Detection and Estimation of Signals

Programme course

6 credits

Detektion och estimering av signaler

TSKS15

Valid from: 2017 Autumn semester

Determined by
Board of Studies for Electrical
Engineering, Physics and Mathematics

Date determined
2017-01-25

Main field of study

Electrical Engineering

Course level

Second cycle

Advancement level

A1X

Course offered for

- Applied Physics and Electrical Engineering, M Sc in Engineering
- Information Technology, M Sc in Engineering
- Computer Science and Engineering, M Sc in Engineering
- Industrial Engineering and Management, M Sc in Engineering
- Industrial Engineering and Management - International, M Sc in Engineering
- Communication Systems, Master's Programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Mathematics, Master's programme

Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites

Linear algebra, probability theory, and a course similar to Signals, Information and Communications.

Intended learning outcomes

After completed course the student should

- with adequate terminology, in a well-structured manner and logically coherent, be able to describe and conduct simpler calculations that relate to classical and Bayesian estimation and detection theory, specifically the Neyman-Pearson theorem, error probabilities, decision regions, maximum-likelihood, linear and nonlinear models, Fisher information, Cramer-Rao bound, circularly symmetric noise, noise whitening, MMSE and LMMSE, GLRT, model order selection, coherent and non-coherent detection, composite hypothesis testing, nuisance parameters and basis expansions of waveforms in continuous time
- be able to describe, apply and implement in a conventional programming language, and show engineering understanding, for the theory and models used in the course
- be able to report work in written and oral form, using adequate language, terminology, structure and typography.

Course content

Binary hypothesis tests, Neyman-Pearson theorem, error probability. M-ary detection problems. Bayes cost, minimum probability of error. Nuisance parameters. Classical estimation: Maximum-likeihood. Cramer-Rao bound, Slepian-Bang's formula, efficiency. Linear, vector-valued models with Gaussian noise. Non-linear models. Noise whitening, complex-valued data, Gaussian noise, circularly symmetric noise. Bayesian estimation: MMSE and LMMSE. Composite hypothesis testing: GLRT and Bayesian approach, model selection. Finite-dimensional basis expansions of waveforms. Performance calculations: union bound, asymptotic properties of estimators. Applications to amplitude and phase estimation, frequency estimation, angle-of-arrival estimation, time-of-arrival estimation, source localization, coherent and non-coherent detection of waveforms.

Teaching and working methods

Lectures, problem classes and computer laboratory work. Written (individual) reports of laboratory work.

Examination

LAB1	Laboratory work	2 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

Grades

Four-grade scale, LiU, U, 3, 4, 5

Department

Institutionen för systemteknik

Director of Studies or equivalent

Klas Nordberg

Examiner

Erik G. Larsson

Course website and other links

http://www.commsys.isy.liu.se/en/student/Akurser

Education components

Preliminary scheduled hours: 88 h
Recommended self-study hours: 72 h

Course literature

Additional literature

Books

Kay, S, *Statistical Signal Processing: Estimation Theory och Statistical Signal Processing: Detection Theory* Prentice.Hall

Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.