FRTN35 System Identification, Autumn 2017

Welcome to the course *System Identification (FRTN35)* 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, 046-2228791). Tutorials and laboratory sessions will be held by Fredrik Bagge Carlson (FredrikB@control.lth.se, 046-2220847), Martina Maggio (Martina.Maggio@control.lth.se, 046-2224785), and Johan Ruuskanen (Johan.Ruuskanen@gmail.com, 0706-902713). Office hours are Mondays 4-5pm (RJ), and Wednesdays 4-5pm (FBC), and Fridays 1-2pm (MM).

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 or 15.15-17; Thursdays 10.15-12; and Tuesdays 10.15-12 (Aug 29, Sep 5) in M:2112B according to the following schedule:

Week & Date			N^o	Contents
35	Aug	29	L1:	Introduction. Transient response analysis (RJ Chap. 1-2);
	Aug	29	L2:	Frequency response analysis (RJ Chap. 2);
	Sep	31	L3:	Spectrum analysis (RJ Chap. 3-4). Interactive software;
36	Sep	5	L4:	Linear regression. Least-squares method. (RJ Chap. 5);
	Sep	5	L5:	Model parametrizations (RJ Chap. 6);
	Sep	7	L6:	Maximum-likelihood methods (RJ Chap. 6);
37	Sep	12	L7:	Prediction error methods. Algorithms. (RJ Chap. 6);
	Sep	13	L8:	Modeling (RJ Chap. 7);
39	Sep	26	L9:	The experimental procedure (RJ Chap. 8);
	Sep	27	L10:	Model validation (RJ Chap. 9);
40	Oct	3	L11:	Model approximation (RJ Chap. 10);
	Oct	5	L12:	State-space models. Subspace model identification. (RJ Chap. 13);
41	Oct	10	L13:	Real-time identification. Continuous-time models. (RJ Chap. 12);
	Oct	12	L14:	Nonlinear system identification and 2D methods (RJ Chap. 14-15).

Tutorials

Tutorials will be held in M:R on Fridays at 10.15-12.00. Exercises denoted 'x' are found on our web server.

Week	Date	Contents	Class	Home work
35	Sep 1	**E1:** Frequency response analysis	2.3, 2.4, 8.2,8.3	x1, 2.5, 8.4, x2
36	Sep 8	**E2:** Spectrum Analysis	2.6, 8.5, 8.6, x3	x4
37	Sep 15	**E3:** Linear regression	5.12, 6.3, 5.11	x5
38	Sep 22	**E4:** Time-Series Analysis	8.7, x6, x7	6.1, 6.10, x8
39	Sep 29	**E5:** Model validation	x9, x10,	
		Model reduction	10.1, x11	10.2, x12
40	Oct 6	**E6:** Real-time identification	x15, x16, x13	
		Continuous-time models	12.1	11.1
41	Oct 13	**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 36, 38 and 39 with deadlines on Sep 10, Sep 24 and Oct 1.

Laboratory Exercises

Laboratory exercises will be held in the course laboratory Lab B 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	F. Bagge Carlson	2220847	Frequency response analysis
Lab PI2	w.39	Lab B	M. Maggio	2224785	Interactive identification
Lab PI3	w.41	Lab B	J. Ruuskanen	0706-902713	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 25**. The project should be finished and reported during the autumn semester 2017. Oral reports will take place in the seminar room **M:2112B** on **Friday, Nov 24, 10.15 a.m.–**. 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 25 at 8.00-13.00 (8am-1pm** in *MA:9E-F*. 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 2017

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, Fredrk Bagge Carlson

Examination

An oral report in class should take place on **Friday, Nov 24, 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.