Signal Theory

Programme course

6 credits

Signalteori

TSDT14

Valid from: 2017 Spring 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
- Biomedical Engineering, Master's Programme
- Communication Systems, Master's Programme
- Computer Science and Engineering, M Sc in Engineering
- Industrial Engineering and Management - International, M Sc in Engineering
- Electronics Design Engineering, M Sc in Engineering
- Industrial Engineering and Management, M Sc in Engineering
- Information Technology, M Sc in Engineering
- Biomedical Engineering, M Sc in Engineering
- Computer Science and Software Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering

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
From Calculus: Derivatives and integrals.
From Probability theory: Most, but with focus on binary distributions, rectangular distributions and Gaussian distributions.
From Signals and systems: Fourier transforms, LTI systems, convolution, amplitude modulation, sampling and pulse amplitude modulation. (all of it deterministic)

Intended learning outcomes

After passing the course, the student should

- be able to clearly define central concepts regarding stochastic processes, using own words.
- be able to reliably perform standard calculations regarding stochastic processes, e.g. LTI filtering (both time continuous and time discrete), sampling and pulse amplitude modulation, but also certain momentary non-linearities that are common in telecommunication.
- with some reliability be able to solve problems that demand integration of knowledge from different parts of the course, i.e. analysis of LTI-filtering, modulation, sampling and non-linear filtering of stochastic processes, both one-dimensional and multi-dimensional.
- be able to account for the connection between different concepts in the course in a structured way using adequate terminology.
- be able to estimate the auto correlation function and power spectral density of a stochastic process based on a realization of the process. Also, clearly and logically account for those estimations and conclusions that can be drawn from them.

Course content

- Time continuous and time discrete stochastic processes: Probability distribution, probability density, expectation, ensemble expectation, auto correlation function, power spectral density, cross correlation function, cross spectral density, stationarity, ergodicity. Especially Gaussian processes and white processes. Multidimensional processes.
- LTI filtering of stochastic processes: Relations between statistical properties of the input process and the output process. Especially matched filters and white Gaussian noise as input.
- Amplitude and angle modulation of stochastic processes: Relations between statistical properties of the input process and the output process. Especially Gaussian processes as input. Noise analysis of those modulation forms, primarily with white Gaussian noise as disturbance.
- Non-linear momentary systems: Quantization and monomial non-linearities. Relations between statistical properties of the input process and the output process. Especially Gaussian processes as input. Properties of quantization noise.
- Transformation between time continuous and time discrete stochastic processes: Sampling and pulse amplitude modulation, the sampling theorem, reconstruction and reconstruction error.
- Case study: Reconstruction in CD players.
- Estimation of expectations, auto correlation function and power spectral density.

Teaching and working methods

Teaching is given in the form of lectures, tutorial and laborations

Examination

LAB1	Laboratory Work	2 credits	U, G
TEN1	Written Examination	4 credits	U, 3, 4, 5

At the exam, there will be an introductory task that examines the learning outcomes "be able to clearly define..." and " be able to reliably perform standard calculations...". This task has to be solved correctly, in order to pass the exam. The rest of the exam examines the learning outcome " with some reliability be able to solve problems...". The grade on the exam, and also on the course as a whole is based on this part.
The laborations are performed in small groups and is examined based on a report. This examines the last two learning outcomes, " be able to account for..." and " be able to estimate...".

Grades

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

Other information

Supplementary courses: Digital Communication Continuation Course, Radio communication, Data compression, Image and audio coding, Communication systems CDIO.

Department

Institutionen för systemteknik

Director of Studies or equivalent

Klas Nordberg

Examiner

Mikael Olofsson

Course website and other links

http://www.commsys.isy.liu.se/en/student/kurser/TSDT14

Education components

Preliminary scheduled hours: 54 h
Recommended self-study hours: 106 h

Course literature

Additional literature

Books

Mikael Olofsson, (2011) *Signal Theory*
ISBN: 978-91-44-07353-8
Studentlitteratur
Mikael Olofsson, (2011) *Tables and Formulas for Signal Theory*
ISBN: 978-91-44-07328-6
Studentlitteratur

Compendia

Additional problems and Lab Memo will be distributed during the course.

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.