Faculty of Science

# MASM34, Mathematical Statistics: Valuation of Derivative Assets, 7.5 credits

*Matematisk statistik: Prissättning av derivattillgångar, 7,5 högskolepoäng*

**Second Cycle / Avancerad nivå**

## Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2023-09-10 to be valid from 2023-09-10, autumn semester 2024.

## General Information

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

*Language of instruction:* English

| *Main field of studies* | *Depth of study relative to the degree requirements* |
|---|---|
| Mathematical Statistics | A1N, Second cycle, has only first-cycle course/s as entry requirements |
| Mathematics | A1N, Second cycle, has only first-cycle course/s as entry requirements |

## Learning outcomes

The aim of the course is that students on completion of the course should have learned the principals of arbitrage valuation of options as well the mathematical tools required to do so.

### Knowledge and understanding

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

- understand the fundamental economical concepts : Financial contract/Contingent claim, Self financing portfolio, Arbitrage, Replicating portfolio/Hedge and Complete market,

- understand the tools and concepts from stochastic calculus: martingales, Itô's formula, Itô isometry, Feynman-Kac representation, change of measure (Girsanov transformation) and change of numeraire,
- understand how the basic financial contracts work and how they relate to each other, e.g., European and Asian options, Forward contracts, zero coupon bonds, coupon bond, LIBOR and interest rate swap.

### Competence and skills

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

- use the fundamental financial concepts to express relations between various financial contracts,
- use the tools and concepts from stochastic calculus to price financial contracts assuming specific models for the underlying assets. This especially includes the ability to use, derive and understand the Black-Scholes formula as well as the ability of extending it to similar contracts,
- use Monte Carlo methods to price financial derivatives. Here the student should be able to use various variance reduction techniques such as antithetic variables, control variates and importance sampling. This part of the course is assessed in the home assignments and compulsory computer exercises.

### Judgement and approach

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

- apply a mathematical point of view on financial contracts,
- from a financial and a mathematical perspective, judge what a reasonable valuation of a financial contract should fulfil.

## Course content

The course consists of two related parts. In the first part we will look at option theory in discrete time. The purpose is to quickly introduce fundamental concepts of financial markets such as free of arbitrage and completeness as well as martingales and martingale measures. We will use tree structures to model time dynamics of stock prices and information flows.

In the second part we will study models formulated in continuous time. The models we focus on are formulated as stochastic differential equations (SDE:s). The theories behind Brownian motion, stochastic integrals, Ito's formula, measures changes and numeraires are presented and applied to option theory both for the stock and the interest rate markets. We prove the  Black Scholes partial differential equation and how that leads to the Black-Scholes formula as well as how to create a replicating portfolio for a derivative contract.

## Course design

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

## Assessment

The examination is done by a written exam as well as computer exercises and and a home assignment 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.

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 passing grade on the entire course passed home assignments, computer exercises and written exam are required.

The grades awarded for the computer exercises and home assignment are Fail and Pass. The grade on the written exam is
Fail, Pass, Pass with distinction. The final grade is the grade on the written exam.

## Entry requirements

For admission to the course knowledge equivalent to the courses MASA02, Mathematical Statistics: Basic Course, 15 credits and at least one MASC03, Markov processes, 7.5 credits or MASC14 Stationary stochastic processes 7.5 credits are required together with English B.

## Further information

The course replaces MASM24 Valuation of derivative assets and may not be included in a higher education qualification with this course.

The course is read together FMSN25 Valuation of derivative assets which is a course given by Lund's engineering school LTH.

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

# Subcourses in MASM34, Mathematical Statistics: Valuation of Derivative Assets

Applies from H24

2401 Exam, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction
Written exam.

2402 Laboratory Work part 1, 0,5 hp
Grading scale: Fail, Pass
Computer lab 1.

2403 Laboratory Work part 2, 1,0 hp
Grading scale: Fail, Pass
Computer lab 2 and written home assignment.