



FRTN35 SYSTEM IDENTIFICATION, AUTUMN 2019

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 Tommi Nylander (Tommi.Nylander@control.lth.se, 046-222 8784) supported by Taouba Jouini (Taouba.Jouini@control.lth.se, 046-222 8760). Office hours are Mondays 4-5pm (RJ), and Wednesdays 4-5pm (TN), and Fridays 11-12pm (TJ).

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 13.15-15; and Thursday 13.15-15, Sep 19, in M:2112B according to the following schedule:

Week & Date	N ^o	Contents
36 Sep 3	L1:	Introduction. Transient response analysis (RJ Chap. 1-2);
Sep 5	L2:	Frequency response analysis (RJ Chap. 2);
37 Sep 10	L3:	Spectrum analysis (RJ Chap. 3-4). Interactive software;
Sep 12	L4:	Linear regression. Least-squares method. (RJ Chap. 5);
38 Sep 17	L5:	Model parametrizations (RJ Chap. 6);
Sep 19	L6:	Maximum-likelihood methods (RJ Chap. 6);
39 Sep 24	L7:	Prediction error methods. Algorithms. (RJ Chap. 6);
Sep 26	L8:	Modeling (RJ Chap. 7);
40 Oct 1	L9:	The experimental procedure (RJ Chap. 8);
Oct 3	L10:	Model validation (RJ Chap. 9);
41 Oct 8	L11:	Model approximation (RJ Chap. 10);
Oct 10	L12:	State-space models. Subspace model identification. (RJ Chap. 13);
42 Oct 15	L13:	Real-time identification. Continuous-time models. (RJ Chap. 12);
Oct 17	L14:	Nonlinear system identification and 2D methods (RJ Chap. 14-15).

Tutorials

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

Week	Date	Contents	Class	Home work
36	Sep 4	E1: Frequency response analysis	2.3, 2.4, 8.2,8.3	x1, 2.5, 8.4, x2
37	Sep 11	E2: Spectrum Analysis	2.6, 8.5, 8.6, x3	x4
38	Sep 18	E3: Linear regression	5.12, 6.3, 5.11	x5
39	Sep 25	E4: Time-Series Analysis	8.7, x6, x7	6.1, 6.10, x8
40	Oct 2	E5: Model validation Model reduction	x9, x10, 10.1, x11	10.2, x12
41	Oct 9	E6: Real-time identification Continuous-time models	x15, x16, x13 12.1	11.1
42	Oct 16	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 15, Sep 29 and Oct 6.

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.38	Lab B	T. Nylander	2228784	Frequency response analysis
Lab PI2	w.40	Lab B	T. Jouini	222 8760	Interactive identification
Lab PI3	w.42	Lab B	T. Jouini	222 8760	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 30**. The project should be finished and reported during the autumn semester 2019. Oral reports will take place in the seminar room **M:2112B** on **Friday, Dec 6, 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 30 at 8.00-13.00 (8am-1pm** in *Vic:3B-3C*. 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 2019

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, Tommi Nylander

Examination

An oral report in class should take place on **Friday, Dec 6, 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.