Department of Mathematics
(incl. Math. Statistics)

Stockholm University

Syllabus

for course at advanced level

Computational Methods for Stochastic Differential Equation
Beräkningsmetoder för stokastiska differentialekvationer

7.5 Higher Education Credits
7.5 ECTS credits

Course code:	BE7006
Valid from:	Autumn 2019
Date of approval:	2007-08-28
Changed:	2007-08-28
Department	Department of Mathematics (incl. Math. Statistics)
Main field:	Scientific Computing
Specialisation:	A1N - Second cycle, has only first-cycle course/s as entry requirements

Decision

This syllabus has been approved by the Board of the Faculty of Science at Stockholm University, August 28, 2007.

Prerequisites and special admittance requirements

For course admission knowledge equivalent to Applied Numerical Methods, FL, 9 HECs (BE3007), is required. English B/English 6 from Upper Secondary School level.

Course structure

Examination code	Name	Higher Education Credits
SAKU	All Course Items	7.5

Course content

The course covers stochastic differential equations and their numerical solution, with applications in financial mathematics, turbulent diffusion, control theory and Monte Carlo methods. Basic questions for solving stochastic differential equations are discussed, e.g. to determine the price of an option is it then more efficient to solve the deterministic Black and Scholes partial differential equation or to use a Monte Carlo method based on stochastics. Basic theory of stochastic differential equations, including weak and strong approximation, efficient numerical methods and error estimates, the relation between stochastic differential equations and partial differential equations, stochastic partial differential equations, variance reduction.

Learning outcomes

It is expected that the student after taking the course will be able to:
• present some models in science and technology based on stochastic differential equations, and evaluate methods to determine their solution
• derive and use the correspondence between expected values of stochastic diffusion processes and solutions to certain deterministic partial differential equations
• formulate, use and analyse the main numerical methods for stochastic differential equations, based on Monte Carlo stochastics and partial differential equations
• formulate some stochastic and deterministic optimal control problems in science and technology using differential equations and Markov chains
• formulate, use and analyse deterministic and stochastic optimal control problems using both differential equations constrained minimization, and dynamic programming, leading to the Hamilton-Jacobi-Bellman nonlinear partial differential equations

• derive the Black-Scholes equation for options in mathematical finance and analyse the alternatives to determine option prices numerically
• determine and analyse reaction rate problems for stochastic differential equation with small noise using optimal control theory

Education
The education consists of lectures, practical exercises, and project with presentation.

Participation in the practical exercises is compulsory. The examiner may rule that a student is not obliged to participate in certain compulsory education, if there are special grounds for this, after consultation with the relevant teacher.

Forms of examination
a. Examination for the course is in the following manner: measurement of knowledge takes place through written and/or oral examination and through written and/or oral presentations of projects.

b. Grading is carried out according to a 7-point scale related to learning objectives:
A = Excellent
B = Very Good
C = Good
D = Satisfactory
E = Sufficient
Fx = Fail
F = Fail

c. Grading criteria for the course will be distributed at the start of the course.

d. A minimum grade of E is required to pass the course, together with completion of practical exercises and participation in all compulsory education.

e. Students who fail to achieve a pass grade in an ordinary examination have the right to take at least further four examinations, as long as the course is given. The term “examination” here is used to denote also other compulsory elements of the course. Students who have achieved a pass grade on an examination may not retake this examination in order to attempt to achieve a higher grade. Students who have failed to reach a pass grade on two occasions have the right to request that a different teacher be appointed to set the grade of the course. A request for such appointment must be sent to the departmental board.

Interim
Students may request that the examination is carried out in accordance with this syllabus even after it has ceased to apply. This right is limited, however, to a maximum of three occasions during a two-year-period after the end of giving the course. A request for such examination must be sent to the departmental board.

Limitations
The course may not be included in a degree together with the course Mathematical Models, Analysis and Simulation, part 2, Advanced Course (BT3120), or the equivalents.

Misc
The course is given as an individual course

Required reading
Course literature is decided by the departmental board and is described in an appendix to the syllabus.