Faculty of Science

MASC14, Mathematical Statistics: Stationary Stochastic Processes, 7.5 credits

Matematisk statistik: Stationära stokastiska processer, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2022-12-05 to be valid from 2022-12-05, autumn semester 2023.

General Information

The course is an elective course for first-cycle studies for a degree of Bachelor of Science in Mathematics, as well as a compulsory course on basic level for a degree of Master of Science in Computational Science with specialisation in Scientific Computing and is an alternative compulsory course for a degree of Master of Science in Computational Science with specialisation in Geoscience.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics	G1F, First cycle, has less than 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The aim of the course is that the student shall acquire 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.

Knowledge and understanding

On completion of the course, the student shall be able to:

- perform calculations using expectations, variance, covariance, and cross-covariance within and between different stationary processes,
- explain the relationship between covariance properties in the time domain and spectral properties in the frequency domain for one and several processes,
- formulate linear filters using covariance and spectral properties,
- explain covariance function, spectrum, and other parameters in stationary processes using data.

Competence and skills

On completion of the course, the student shall be able to:

- estimate covariance function, spectrum, and other parameters in stationary processes using data.
- calculate the relationship between covariance properties in the time domain and spectral properties in the frequency domain for one and several processes,
- identify natural situations where a stationary process is a suitable mathematical model, e.g., within at least one engineering, science, or economics application,
- formulate a stationary stochastic process model using a concrete problem within the chosen application as defined above,
- suggest model parameters, with the help of data,
- interpret the model and translate model concepts to a conclusion regarding the original problem.

Judgement and approach

On completion of the course, the student shall be able to:

- read and interpret technical literature with elements of stationary processes within the chosen application as defined above,
- discuss the model structure and the conclusions,
- evaluate the possibilities and limitations of stochastic models.

Course content

The course covers:

- 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), derivatives and integrals 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.

Course design

Teaching consists of lectures, exercises and computer exercises. Participation in computer exercises is compulsory.

Assessment

Examination consists of a written exam at the end of the course, and computer exercises during the course.

Students who did not pass an assessment in the regular session will be offered another opportunity for assessment during the scheduled period for resits according to the LTH exam-schedule..

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.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a passing grade on the entire course a passed written exam, passed computer exercises and participation in compulsory parts are required.

The grading scale for the computer exercises are Fail and Pass, whereas the written exam is graded according to the scale Fail, Pass, Pass with Distinction.

The final grade is determined by the grade on the written exam.

Entry requirements

General eligibility and knowledge corresponding to MASA02 Mathematical statistics: Basic course, 15 ECTS (the courses MASB13 Mathematical Statistics for Physicists 7.5 ECTS, and MASB02 Mathematical Statistics for Chemists 7.5 ECTS, are also valid for eligibility). English course 6/B.

Further information

The course replaces MASC04 Stationary stochastic processes 7.5 credits and cannot be counted in a degree together with this course.

The course is studied together with FMSF10 Stationary stochastic processes 7.5 credits, which is a course at Lund University's Faculty of Engineering, LTH.

The course is assessed according to the LTH exam schedule.

The course is offered at the Centre for Mathematical Sciences, Lund University.

Subcourses in MASC14, Mathematical Statistics: Stationary Stochastic Processes

Applies from H23

2301 Exam, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction
Written exam.

2302 Computer exercise part 1, 0,5 hp
Grading scale: Fail, Pass

2303 Computer exercise part 2, 1,0 hp
Grading scale: Fail, Pass