

## Course ELEC-E8103 - Modelling, Estimation and Dynamic Systems, 2024

**Credits:** 5 ECTS, **Duration:** 4.09.2024 - 27.11.2024

### Learning outcomes:

After completing the course, a student can select proper modeling approaches for specific practical problems, formulate mathematical models of physical systems, construct models of systems using modeling tools such as MATLAB and Simulink, and estimate the parameters of linear and nonlinear static systems and linear dynamic systems from measurement data.

### Content:

Basic modeling methods, including first principle modeling and data-driven modeling, for both static and dynamic systems: first principle modeling, black-box modeling, basics of regression methods, parameter estimation for static linear and non-linear systems, parameter estimation for linear time-invariant dynamical systems, model validation, and selected advanced topics.

### Recommended prerequisites:

Programming in Matlab, Matrix and Linear Algebra, Basic course in Control Engineering or relevant knowledge.

**Course Homepage:** <https://mycourses.aalto.fi/course/info.php?id=43523>

**Teaching language:** English.

**Teacher in charge:** Quan Zhou

### Contact information:

Responsible teacher: Prof. Quan Zhou, [quan.zhou@aalto.fi](mailto:quan.zhou@aalto.fi)

Other teachers/assistants:

- M.Sc. Artur Kopitca, [artur.kopitca@aalto.fi](mailto:artur.kopitca@aalto.fi)
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### Assessment Methods and Criteria

The course will be evaluated by five home exercises and the final exercise.

- **Home exercise 1-5** (8 percentage points for each exercise, 40 percentage points in total). Exercise sessions will be held to help you conduct each of the exercises. The points for home exercises will be given if you demonstrate sufficient effort. Standard answers will be published after each submission deadline.
- **Final home exercise** (60 percentage points). The points will be given based on the correctness of your submission. The final home exercise replaces the exam, so **no discussion** is allowed, and there will be also **no exercise session** for the final exercise.
- The final grade will be given based on your total points: [50%, 60%) → 1, [60, 70%) → 2, [70%, 80%) → 3, [80%, 90%) → 4, [90%, inf] → 5.

The evaluation criteria will be clarified/ revised in the first lecture.

### Workload

- Lectures, exercise sessions, independent study and problem-solving, and home assignments. Contact hours: 24 + 12 h, Independent study: 93 h
- There will be 11 lectures. The lectures are held only in certain weeks: W36, W38, W40, W43, W45, and possibly W47. For each lecture week, there are two lectures: Wednesday 12:15-14:00 and Thursday 12:15-14:00.
- There will be 5 exercise sessions. The exercise sessions will be held in certain weeks: W37, W39, W41, W44, W46. There will be 3-4 instances of the same exercise sessions, where you should only attend one. The exercise session time slots are Monday 14:15-16:00, 16:15-18:00, both on-site; Wednesday 12:15-14:00, and 16:15-18:00 (if needed), at least one session will be online.
- The exercise sessions are not mandatory but highly recommended. You should already work on your exercises before you come to the exercise sessions. You should sign up for the exercise session you will attend at the beginning of the course.
- The final home exercise will be online, held during 25.11-2.12.2024 (tentative), the submission will be via MyCourses.

### Study Material

Handouts/ lecture slides, Ljung, Modeling of dynamic systems, 1994, additional book chapters. The main course materials are the lecture handouts (in the Materials section). The additional readings of each lecture will be given at the end of each lecture.

## Schedule

	M	T	W	T	F	S	S
<b>W35</b>	Starting survey						
<b>W36</b>			<b>12:15-14:00 Introduction</b> (Zhou)	<b>12:15-14:00 Physical modelling</b> (Zhou) EX1 assigned			
<b>W37</b>	14:15-16:00 EX1_1, 16:15-18:00 EX1_2		12:15-14:00 EX1_3, 16:15-18:00 (EX1_4)				DL EX1
<b>W38</b>			<b>12:15-14:00 Simulation</b> (Zhou)	<b>12:15-14:00 Simulink</b> (Kopitca) EX2 assigned			
<b>W39</b>	14:15-16:00 EX2_1, 16:15-18:00 EX2_2		12:15-14:00 EX2_3, 16:15-18:00 (EX2_4)				DL EX2
<b>W40</b>			<b>12:15-14:00 Regression</b> (Zhou)	<b>12:15-14:00 Curve fitting</b> (Kopitca) EX3 assigned			
<b>W41</b>	14:15-16:00 EX3_1, 16:15-18:00 EX3_2		12:15-14:00 EX3_3, 16:15-18:00 (EX3_4)				DL EX3
<b>W42</b>	Break Mid-term survey						
<b>W43</b>			<b>12:15-14:00 Analysis of dynamic systems</b> (Bettahar)	<b>12:15-14:00 System Identification 1</b> (Bettahar) EX4 assigned			
<b>W44</b>	14:15-16:00 EX4_1, 16:15-18:00 EX4_2		12:15-14:00 EX4_3, 16:15-18:00 (EX4_4)				DL EX4
<b>W45</b>			<b>12:15-14:00 System identification 2</b> (Bettahar)	<b>12:15-14:00 System identification 3</b> (Bettahar) EX5 assigned			
<b>W46</b>	14:15-16:00 EX5_1, 16:15-18:00 EX5_2		12:15-14:00 EX5_3, 16:15-18:00 (EX5_4)				DL EX5
<b>W47</b>			<b>12:15-14:00 Modelling in Python</b> (Kopitca)				
<b>W48</b>	Final EX6 assigned (tentative)	...					
<b>W49</b>	DL EX6 (tentative)						

### Further Information

- Teaching activities (lectures, exercise sessions) of this course will be primarily held on-site. One online exercise session will be provided. Lecture recordings of toolbox lectures will be provided for students.
- The first lecture will be held on Wednesday, September 4, 2024, at 12:15.
- The attendance of the lectures and the exercise sessions is not mandatory. More details of the arrangement of the guided exercise sessions will be instructed later.
- Each exercise (EX1 - EX5) will have guided exercise sessions.
- Depending on the number of students, the guided exercise session will be held 3-4 times (EXn\_1 - EXn\_4). You should only attend one of them. You should sign up for the exercise session you will attend at the beginning of the course.
- The final home exercise (EX6, = exam) will be held online for a duration of about one week.