TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

Module handbook for the Master's degree programme Financial Engineering at Technische Universität Kaiserslautern (hereinafter referred to as TUK)

Last updated: WS 2019/20

Table of contents

In the following, on-campus hours describe the time spent in the context of on-campus phases at TUK, but also time spent through participation in online tutorials or online presentations which do not require being present at TUK in person.

Introduction to Financial Mathematics

Module ID:	Module coordinator:		Lecturers and authors:	
M1	Prof. Dr Jörn Saß		Dr Martin Bracke, Dr Sascha Desmettre, Prof. Dr Jörn Saß, Dr Stefanie Schwaar, scientific staff of the study programme	
Total workload:	Credit points (CP):	Recommended semester:	Duration of the module:	Module frequency:
150 h	6 CP	1. semester	1 semester	Winter semester

	Courses (module components)	On-campus hours	Self-study hours	CP	Frequency
1.	Probability Concepts for Finance	10 h	102.5 h	4.5	Winter semester
	Probability Concepts for Finance Lab Course	8 h	29.5 h	1.5	Winter semester

2. Classification within the curriculum:

Compulsory

3. Content:

- Modelling of discrete-time financial markets
- Applications of concepts of probability theory: Conditional expectation, martingales, stopping times, change of measure
- Binomial model
- Theory of pricing in discrete-time financial markets
- Pricing of European options
- Pricing of American options
- Introduction to Matlab for stochastic problems

4. Competencies/learning outcomes:

The students have learned to formulate and develop mathematically precise financial mathematical discrete-time models with the concepts of the measure-theoretical probability theory. They have prepared concepts of discrete-time stochastic processes from probability theory and learned to apply them to financial mathematical questions. They have developed the basic principles of price theory in discrete-time financial market models and can apply the methods to various types of financial derivatives. They can also implement such methods.

5. Requirements for participation in the module:

Formally:	None
Content-wise:	None

6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Mail-in exercises
	Coursework:	Active participation during on-campus phases
	Preliminary examination(s):	None
7.	Module grade: This module is ungraded.	
8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	N.H. Bingham, R. Kiesel: Risk-Neutral Valuation: Pricing and Hedging of Financial Derivatives, J. Jacod, P. Protter: Probability Essentials, S. Pliska: Introduction to Mathematical Finance, S. Shreve: Stochastic Calculus for Finance I: The Binomial Asset Pricing Model.
	Learning materials and/or other materials:	Learning material: „Probability Concepts for Finance” and “Introduction to MATLAB for Probability and Statistics“
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

<table>
<tr><th colspan="7">Insurance Mathematics</th></tr>
<tr><td colspan="2">Module ID:</td><td colspan="2">Module coordinator:</td><td colspan="3">Lecturers and authors:</td></tr>
<tr><td colspan="2">M2</td><td colspan="2">Prof. Dr Jörn Saß</td><td colspan="3">Dr Sascha Desmettre, Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, scientific staff of the study programme</td></tr>
<tr><td colspan="2">Total workload:</td><td>Credit points (CP):</td><td>Recommended semester:</td><td colspan="2">Duration of the module:</td><td>Module frequency:</td></tr>
<tr><td colspan="2">225 h</td><td>9 CP</td><td>1. semester</td><td colspan="2">1 semester</td><td>Winter semester</td></tr>
</table>

<table>
<tr><td rowspan="2">1.</td><td>Courses
(module components)</td><td>On-campus hours</td><td>Self-study hours</td><td>CP</td><td>Frequency</td></tr>
<tr><td>Insurance Mathematics</td><td>4 h</td><td>221 h</td><td>9</td><td>Winter semester</td></tr>
<tr><td>2.</td><td colspan="5">Classification within the curriculum:
Compulsory</td></tr>
<tr><td>3.</td><td colspan="5">Content:
Life Insurance Mathematics:
• Elementary financial mathematics (calculation of interest)
• Mortality
• Insurance benefits
• Net premiums and net actuarial reserves
• Inclusion of costs
• Multiple life insurance
• Multiple decrements
Non-Life Insurance Mathematics:
• Convolution and transforms
• Claim size distribution
• Individual risk model
• Collective risk models
• Total claim size distribution
• Models for claim number process
• Risk process
• Ruin theory and ruin probabilities
• Premium calculation
• Experience rating
• Reserves
• Reinsurance and risk sharing</td></tr>
<tr><td>4.</td><td colspan="5">Competencies/learning outcomes:
The students have acquired basic knowledge in the mathematical and practical basics of classical life insurance mathematics. They can use the knowledge they have acquired to evaluate and deter-</td></tr>
</table>

	mine life insurance products, their cash flows and the actuarial reserves of various insurance benefits. In addition, the students have acquired a sound overview of the modelling of claim sizes, time of loss and the reserve process within the framework of the generalised Cramer-Lundberg model in non-life insurance mathematics. They understand the mathematical foundations of ruin theory and premium calculation. They have become acquainted with the basic features of experience rating as well as the concepts of loss reserves and reinsurance and are able to critically question them. The students have worked out a safe, precise and independent handling of the terms, statements and methods of the learning material. They understand the arguments presented in the learning materials and are able to transfer them to similar problems.	
5.	Requirements for participation in the module:	
	Formally:	None
	Content-wise:	None
6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Written test (90 to 120 minutes)
	Coursework:	Successful preparation of mail-in exercises
	Preliminary examination(s):	Successful preparation of mail-in exercises
7.	Module grade: The grade of the module examination is also the module grade.	
8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	H. Bühlmann: Mathematical Methods in Risk Theory, H. Bühlmann, A. Gisler: A Course in Credibility Theory and its Applications, H.U. Gerber: Life Insurance Mathematics, R. Kaas, M. Goovaerts, J. Dhaene, M. Denuit: Modern Actuarial Risk Theory, M. Koller: Stochastic Models in Life Insurance, T. Mikosch: Non-Life Insurance: An Introduction with the Poisson Process, E. Straub: Non-Life Insurance Mathematics.
	Learning materials and/or other materials:	Learning material
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

<table>
<tr><th colspan="8">Financial Mathematics</th></tr>
<tr><td colspan="2">Module ID:</td><td colspan="2">Module coordinator:</td><td colspan="4">Lecturers and authors:</td></tr>
<tr><td colspan="2">M3</td><td colspan="2">Prof. Dr Jörn Saß</td><td colspan="4">Dr Sascha Desmettre, Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, scientific staff of the study programme</td></tr>
<tr><td colspan="2">Total workload:</td><td>Credit points (CP):</td><td>Recommended semester:</td><td colspan="3">Duration of the module:</td><td>Module frequency:</td></tr>
<tr><td colspan="2">225 h</td><td>9 CP</td><td>2. semester</td><td colspan="3">1 semester</td><td>Summer semester</td></tr>
<tr><td rowspan="2">1.</td><td colspan="3">Courses (module components)</td><td>On-campus hours</td><td>Self-study hours</td><td>CP</td><td>Frequency</td></tr>
<tr><td colspan="3">Financial Mathematics</td><td>12 h</td><td>213 h</td><td>9</td><td>Summer semester</td></tr>
<tr><td>2.</td><td colspan="7">Classification within the curriculum:
Compulsory</td></tr>
<tr><td>3.</td><td colspan="7">Content:
• Fundamentals of stochastic analysis (Brownian motion, Itô integral, Itô formula, martingale representation theorem, Girsanov theorem, linear stochastic differential equations, Feynman-Kac theorem)
• Diffusion model for stock prices and trading strategies
• Completeness of market
• Valuation of options with the duplication principle, Black-Scholes formula
• Valuation of options and partial differential equations
• Exotic options
• Arbitrage bounds (put-call parity, parity of prices for European and American calls)</td></tr>
<tr><td>4.</td><td colspan="7">Competencies/learning outcomes:
The students know and understand the basic design and properties of stochastic integrals and stochastic differential equations. In particular, they are familiar with the Itô formula, the Girsanov theorem, and the representation theorems. Based on corresponding financial market models, in particular the Black-Scholes model, they have learned various methods for determining the price of financial derivatives. They can critically assess the limits of modelling and the applicability of methods to different financial derivatives.
The students have worked out a safe, precise and independent handling of the terms, statements and methods of the learning material. They understand the arguments presented in the learning materials and are able to transfer them to similar problems.</td></tr>
<tr><td rowspan="3">5.</td><td colspan="7">Requirements for participation in the module:</td></tr>
<tr><td>Formally:</td><td colspan="6">None</td></tr>
<tr><td>Content-wise:</td><td colspan="6">M1 (Introduction to Financial Mathematics)</td></tr>
</table>

6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Written test (90 to 120 minutes)
	Coursework:	Successful preparation of mail-in exercises
	Preliminary examination(s):	Successful preparation of mail-in exercises
7.	Module grade: The grade of the module examination is also the module grade.	
8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	N.H. Bingham, R. Kiesel: Risk-Neutral Valuation: Pricing and Hedging of Financial Derivatives, T. Björk: Arbitrage Theory in Continuous Time, R. Korn, E. Korn: Option Pricing and Portfolio Optimization – Modern Methods of Financial Mathematics, M. Steele: Stochastic Calculus and Financial Applications.
	Learning materials and/or other materials:	Learning material
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

Economics of Banking							
Module ID:	Module coordinator:		Lecturers and authors:				
M4	Prof. Dr Jan Wenzelburger		Prof. Dr Jan Wenzelburger, scientific staff of the study programme				
Total workload:	Credit points (CP):	Recommended semester:	Duration of the module:				Module frequency:
150 h	6 CP	2. semester	1 semester				Summer semester
1.	Courses (module components)		On-campus hours	Self-study hours	CP		Frequency
	Economics of Banking		6 h	144 h	6		Summer semester
2.	Classification within the curriculum: Compulsory						
3.	Content: • What is a bank, what are its core activities? • The role of capital markets in intertemporal consumer choices • Liquidity insurance or why banks exist • Theory of the bank as a company • Banks as portfolio managers • Risk management • Credit rationing • Run on banks and how to prevent them • Macroeconomic aspects of banking • The regulation of banks						
4.	Competencies/learning outcomes: The overall learning objective is to explain and question the importance of banks for national economies. Students acquire the competence to independently analyse the role and function of banking, and in particular to develop different economic perspectives of banking. They understand the corresponding theoretical fundamentals of micro- and macroeconomics and have developed a model-theoretical understanding of a bank as a special firm and its activities as a financial intermediary as well as the macroeconomic role of banking for an economy (e.g. causes of banking crises, the importance of systemic risks for an economy, the role of central banks and various aspects of banking regulation). In addition, they are able to use the learned theory as a decision-making aid for real decisions. Students will deepen, apply and discuss what they have learned in the study letters in on-campus phases. In this way, students acquire methodological and social competence.						
5.	Requirements for participation in the module:						
	Formally:	None					
	Content-wise:	None					

6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Written test (60 to 90 minutes)
	Coursework:	Active participation during on-campus phases, successful preparation of mail-in exercises
	Preliminary examination(s):	Successful preparation of mail-in exercises
7.	Module grade: The grade of the module examination is also the module grade.	
8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	J. Eichberger, I.R. Harper: Financial Economics, X. Freixas, J.-C. Rochet: Microeconomics of Banking, H. Keiding: Economics of Banking, K. Mattews, J. Thompson: Economics of Banking.
	Learning materials and/or other materials:	Learning material
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

Interest Rate Models

Module ID:	Module coordinator:	Lecturers and authors:
M5	Prof. Dr Jörn Saß	Dr Sascha Desmettre, Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, Prof. Dr Frank Seifried, scientific staff of the study programme

Total workload:	Credit points (CP):	Recommended semester:	Duration of the module:	Module frequency:
150 h	6 CP	3. semester	1 semester	Winter semester

1.	Courses (module components)	On-campus hours	Self-study hours	CP	Frequency
	Interest Rate Models	4 h	108.5 h	4.5	Winter semester
	Financial Mathematics Lab Course	2 h	35.5 h	1.5	Winter semester

2. Classification within the curriculum:

Compulsory

3. Content:

- Basics of interest modelling (Bonds and linear products, swaps, caps and floors, bond options, rate of interest options, interest rate term structure curve, interest rates (short rates and forward rates))
- Heath–Jarrow–Morton framework (simple example: Ho-Lee model, general HJM drift condition, one- and multidimensional modelling)
- Short rate models (general one factor-modelling, term structure equation, affine modelling of interest rate structure, Vasicek-, Cox-Ingersoll-Ross- and further models, option pricing model, model calibration)
- Defaultable bonds (Merton model)

4. Competencies/learning outcomes:

Students understand the fundamentals of the theory of interest rate products and modelling of interest rate markets. They are able to understand the essential relations between modelling interest rates and pricing interest rate products and can apply these critically.

The students gain a precise and independent handling of terms, propositions and methods of the learning material. They understand the arguments presented in the learning materials and are able to reproduce and explain them. They are able to transfer and implement more complex problems into practice in combination with contents of the modules M2 and M3.

5. Requirements for participation in the module:

Formally:	None
Content-wise:	M1 (Introduction to Financial Mathematics), M2 (Insurance Mathematics) and M3 (Financial Mathematics)

6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Presentation (15 to 30 minutes)
	Coursework:	Active participation during on-campus phases, successful preparation of mail-in exercises
	Preliminary examination(s):	None
7.	Module grade: This module is ungraded.	
8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	T. Björk: Arbitrage Theory in Continuous Time, D. Brigo, F. Mercurio: Interest Rate Models – Theory and Practice, D. Filipovič: Term Structure Models: A Graduate Course, R. Zagst: Interest Rate Management.
	Learning materials and/or other materials:	Learning material
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

<table>
<tr><th colspan="8">Financial Decision Making</th></tr>
<tr><td>Module ID:</td><td colspan="2">Module coordinator:</td><td colspan="5">Lecturers and authors:</td></tr>
<tr><td>M6</td><td colspan="2">Prof. Dr Jörn Saß</td><td colspan="5">Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, Prof. Dr Jan Wenzelburger, scientific staff of the study programme</td></tr>
<tr><td>Total workload:</td><td>Credit points (CP):</td><td>Recom-mended se-mester:</td><td colspan="4">Duration of the module:</td><td>Module fre-quency:</td></tr>
<tr><td>225 h</td><td>9 CP</td><td>3. semester</td><td colspan="4">1 semester</td><td>Winter semes-ter</td></tr>
<tr><td>1.</td><td colspan="2">Courses (module components)</td><td>On-cam-pus hours</td><td>Self-study hours</td><td colspan="2">CP</td><td>Frequency</td></tr>
<tr><td></td><td colspan="2">Financial Decision Making</td><td>4 h</td><td>221 h</td><td colspan="2">9</td><td>Winter semes-ter</td></tr>
<tr><td>2.</td><td colspan="7">Classification within the curriculum:
Compulsory</td></tr>
<tr><td>3.</td><td colspan="7">Content:
• Mean-variance analysis (efficient portfolios, two-fund separation, CAPM model)
• Valuation of financial derivatives in CAPM and its variants
• Expected utility approach
• Risk aversion
• Extensions (e.g. asymmetric information, constraints)
• Multi-periodic planning horizon
• Continuous-time portfolio problem: expected utility approach
• Martingale method in complete markets
• Stochastic control approach (HJB equation, verification theorems)
• Portfolio optimisation with constraints (e.g. risk bounds)
• Outlook on incomplete markets: convex constraints
• Alternative methods</td></tr>
<tr><td>4.</td><td colspan="7">Competencies/learning outcomes:
In the one-period financial market, students are familiar with various approaches in agent-based financial market models and can evaluate them. With the help of these models, they can decide on different investment forms. In addition, they are in a position to justify risk minimization through diversification and to critically evaluate approaches to decisions under uncertainties. They can assess what can be transferred to a multi-period model and understand the backward induction approach and the Bellman principle.
In the continuous-time financial market model, students know and understand the two essential methods for solving stochastic control problems in financial and actuarial mathematics, the stochastic control approach and the duality approach. They are able to apply the methods to various portfolio optimisation problems and critically assess the implementation and applicability of the theoretical results.</td></tr>
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<tr><td>5.</td><td colspan="2">Requirements for participation in the module:</td></tr>
<tr><td></td><td>Formally:</td><td>None</td></tr>
<tr><td></td><td>Content-wise:</td><td>M1 (Introduction to Financial Mathematics) and M3 (Financial Mathematics)</td></tr>
<tr><td>6.</td><td colspan="2">Prerequisites for awarding credit points:
The following examination(s), coursework and preliminary examination(s) have to be completed:</td></tr>
<tr><td></td><td>Examination(s):</td><td>Written test (90 to 120 minutes)</td></tr>
<tr><td></td><td>Coursework:</td><td>Successful preparation of mail-in exercises</td></tr>
<tr><td></td><td>Preliminary examination(s):</td><td>Successful preparation of mail-in exercises</td></tr>
<tr><td>7.</td><td colspan="2">Module grade:
The grade of the module examination is also the module grade.</td></tr>
<tr><td>8.</td><td colspan="2">Applicability of the module:
Compulsory module in the Master's programme Financial Engineering</td></tr>
<tr><td>9.</td><td colspan="2">Recommendations for preparing the module:</td></tr>
<tr><td></td><td>Recommended literature:</td><td>L. Eeckhoudt, H. Schlesinger, C. Gollier: Economics and Financial Decisions under Risk,
J. Ingersoll: Theory of Financial Decision Making,
T. Hens, K. Schenk-Hoppé: Handbook of Financial Markets, Dynamics and Evolution,
R. Korn, E. Korn: Option Pricing and Portfolio Optimization – Modern Methods of Financial Mathematics,
H. Pham: Continuous-Time Stochastic Control and Optimization with Financial Applications,
S. Pliska: Introduction to Mathematical Finance</td></tr>
<tr><td></td><td>Learning materials and/or other materials:</td><td>Learning material</td></tr>
<tr><td>10.</td><td colspan="2">Registration procedure:
Course registration via a Learning Management System (e.g. OpenOLAT)</td></tr>
<tr><td>11.</td><td colspan="2">Language of instruction:
English</td></tr>
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<table>
<tr><th colspan="8">Risk and Statistical Modelling</th></tr>
<tr><td colspan="2">Module ID:</td><td colspan="2">Module coordinator:</td><td colspan="4">Lecturers and authors:</td></tr>
<tr><td colspan="2">M7</td><td colspan="2">Prof. Dr Jörn Saß</td><td colspan="4">Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, Dr Jean-Pierre Stockis, scientific staff of the study programme</td></tr>
<tr><td colspan="2">Total workload:</td><td>Credit points (CP):</td><td>Recommended semester:</td><td colspan="3">Duration of the module:</td><td>Module frequency:</td></tr>
<tr><td colspan="2">225 h</td><td>9 CP</td><td>4. semester</td><td colspan="3">1 semester</td><td>Summer semester</td></tr>
<tr><td rowspan="3">1.</td><td colspan="3">Courses (module components)</td><td>On-campus hours</td><td>Self-study hours</td><td>CP</td><td>Frequency</td></tr>
<tr><td colspan="3">Risk Measures and Rating Systems</td><td>3.5 h</td><td>109 h</td><td>4.5</td><td>Summer semester</td></tr>
<tr><td colspan="3">Financial Statistics</td><td>3.5 h</td><td>109 h</td><td>4.5</td><td>Summer semester</td></tr>
<tr><td>2.</td><td colspan="7">Classification within the curriculum:
Compulsory</td></tr>
<tr><td>3.</td><td colspan="7">Content:
Risk Measures and Rating Systems:
• Preferences and expected utility
• Axiomatic introduction of risk measures
• Examples: Value at Risk, Average Value at Risk, Shortfall, Worst Case
• Outlook: Robust representation of convex and coherent risk measures
• Estimation of risk measures
• Score-based rating systems
• Utility-based ratings for financial products
• Risk-opportunity classes for insurance products
• Credit default risks: Structural models and reduction models
• Development and valuation of credit portfolios
• Risk-based insurance premiums
• Portfolio optimisation under risk constraints
Financial Statistics:
• Models and estimation methods for financial time series (ARCH, GARCH and generalisations), Value at Risk
• Copulas and their risk management applications based on multivariate data
• Stochastic methods for estimating the probability of extreme events or extreme quantiles</td></tr>
<tr><td>4.</td><td colspan="7">Competencies/learning outcomes:
The students know and understand the motivation and the basics of the axiomatic theory of risk measures. They are able to classify different risk measures and assess the advantages and disadvantages of special risk measures in different application areas of financial mathematics. They are</td></tr>
</table>

	also familiar with various rating procedures and methods for measuring credit risks and can critically assess and apply them. The students know and understand advanced statistical techniques for modelling time series that represent fundamental stochastic dependencies in the economy and for modelling and estimating risks, primarily in the financial and insurance industries. They are able to apply them, and they can critically assess the possibilities and limits of their use.	
5.	Requirements for participation in the module:	
	Formally:	None
	Content-wise:	Modules M2 (Insurance Mathematics) and M3 (Financial Mathematics)
6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Two examinations (60 to 90 minutes each)
	Coursework:	Active participation during on-campus phases, successful preparation of mail-in exercises for both courses
	Preliminary examination(s):	Successful preparation of mail-in exercises for each course
7.	Module grade: The module grade is the average of the two grades of the sub-module examinations.	
8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	P. Embrechts, C. Klüppelberg, T. Mikosch: Modelling Extremal Events for Insurance and Finance, H. Föllmer, A. Schied: Stochastic Finance: An Introduction in Discrete Time, J. Franke, W.K. Härdle, C.M. Hafner: Statistics of Financial Markets: An Introduction, D. Lando: Credit Risk Modeling: Theory and Applications, E. Lütkebohmert: Concentration Risk in Credit Portfolios, L. Rüschendorf: Mathematical Risk Analysis.
	Learning materials and/or other materials:	Study material “Risk Measures and Rating Systems” and “Financial Statistics”
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

Computational Methods in Finance							
Module ID:	Module coordinator:		Lecturers and authors:				
M8	Prof. Dr Jörn Saß		Dr Sascha Desmettre, Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, scientific staff of the study programme				
Total workload:	Credit points (CP):	Recommended semester:	Duration of the module:				Module frequency:
250 h	10 CP	4. semester	2 semesters				Summer semester
1.	Courses (module components)		On-campus hours	Self-study hours	CP		Frequency
	Computational Finance		0 h	137.5 h	5.5		Summer semester
	Modelling seminar		6 h	106.5 h	4.5		Winter semester
2.	Classification within the curriculum: Compulsory						
3.	Content: • Standard models: Black-Scholes, Heston and other SV models, local volatility, • Model selection and calibration • Approaches to option valuation: analytical formula, partial differential equations, Monte Carlo simulations, tree methods • Price calculation for exotic options and certificates • Selected topics on Monte Carlo simulations: Generation of random variables, numerical methods for SDE, variance reduction, stochastic Taylor series expansion • Convergence of stochastic methods and theorem of Donsker						
4.	Competencies/learning outcomes: Students will be able to apply numerically efficiently the methods acquired in the introductory lectures on financial mathematics for the price valuation of financial derivatives using various methods. They understand the different procedures and are able to independently assess which calculation and approximation methods are suitable for other complex products and implement them numerically efficiently.						
5.	Requirements for participation in the module:						
	Formally:	None					
	Content-wise:	Modules M2 (Insurance Mathematics) and M3 (Financial Mathematics)					

<table>
<tr><td rowspan="4">6.</td><td colspan="2">Prerequisites for awarding credit points:
The following examination(s), coursework and preliminary examination(s) have to be completed:</td></tr>
<tr><td>Examination(s):</td><td>Presentation (15 to 30 minutes)</td></tr>
<tr><td>Coursework:</td><td>Successful preparation of mail-in exercises</td></tr>
<tr><td>Preliminary examination(s):</td><td>Successful preparation of mail-in exercises</td></tr>
<tr><td>7.</td><td colspan="2">Module grade:
This module is ungraded.</td></tr>
<tr><td>8.</td><td colspan="2">Applicability of the module:
Compulsory module in the Master's programme Financial Engineering</td></tr>
<tr><td rowspan="3">9.</td><td colspan="2">Recommendations for preparing the module:</td></tr>
<tr><td>Recommended literature:</td><td>R. Korn, E. Korn, G. Kroisandt: Monte Carlo Methods and Models in Finance and Insurance,
Ö. Ugur: An Introduction to Computational Finance.</td></tr>
<tr><td>Learning materials and/or other materials:</td><td>Learning material</td></tr>
<tr><td>10.</td><td colspan="2">Registration procedure:
Course registration via a Learning Management System (e.g. OpenOLAT)</td></tr>
<tr><td>11.</td><td colspan="2">Language of instruction:
English</td></tr>
</table>

Advanced Financial Engineering

Module ID:	Module coordinator:	Lecturers:
M9	Prof. Dr Jörn Saß	Dr Sascha Desmettre, Prof. Dr Ralf Korn, Prof. Dr Jörn Saß, Dr Jean-Pierre Stockis, Prof. Dr Jan Wenzelburger, scientific staff of the study programme

Total workload:	Credit points (CP):	Recommended semester:	Duration of the module:	Module frequency:
150 h	6 CP	5. semester	1 semester	Winter semester

1.	Courses (module components)	On-campus hours	Self-study hours	CP	Frequency
	Reading Course: Advanced Financial Engineering	0 h	150 h	6	Winter semester

2.	Classification within the curriculum: Compulsory
3.	Content: Current topics (e.g. “Factor analysis for credit portfolios” or “Risk assessment of combined financial and insurance products”), topics with current application relevance (e.g. “The mathematics behind Solvency II”) or classic areas that cannot be covered in the study material (e.g. reading original papers from the beginnings of financial mathematics) are covered.
4.	Competencies/learning outcomes: The students have learned to work independently on an advanced area of financial mathematics using given literature and scientific methods. They are able to write a scientific Master's thesis in the field of financial mathematics.

5.	Requirements for participation in the module:	
	Formally:	None
	Content-wise:	Depending on the topic of the Reading Course

6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:	
	Examination(s):	Mail-in exercises
	Coursework:	None
	Preliminary examination(s):	None

7.	Module grade: This module is ungraded.

8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	References to literature will be communicated upon announcement of the Reading Course.
	Learning materi-als and/or other materials:	
10.	Registration procedure: Course registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: English	

Master's thesis							
Module ID:	Module coordinator:		Lecturers:				
M10	Prof. Dr Jörn Saß		Supervisors in accordance with examination regulations				
Total workload:	Credit points (CP):	Recommended semester:	Duration of the module:				Module frequency:
500 h	20 CP	6. semester	6 months				Every semester
1.	Courses (module components)			On-campus hours	Self-study hours	CP	Frequency
	Master's thesis			1 h	499 h	20	
2.	Classification within the curriculum: Compulsory						
3.	Content: Limited (advanced) mathematical tasks from financial mathematics						
4.	Competencies/learning outcomes: The students • are able to independently work on a mathematical task within a given period of time according to scientific methods and can apply the technical and methodological competencies acquired during their studies; • can interpret scientific results critically and place them in the respective state of knowledge; • are able to present their results in writing according to the principles of good scientific practice; • can present the results obtained orally in a conclusive form and provide well-founded answers to questions.						
5.	Requirements for participation in the module:						
	Formally:	M1 - M5 and M9					
	Content-wise:	Depending on the choice of topic of the Master's thesis					
6.	Prerequisites for awarding credit points: The following examination(s), coursework and preliminary examination(s) have to be completed:						
	Examination(s):	Master's thesis (including presentation as a component)					
	Coursework:	None					
	Preliminary examination(s):	None					
7.	Module grade: The grade of the module examination is also the module grade.						

8.	Applicability of the module: Compulsory module in the Master's programme Financial Engineering	
9.	Recommendations for preparing the module:	
	Recommended literature:	After consultation with the supervisor.
	Learning materials and/or other materials:	
10.	Registration procedure: Registration via a Learning Management System (e.g. OpenOLAT)	
11.	Language of instruction: German or English	