

2102531 System Identification

Semester 1, 2017

Tentative Schedule: Mon Wed 9:30-11 am

Classroom: EE 404

Exams: Midterm and Final (TBA).

Instructors: Jitkomut Songsiri, EE410, jitkomut.s@chula.ac.th

Course Web: <http://jitkomut.eng.chula.ac.th/ee531.html>

Course Description: Modeling and Identification, reviews of random signals and random processes, statistical characterization of disturbances, input selection, nonlinear least-squares estimation, maximum-likelihood identification, Bayesian estimation, instrumental variable method, model parametrization, prediction-error method, subspace identification, model selection, model validation, recursive identification, applications in causal inference from data

Course Objectives:

1. Apply elements of probability theory, random processes and linear systems to formulating probabilistic models
2. Formulate estimation problems into least-squares estimation problem
3. Apply suitable numerical methods to find solutions to least-squares problems
4. Apply statistical estimation methods such as minimum mean square error (MSE), maximum likelihood (ML) and maximum a posteriori (MAP) methods.
5. Apply various system identification methods; prediction error method, instrumental variable method, subspace identification, or recursive identification to estimation problems in engineering
6. Explain criteria of choosing input signals and order of persistent excitation that are suitable for system identification experiments
7. Explain and apply the principle of model selection and model validation to select the best model for the problem of interest
8. Explain real-world applications in system modeling and provide a model estimation formulation

Assessment: Homework 30 % Midterm 30 % Final 10 % Project 30 %

Textbooks:

1. L. Ljung, *System Identification: Theory for the User*, 2nd Edition, Prentice-Hall, 1999
2. T. Soderstrom and Petre Stoica, *System Identification*, Prentice-Hall, 1989
3. J.P. Norton, *An Introduction to Identification*, Dover, 1986
4. P. Van Overschee and B.D. Moor, *Subspace identification for linear systems: Theory Implementation Applications*, Kluwer Academic Publishers, 2012
5. G. James and D. Witten, T. Hastie, and R. Tibshirani, *An Introduction to Statistical Learning with Applications in R*, Springer, 2013

Exam Rules: In any exam, one sheet (two pages) of A4-sized paper with only handwritten formulas will be allowed. A scientific calculator per student is permitted. We will not have any make-up exams if you are absent.

Course Calendar:

| Week | Date | Outline | Homework |
|-------------|---------------|---|-----------------|
| 1 | Aug 16 | Review on linear systems and random processes | |
| 2 | Aug 21,23 | Input signals | HW 1 |
| 3 | Aug 28,30 | Linear least-squares (LS) | |
| 4 | Sep 4, 6 | Examples and variants of linear LS | |
| 5 | Sep 11,13 | Nonlinear least-squares (NLS) | HW 2 |
| 6 | Sep 18, 20 | Numerical techniques in solving NLS | |
| 7 | Sep 25, 27 | Statistical estimation (MSE/MLE/MAP) | HW3 |
| 8 | Oct 2-6 | Midterm exam | |
| 9 | Oct 9,11 | Statistical estimation (MSE/MLE/MAP) | |
| 10 | Oct 16,18 | Model parametrization | HW 4 |
| | | Prediction error method (PEM) | |
| 11 | Oct 25 | Prediction error method (PEM) | |
| 12 | Oct 30, Nov 1 | Instrument variable method (IVM) | |
| 13 | Nov 6,8 | Subspace Identification | HW 5 |
| 14 | Nov 20,22 | Subspace Identification | |
| 15 | Nov 27,29 | Model selection/Model validation | |
| 16 | Dec 4-8 | Final Exam | |
| | | Term Project Presentation | |