap. 13);
41	Oct	7	L13:	Real-time identification. Continuous-time models. (RJ Chap. 12);
	Oct	9	L14:	Nonlinear system identification and 2D methods (RJ Chap. 14-15).

Tutorials

Tutorials will be held in M:L1 on Fridays at 8.15-10.00. Exercises denoted 'x' are found on our web server.

Week	Date	Contents	Class	Home work
36	Sep 5	**E1:** Frequency response analysis	2.3, 2.4, 8.2,8.3	x1, 2.5, 8.4, x2
37	Sep 12	**E2:** Spectrum Analysis	2.6, 8.5, 8.6, x3	x4
38	Sep 19	**E3:** Linear regression	5.12, 6.3, 5.11	x5
39	Sep 26	**E4:** Time-Series Analysis	8.7, x6, x7	6.1, 6.10, x8
40	Oct 3	**E5:** Model validation	x9, x10,	
		Model reduction	10.1, x11	10.2, x12
41	Oct 10	**E6:** Real-time identification	x15, x16, x13	
		Continuous-time models	12.1	11.1
42	Oct 17	**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 37, 39 and 40 with deadlines on Sep 14, Sep 28 and Oct 5.

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.37	Lab B	Mahdi Ghazaei	222 8795	Frequency response analysis
Lab PI2	w.40	Lab B	Mahdi Ghazaei	222 8795	Interactive identification
Lab PI3	w.41	Lab B	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 **Sep 28**. The project should be finished and reported during the autumn semester 2014. Oral reports will take place on **Friday, Nov 28, 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 the office of Mr. Anders Blomdell, M:2429, M-building. (Notice that a separate permission is required to enter the M-building. This should be acquired before visiting Mr. Blomdell.)

Exam and Exam Policy

The final exam is to be given on **Wednesday, Oct 29 at 8.00-13.00 (8am-1pm** in *Vic:1C-D*. 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 2014

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, Nov 28, 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 laboratory B with computers are available with the following software: Matlab.