Course syllabus

Mathematical Statistics, Time Series Analysis
Matematisk statistik, tidsserieanalys

FMSN45, 7.5 credits, A (Second Cycle)

Valid for: 2025/26
Faculty: Faculty of Engineering LTH
Decided by: PLED I
Date of Decision: 2025-03-28
Effective: 2025-05-05

General Information

Depth of study relative to the degree requirements: Second cycle, in-depth level of the course cannot be classified
Elective for: BME4-sbh, C4-ks, D4-ssr, E4-sb, F4, F4-bg, F4-bm, F4-fm, F4-r, F4-ss, F4-mai, I4-fir, MMSR2, Pi4-fm, Pi4-ssr, Pi4-biek, Pi4-bam, R4
Language of instruction: The course will be given in English

Aim

Practical and theoretical knowledge in modelling, estimation, validation, prediction, and interpolation of time discrete dynamical stochastic systems, mainly linear systems. The course also gives a basis for further studies of time series systems, e.g. Financial statistics and Non-linear systems.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to construct a model based on data for a concrete practical time series problem,
- be able to perform simple transformations of a non-stationary time series into a stationary time series,
- be able to predict and interpolate in linear time series models,
- be able to estimate parameters in linear time series models and validate a resulting model,

- be able to construct a Kalman-filter based on a linear state model,
- be able to estimate in time varying stochastic systems using recursive and adaptive techniques.

Competences and skills
For a passing grade the student must

- be able to present the analysis of a practical problem in a written report and present it orally.

Contents

Time series analysis concerns the mathematical modelling of time varying phenomena, e.g., ocean waves, water levels in lakes and rivers, demand for electrical power, radar signals, muscular reactions, ECG-signals, or option prices at the stock market. The structure of the model is chosen both with regard to the physical knowledge of the process, as well as using observed data. Central problems are the properties of different models and their prediction ability, estimation of the model parameters, and the model's ability to accurately describe the data. Consideration must be given to both the need for fast calculations and to the presence of measurement errors. The course gives a comprehensive presentation of stochastic models and methods in time series analysis. Time series problems appear in many subjects and knowledge from the course is used in, i.a., automatic control, signal processing, and econometrics.

Further studies of ARMA-processes. Non-stationary models, slowly decreasing dependence. Transformations. Optimal prediction and reconstruction of processes. State representation, principle of orthogonality, and Kalman filtering. Parameter estimation: Least squares and Maximum likelihood methods as well as recursive and adaptive variants. Non-parametric methods,covariance estimation, spectral estimation. An orientation on robust methods and detection of outliers.

Examination details

Grading scale: TH - (U, 3, 4, 5) - (Fail, Three, Four, Five)
Assessment: Written and oral project presentation, and compulsory computer exercises. The final grade is based on the project with bonus assignments for higher grade.

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.

Modules
Code: 0120. **Name:** Computer Work 1.
Credits: 0.5. **Grading scale:** UG - (U, G). **Assessment:** Computer exercise 1
Code: 0220. **Name:** Computer Work 2.
Credits: 0.5. **Grading scale:** UG - (U, G). **Assessment:** Computer exercise 2 och 3
Code: 0320. **Name:** Project Work and Home Exam.
Credits: 6.5. **Grading scale:** TH - (U, 3, 4, 5). **Assessment:** Written and oral project report for passing grade; written take-home exam for higher grades.

Admission

Admission requirements:

- FMSF10 Stationary Stochastic Processes **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: FMSF10 Stationary Stochastic Processes.
The number of participants is limited to: No
Kursen överlappar följande kurser: FMS051 MASM17

Reading list

- Andreas Jakobsson: An Introduction to Time Series Modeling. Studentlitteratur, 2021, ISBN: 9789144158945. Minor differences with previous editions.

Contact

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Course homepage: https://www.maths.lu.se/utbildning/civilingenjoersutbildning/matematisk-statistik-paa-civilingenjoersprogram/

Further information

The course is also given at the faculty of science with the code MASM17.