Faculty of Science

MASC13, Mathematical Statistics: Markov Processes, 7.5 credits

Matematisk statistik: Markovprocesser, 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 an alternative- compulsory course on basic level for a degree of Master of Science in Computational Science with specialisation in Scientific Computing and 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 this course is to give the student the basic concepts and methods for Poisson processes, discrete Markov chains and processes, and also the ability to apply them. The course presents examples of applications in different fields, in order to facilitate the use of the knowledge in other courses where Markov models appear.

Knowledge and understanding

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

- explain the Markov property and the intensity concept,
- explain the concepts of recurrence, communication, stationary distribution, and how they relate to each other,
- explain stationary distributions and absorption times for discrete Markov chains and processes,

- give account of the suitability of the Poisson process as a model for rare events.

Competence and skills

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

- construct a model graph for a Markov chain or process describing a given system, and use the model for studying the system,
- perform calculations of stationary distributions and absorption times for discrete Markov chains and processes,
- perform calculations of probabilities using the properties of the Poisson process in one and several dimensions,
- in connection with problem solving, show ability to integrate knowledge from the different parts of the course,
- read and interpret basic literature with elements of Markov models and their applications.

Judgement and approach

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

- identify problems that can be solved using Markov models, and choose an appropriate method.

Course content

Markov chains and processes are a class of models which, apart from a rich mathematical structure, also has applications in many disciplines, such as telecommunications and production (queue and inventory theory), reliability analysis, financial mathematics (e.g., hidden Markov models), automatic control, and image processing (Markov fields).

The course covers:

- Markov chains: model graphs.
- Markov property, transition probabilities, persistent and transient states, positive and null persistent states, communication, existence and uniqueness of stationary distribution, and calculation thereof, absorption times.
- Poisson process: Law of small numbers, counting processes, event distance, non-homogeneous processes, diluting and super positioning, processes on general spaces.
- Markov processes: transition intensities, time dynamic, existence and uniqueness of stationary distribution, and calculation thereof, birth-death processes, absorption times.
- Introduction to renewal theory and regenerative processes.

Course design

Teaching consists of lectures, exercises and computer exercises. Participation in computer exercises and with this integrated teaching 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 grades awarded for the computer exercises are Fail and Pass. The grade on the written exam is 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 MASC03 Markov processes 7.5 credits and cannot be counted in a degree together with this course.

The course is studied together with FMSF15 Markov 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 MASC13, Mathematical Statistics: Markov Processes

Applies from H23

2301 Exam, 6,5 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, 0,5 hp
Grading scale: Fail, Pass