Faculty of Science

MASM26, Mathematical Statistics: Stationary and Non-stationary Spectral Analysis, 7.5 credits

Matematisk statistik: Stationär och icke stationär spektralanalys, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2007-01-31 (N2007148) and was last revised on 2025-12-05 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2025-12-05 and is valid from the autumn semester 2026.

General information

The course is an elective course for second-cycle studies for a Master of Science in Mathematical statistics.

Language of instruction: Swedish and English

Main field of study	*Specialisation*
Mathematics	A1F, Second cycle, has second-cycle course/s as entry requirements
Mathematical Statistics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

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 well-known 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 resent 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.

The aim of the course is that students on completion of the course should have acquired the following knowledge and skills:

Knowledge and understanding

On completion of the course, the students are expected to be able to:

- 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.

Competence and skills

On completion of the course, the students are expected to be able to:

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

Course content

- Basic definitions,
- Extended studies of AR (auto regressive),
- MA (moving average) and ARMA-processes,
- Line-spectra and parametric estimation methods,
- Noise-space based techniques,
- Non-parametric spectral estimators, data-adaptive techniques and multi-taper 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,
- Multi-taper techniques for non-stationary signals,
- Orientation about bi-spectrum.

Course design

Teaching consists of lectures and computer exercises. Participation in computer exercises and thereby integrated teaching is compulsory.

Assessment

Assessment takes the form of computer exercise reports (3 credits) during the course and written and orally by project report (4,5 credits) at the end of the course.

Students who fail the regular exam are offered a re-examination shortly afterwards.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
For passing grade on the entire course approved laboratory work and project report as well as participation in all compulsory parts are required.

The final grade is given by a summary of the results on the written and oral project report.

Entry requirements

For admission to the course knowledge equivalent to the courses MASC14, Stationary Stochastic processes, 7.5 credits and MASM17, Mathematical Statistics: Time series analysis, 7.5 credits are required together with English B.

Further information

The course is given by Centre for Mathematical Sciences, Lund University.

The course is read together FMSN35 Stationary and Non-stationary Spectral Analysis, 7.5 credits which is a course given by Lund's engineering school LTH.

The examination of the course is scheduled according to LTH:s exam schedule.