LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Stationära stokastiska processer
Stationary Stochastic Processes

FMSF10, 7,5 credits, G2 (First Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED I
Date of Decision: 2023-04-14

General Information

Compulsory for: Pi3
Elective Compulsory for: MWIR1
Elective for: BME4-sbh, C4-ks, D4-bg, D4-ssr, D4-mai, E4-ss, E4-bg, F4, F4-bg, F4-bm, F4-fm, F4-r, F4-ss, F4-mai, I4-fir, M4, MMSR2, R4
Language of instruction: The course will be given in English

Aim

The student shall aquire a toolbox containing concepts and models for description and handling of stationary stochastic processes within many different areas, such as, signal processing, automatic control, information theory, economics, biology, chemistry, and medicine. The mathematical and statistical elements are therefore illustrated using a wide variety of examples from different areas of application.

The course shall also give the student the ability to identify the presence of stationary processes in other courses in the education, use the knowledge of stationary processes in other courses, and translate the concepts and tools between different courses, building on stationary processes.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to perform calculations using expectations, variance, covariance, and cross-covariance within and between different stationary processes,
- be able to calculate the relationship between covariance properties in the timedomain

and spectral properties in the frequency domain for one and several processes,
- be able to formulate linear filters using covariance and spectral properties,
- be able to estimate covariance function, spectrum, and other parameters in stationary processes using data.
- Model observational data as a simple stochastic process.

Competences and skills
For a passing grade the student must

- be able to identify natural situations where a stationary process is a suitable mathematical model, e.g., within at least one engineering, science, or economics application,
- be able to formulate a stationary stochastic process model using a concrete problem within the chosen application,
- be able to suggest model parameters, with the help of data,
- be able to interpret the model and translate model concepts to a conclusion regarding the original problem.

Judgement and approach
For a passing grade the student must

- be able to read and interpret technical literature with elements of stationary processes within the chosen application,
- be able to describe the model structure and the conclusions,
- be able to describe the possibilities and limitations of stochastic models.

Contents

- Models for stochastic dependence.
- Concepts of description of stationary stochastic processes in the time domain: expectation, covariance, and cross-covariance functions.
- Concepts of description of stationary stochastic processes in the frequency domain: effect spectrum, cross spectrum.
- Special processes: Gaussian process, Wiener process, white noise, Gaussian fields in time and space.
- Stochastic processes in linear filters: relationships between in- and out-signals, auto regression and moving average (AR, MA, ARMA), derivation and integration of stochastic processes.
- The basics in statistical signal processing: estimation of expectations, covariance function, and spectrum.
- Application of linear filters: frequency analysis and optimal filters.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written exam and compulsory computer exercises.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0115. **Name:** Examination.

Credits: 6. **Grading scale:** TH. **Assessment:** Written examination.
Code: 0215. **Name:** Laboratory part 1.
Credits: 0,5. **Grading scale:** UG. **Assessment:** The first computer exercise
Code: 0315. **Name:** Laboratory part 2.
Credits: 1. **Grading scale:** UG. **Assessment:** The rest of the computer exercises

Admission

Admission requirements:

- FMAA20 Linear Algebra with Introduction to Computer Tools or FMAA21 Linear Algebra with Numerical Applications or FMAB20 Linear Algebra or FMSF20 Mathematical Statistics, Basic Course or FMSF25 Mathematical Statistics - Complementary Project or FMSF32 Mathematical Statistics or FMSF45 Mathematical Statistics, Basic Course or FMSF50 Mathematical Statistics, Basic Course or FMSF55 Mathematical Statistics, Basic Course or FMSF70 Mathematical Statistics or FMSF75 Mathematical Statistics, Basic Course or FMSF80 Mathematical Statistics, Basic Course
- FMAB30 Calculus in Several Variables or FMAB35 Calculus in Several Variables or FMSF20 Mathematical Statistics, Basic Course or FMSF25 Mathematical Statistics - Complementary Project or FMSF32 Mathematical Statistics or FMSF45 Mathematical Statistics, Basic Course or FMSF50 Mathematical Statistics, Basic Course or FMSF55 Mathematical Statistics, Basic Course or FMSF70 Mathematical Statistics or FMSF75 Mathematical Statistics, Basic Course or FMSF80 Mathematical Statistics, Basic Course

Assumed prior knowledge: A basic course in mathematical statistics and knowledge in complex and linear analysis.
The number of participants is limited to: No
The course overlaps following course/s: FMS045, FMS047, MASC04, MASC14

Reading list

- Lindgren, G., Rootzén, H., Sandsten, M.: Introduction to Stationary Stochastic Processes: Applications in Science and Engineering. Chapman & Hall, 2013, ISBN: 9781466586185.

Contact and other information

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Course homepage:
https://www.maths.lu.se/utbildning/civilingenjoersutbildning/matematisk-statistik-paa-civilingenjoersprogram/
Further information: Also given at the faculty of science with the course code MASC14.