



**PROPOSAL TO MODERNISE THE BSc PROGRAMME AND MSc  
PROGRAMME IN ACTUARIAL MATHEMATICS**

15 OCTOBER 2021

This document serves to announce a proposal to modernise the BSc Programme and MSc Programme in Actuarial Mathematics. The proposal has been discussed and is supported within the Section for Insurance and Economics. It is part of a larger modernisation process of various BSc and MSc programmes at the Department of Mathematical Sciences. The proposed changes are yet to be presented to and approved by the Study Board of Mathematics and Computer Science. It is my intent to seek the changes outlined here approved and brought into effect for students admitted at least from the academic year 2022/23 and onwards.

The proposal is strictly speaking only concerned with the compulsory subject elements of the programme. It builds on the current *Den uddannelsesspecifikke del af studieordningen for bacheloruddannelsen i forsikringsmatematik* [Programme-specific Section of the Curriculum for the BSc programme in Actuarial Mathematics], the current *Programme-specific Section of the Curriculum for the MSc Programme in Actuarial Mathematics*, as well as current course descriptions.

**Structure of the BSc Programme**

The programme currently consists of compulsory subject elements (150 ECTS), elective subject elements (15 ECTS), and a thesis (15 ECTS).

It is proposed that three of the current compulsory subject elements of each 7.5 ECTS, namely *Stochastic Processes*, *Stochastic Processes 2*, and *Stochastic Processes 3*, be replaced by the following three compulsory elements:

- Stochastic Processes in Discrete Time (Sand2, 7.5 ECTS)
- Finance 1 (Fin1, 7.5 ECTS)
- Regression (Reg, 7.5 ECTS).

While *Stochastic Processes in Discrete Time* is a new subject element, *Finance 1* and *Regression* were hitherto elective elements.

It is furthermore proposed that the current compulsory subject element *Mathematical Statistics* of 15 ECTS be split into two compulsory subject elements of each 7.5 ECTS and with comparable content. We also intend to modernise the contents of one of the current compulsory subject elements, namely *Accounting and Law (Regn&Jura2, 7.5 ECTS)*.

### **Structure of the MSc Programme**

The programme currently consists of compulsory subject elements (45 ECTS), restricted elective subject elements (15 ECTS), elective subject elements (30 ECTS), and a thesis (30 ECTS).

It is proposed that two of the current six compulsory subject elements of each 7.5 ECTS be replaced by the following two new compulsory elements:

- Stochastic Processes in Continuous Time (StokKont, 7.5 ECTS)
- Statistics for Stochastic Processes (StatStok, 7.5 ECTS).

Furthermore, we intend to modernise the contents of the four compulsory subject elements that I propose preserved.

### **Content for compulsory subjects elements**

The following provides outlines of the course contents of the new compulsory BSc subject element and of the two new compulsory MSc subject elements as well as modernised outlines of the course contents of the compulsory BSc subject element *Accounting and Law* and four compulsory MSc subject elements that I propose preserved.

#### *Stochastic Processes in Discrete Time (Sand2, 7.5 ECTS)*

- Brief introduction to Hilbert space theory
- Conditional expectations including conditional distributions and conditional independence
- Radon-Nikodym theorem
- Filtrations and adapted processes
- Martingales, submartingales, and supermartingales
- Stopping times and related concepts
- Markov processes in discrete time

#### *Accounting and Law (Regn&Jura2, 7.5 ECTS)*

- Financial systems: role, structure, participants, and stability
- Accounting rules and regulation
- International accounting standards
- Solvency rules and regulation
- International solvency standards

*Stochastic Processes in Continuous Time (StokKont, 7.5 ECTS)*

PAGE 3 OF 4

- Fundamental concepts
- Brownian motions
- Martingales
- Itô integrals and calculus
- Stochastic differential equations
- Girsanov's theorem and likelihoods
- Outlook: Jump diffusions.

*Statistics for Stochastic Processes (StatStok, 7.5 ECTS)*

- Multivariate counting processes
- Independent filtering, including independent right censoring
- Non-parametric and semiparametric estimation: Nelson-Aalen estimator and hazard rate smoothing (graduation)
- Parametric estimation and regression models: Maximum (partial) likelihood estimation and Poisson regressions
- Claims reserving via continuous chain ladder models.

*Topics in Non-Life Insurance (Skade2, 7.5 ECTS)*

- Distributions in non-life insurance
- Maximum (partial) likelihood methods, including asymptotic properties
- Deductibles, including Pareto regression with deductibles
- Model selection methods
- Insurance data analysis, including implementation in R
- Claims reserving via classic chain ladder models and machine learning.

*Continuous Time Finance (FinKont, 7.5 ECTS)*

- Portfolio theory, self-financing strategies
- Arbitrage pricing and hedging, including:
  - First and second fundamental pricing theorems
  - Martingale representation and Girsanov's theorem
  - One- and multidimensional models, e.g. Black-Scholes
- Incomplete markets
- Fixed income theory, including:
  - Bonds, interest rates, short rates, and forward rates
  - Martingale and forward rate models, including affine term structure models
- Change of numeraire.

*Quantitative Risk Management (QRM, 7.5 ECTS)*

- Risk measures, including Value-at-Risk, Expected Shortfall, and Tail Value-at-Risk
- Extreme Value Theory, including the Hill estimator and the POT method

- Multivariate distributions and dependence, including elliptical distributions and copulas
- Credit risk modelling
- Operational risk, climate risk, and cyber risk.

PAGE 4 OF 4

*Topics in Life Insurance (Liv2, 7.5 ECTS).*

- Markovian jump processes, jump processes with duration dependency (semi-Markovianity), and associated multivariate counting processes
- Payment processes, expected cash flows, and (prospective) reserves
- Semi-Markov models
- Inclusion of financial risk, in particular
  - With-profit (participating) contracts
  - Unit linked contracts
- Incidental modelling of policyholder behaviour.

Head of studies David Glavind Skovmand

18-10-21



---

*date and signature*