



**LUNDS UNIVERSITET**  
Lunds Tekniska Högskola

*Course syllabus*

# **Stationär och icke-stationär spektralanalys**

## **Stationary and Non-stationary Spectral Analysis**

**FMSN35, 7,5 credits, A (Second Cycle)**

**Valid for:** 2023/24

**Faculty:** Faculty of Engineering, LTH

**Decided by:** PLED I

**Date of Decision:** 2023-04-14

### **General Information**

**Elective for:** BME4, C4, D4, E4-ss, F4, F4-ss, I4, Pi4-ssr, Pi4-biek

**Language of instruction:** The course will be given in English

### **Aim**

This course is aimed at those who want to broaden and deepen their knowledge in statistical signal processing and expand their toolkit with more advanced techniques. It lies on the border between statistics and signal processing and builds on the classical non-parametric methods that are wellknown and taught in, e.g. Stationary stochastic processes or Optimal signal processing. Since these methods are not always sufficient we need more advanced techniques in many application areas, e.g. communications or medicine.

Hence, the course covers more statistically robust methods that have become increasingly used in recent years, e.g. time-frequency analysis, which is a modern method for analysis of non-stationary signals and processes. The research in this area has expanded during the last 20 years, making this a commonly used tool.

Many applications will be presented in the course and the participants will work with real world data.

### **Learning outcomes**

*Knowledge and understanding*

For a passing grade the student must

- interpret and understand parametric and non-parametric spectral estimation methods.
- interpret and understand spatial spectral analysis and classical estimation techniques of directions.
- interpret and understand time-frequency analysis and classical estimation techniques of non-stationary spectra.

### *Competences and skills*

For a passing grade the student must

- be able to estimate classical parametric and non-parametric spectral estimates.
- be able to estimate spectra of non-uniformly sampled sequences.
- be able to use classical time-frequency methods for estimation.

## Contents

Basic definitions. Extended studies of AR (auto regressive), MA (moving average) och ARMA-processes. Linespectra and parametric estimation methods. Noise-space based techniques. Non-parametric spectral estimators, data-adaptive techniques and multitaper methods. Non-uniform sampling. Orientation of circular and non-circular processes. Spatial spectral analysis. Non-stationary processes. Spectrogram. Wigner-Ville distribution. Cohen class. Ambiguity spectrum. Multitaper techniques for non-stationary signals. Orientation about bispectrum.

## Examination details

**Grading scale:** TH - (U,3,4,5) - (Fail, Three, Four, Five)

**Assessment:** Approved assignments and project report as well as participation in all compulsory parts. The final grade is given by a summary of the results on the assignments and the written and oral project report.

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:** 0116. **Name:** Computer Exercises.

**Credits:** 3. **Grading scale:** UG. **Assessment:** Project with written and oral report

**Code:** 0216. **Name:** Assignments Part 1.

**Credits:** 1. **Grading scale:** UG. **Assessment:** The first home assignment

**Code:** 0316. **Name:** Assignments Part 2.

**Credits:** 3,5. **Grading scale:** UG. **Assessment:** The rest of the home assignments

## Admission

**Admission requirements:**

- FMSF10 Stationary Stochastic Processes

**Assumed prior knowledge:** FMSN45 Time series analysis

**The number of participants is limited to:** No

**The course overlaps following course/s:** MASM26

## Reading list

- P. Stoica and R. Moses: Spectral analysis of signals. Prentice-Hall, 2005, ISBN: 0-13-113956-8.
- M. Sandsten: Lecture notes, Time-frequency analysis. 2011.

## Contact and other information

**Course coordinator:** Prof Andreas Jakobsson, [andreas.jakobsson@matstat.lu.se](mailto:andreas.jakobsson@matstat.lu.se)

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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 Science faculty with the code MASM26