VU University Amsterdam - Faculteit der Exacte Wetenschappen - M Stochastics and Financial Mathematics - 2015-2016

The field of Stochastics covers the areas of science that are concerned with processes in which chance plays a central role.

Usually the field is subdivided into Statistics, Probability Theory and Stochastic Operations Research. Financial Mathematics is an important field of applications of stochastics. The mathematical point of view for questions in finance has its own virtue and is an interesting subject of research. In view of the relevance of the numerous areas of research in which stochastics is applied, and in view of the reach of these areas of research and their challenging theoretical problems, this master offers a broad spectrum of possible specializations. The theoretically inclined, as well as the more applied master student, will have the possibility to choose a program adapted to his/her personal interests.

The Korteweg-de Vries Institute for Mathematics (UvA) and the Department of Mathematics (VU) of the two universities in Amsterdam, and the Mathematical Institute of the University of Utrecht (UU) have joined forces to offer this two year master in Stochastics and Financial Mathematics. The program offers the possibility to specialize in Statistics, Probability Theory, Financial Mathematics or Stochastic Operations Research.

Index

SFM List of Courses

Each student has to choose 67 European credits (EC) optional courses.
- at least 30 EC from the course list below and at least one Mastermath course (X_400323, X_418139, X_400339, X_400571)
- at most 25 EC can be chosen out of the programs of Business Analytics and/or Econometrics and/or Mathematics
- at most 12 EC are free to choose

Note: Every program, including the choice of optional courses, has to be discussed and agreed upon with the master coordinator and approved by the Examination Board.

Courses:

Name	Period	Credits	Code
Asymptotic Statistics	Period 1+2	8.0	X_400323
Computational Finance	Period 4+5	6.0	X_418045
Interest Rate Models	Period 1+2	6.0	X_418091
Nonparametric Bayesian Statistics	Period 1+2	6.0	X_418124
Portfolio Theory	Period 1+2	6.0	X_400535
Queues & Levy Fluctuation Theory	Period 1+2	8.0	X_405130
Simulation Methods in Statistics	Period 1+2	6.0	X_400258
Statistics for High-Dimensional Data	Period 4+5	6.0	X_405113
Stochastic Integration	Period 4+5	8.0	X_400470
Stochastic Optimization	Period 1+2	6.0	X_400336
Stochastic Processes	Period 4+5	8.0	X_400339
Stochastic Processes for Finance	Period 1+2	6.0	X_400352
Time series	Period 4+5	8.0	X_400571

Compulsory Choice

Courses:

Name	Period	Credits	Code
Asymptotic Statistics	Period 1+2	8.0	X_400323
Queues & Levy Fluctuation Theory	Period 1+2	8.0	X_405130
Stochastic Processes	Period 4+5	8.0	X_400339
Time series	Period 4+5	8.0	X_400571

Compulsory Courses

Note: Every program, including the choice of optional courses, has to be discussed and agreed upon with the master coordinator and approved by the Examination Board.

Courses:

Name	Period	Credits	Code
Master Project Stochastics and Financial Mathematics	Ac. Year (September)	36.0	X_400502
Measure Theoretical Probability	Period 1+2	8.0	X_400244
Scientific Writing in English	Period 4	3.0	X_400512
Seminar Mathematics	Period 1+2	6.0	X_405024

Asymptotic Statistics

Course code	X_400323 (400323)
Period	Period 1+2
Credits	8.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Level	500

Course content
This course is part of the joint national master programme in mathematics. For schedules, course locations and course descriptions see http://www.mastermath.nl. Registration required via http://www.mastermath.nl.

Target group
mMath

Registration procedure
You have to register your participation in each Mastermath course via http://www.mastermath.nl/registration/
Registration is mandatory and absolutely necessary for transferring your grades from Mastermath to the administration of your university.

Computational Finance

Course code	X_418045 ()
Period	Period 4+5
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Teaching method(s)	Lecture
Level	400

Course content
http://studiegids.uva.nl/xmlpages/page/2015-2016/zoek-vak/vak/16398

Target group
mSFM

Remarks
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Interest Rate Models

Course code	X_418091 ()
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Teaching staff	prof. dr. G.J.B. van den Berg
Teaching method(s)	Lecture
Level	500

Course content
http://studiegids.uva.nl/xmlpages/page/2015-2016/zoek-vak/vak/21133

Target group
mSFM, mMath

Registration procedure
Registration is required via https://www.sis.uva.nl during the registration term before the start of the semester.

Master Project Stochastics and Financial Mathematics

Course code	X_400502 (400502)
Period	Ac. Year (September)
Credits	36.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Level	600

Course objective
The objectives of the master project are:
- to explore a research problem in the area of Stochastics and/or Financial Mathematics, or to distill such a mathematical problem formulation from the context of the host organisation.
- to study relevant papers from the (mathematical) literature, to combine those, and to add an original contribution.
- to put the results and conclusions in proper perspective, also in relation to results obtained by others.

- to present the research both in writing and in an oral presentation.

Course content
The Master's programme is concluded by an internal or external master project.

An external project ("internship") is carried out within a business, industry or research facility other than the departments of Mathematics.

For an internal research project, the student starts by identifying a research topic in consultation with his/her supervisor. This leads to a research plan, which is recorded on the form that can be downloaded here: http://www.few.vu.nl/en/current-students/study-guidance-and-contact/final-assessment-form/index.asp (a copy is given to the master coordinator). The project itself usually starts with a literature study, leads towards the boundaries of mathematical knowledge, and ideally culminates in original research by the student. The work is carried out by the student individually, while there are weekly or biweekly meetings with the supervisor to discuss progress and scientific questions. The work is presented both in a master thesis and in an oral presentation (mandatory).

Form of tuition
Either the student performs individual research or the student is an intern at a host organization.

Type of assessment
Assessment is based on the research performed (level, quality, quantity, independence, etcetera), the written master thesis, and the oral presentation. The form used for the assessment of a research project can be downloaded here: http://www.few.vu.nl/en/current-students/study-guidance-and-contact/final-assessment-form/

Course reading
assigned individually

Entry requirements
78 EC of the master program need to be completed before starting the final project.

Target group
mSFM

Remarks
If you are planning to start your external project within four months, please make an appointment with Annemieke van Goor (vangoor@few.vu.nl) at the Internship Office. Additional information can be found at http://www.few.vu.nl/en/current-students/int-car/internships/index.asp

Measure Theoretical Probability

Course code	X_400244 (400244)
Period	Period 1+2
Credits	8.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen

Teaching method(s)	Lecture
Level	400

Course content
This course is part of the joint national master programme in mathematics.
For schedules, course locations and course descriptions see http:/www.mastermath.nl.
Registration required via http:/www.mastermath.nl.

Target group
mMath, mSFM

Registration procedure
You have to register your participation in each Mastermath course via http://www.mastermath.nl/registration/
Registration is mandatory and absolutely necessary for transferring your grades from Mastermath to the administration of your univesity.

Nonparametric Bayesian Statistics

Course code	X_418124 ()
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Level	500

Course content
http://studiegids.uva.nl/xmlpages/page/2015-2016/zoek-vak/vak/19550

Target group
mMath, mSFM

Remarks
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Portfolio Theory

Course code	X_400535 (400535)
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Level	500

Course content
The course description is available on:
http://studiegids.uva.nl/xmlpages/page/2015-2016/zoek-vak/vak/18617

Target group
mSFM, mMath

Remarks
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Queues & Levy Fluctuation Theory

Course code	X_405130 ()
Period	Period 1+2
Credits	8.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Teaching method(s)	Lecture
Level	400

Course content
This course is part of the joint national master programme in mathematics. For schedules, course locations and course descriptions see http://www.mastermath.nl. Registration required via http://www.mastermath.nl .

Target group
mMATH, mSFM

Registration procedure
You have to register your participation in each Mastermath course via http://www.mastermath.nl/registration/
Registration is mandatory and absolutely necessary for transferring your grades from Mastermath to the administration of your university.

Scientific Writing in English

Course code	X_400512 ()
Period	Period 4
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	M. van den Hoorn
Examinator	M. van den Hoorn
Teaching method(s)	Lecture
Level	400

Course objective
The aim of this course is to provide Master's students with the essential linguistic know-how for writing a scientific article in English that is well organized, idiomatically and stylistically appropriate and grammatically correct.

At the end of the course students
- know how to structure a scientific article;
- know what the information elements are in parts of their scientific article;
- know how to produce clear and well-structured texts on complex subjects;
- know how to cite sources effectively;
- know how to write well-structured and coherent paragraphs;
- know how to construct effective sentences;
- know what collocations are and how to use them appropriately;
- know how to adopt the right style (formal style, cohesive style, conciseness, hedging)
- know how to avoid the pitfalls of English grammar;
- know how to use punctuation marks correctly;
- know what their own strengths and weaknesses are in writing;
- know how to give effective peer feedback.

Final texts may contain occasional spelling, grammatical or word choice errors, but these will not distract from the general effectiveness of the text.

Course content
The course will start with a general introduction to scientific writing in English. Taking a top-down approach, we will then analyse the structure of a scientific article in more detail. As we examine each section of an article, we will peel back the layers and discover how paragraphs are structured, what tools are available to ensure coherence within and among paragraphs, how to write effective and grammatically correct sentences and how to choose words carefully and use them effectively.

Topics addressed during the course include the following:
- Structuring a scientific article
- Considering reading strategies: who is your readership? How do they read your text? What do they expect? How does that affect your writing?
- Writing well-structured and coherent paragraphs
- Composing effective sentences (sophisticated word order, information distribution).
- Arguing convincingly – avoiding logical fallacies
- Academic tone and style: hedging – why, how, where?
- Using the passive effectively
- Understanding grammar (tenses, word order, etc.)
- Understanding punctuation
- Referring to sources: summarising, paraphrasing, quoting (how and when?)
- Avoiding plagiarism
- Vocabulary development: using appropriate vocabulary and collocations

Form of tuition
Scientific Writing in English is an eight-week course and consists of 2 contact hours a week. Students are required to spend at least 6 to 8 hours of homework per week. They will work through a phased series of exercises that conclude with the requirement to write several text parts (Introduction, Methods, Discussion and Abstract). Feedback on the writing assignments is given by the course teacher and by peers.

Type of assessment

Students will receive the three course credits when they meet the following requirements:
- Students hand in three writing assignments (Introduction, Methods, Discussion)
- Students get a pass mark for all writing assignments;
- Students provide elaborate peer feedback (Introduction, Methods, Discussion, Abstract);
- Students attend at least 7 out of 8 sessions;
- Students are well prepared for each session (i.e. do all homework assignments);
- Students participate actively in class;
- Students do not plagiarise or self-plagiarise.

Writing assignments:
1. If students have a BSc thesis in a traditional thesis form (e.g., 20+ pages) and written in English, they may use this for the writing assignments.
2. If students have a BSc thesis in a traditional form (e.g., 20+ pages) written in another language than English, they may use this for the writing assignments.
3. If students have written a paper or report in English that's not already in article form, they may use this for the writing assignment.
4. If students are working on their MSc thesis or internship report when taking Scientific Writing in English, they may use this for the writing assignments. They will have to notify their supervisor to make sure that they won't be accused of self-plagiarism.
5. If students cannot or do not wish to use any of the above-mentioned texts for the writing assignments (1-4), they are expected to do a limited Literature Review on a topic in their field of research, using at least 5 articles.

Students are not allowed to use the following texts for the writing assignments:
1. A BSc thesis written in English that's already in article form.
2. A MSc thesis written in English that's already in article form (and that has already been marked).
3. An internship report written in English that's already in article form (and that has already been marked).
4. A paper or report written in English that's already in article form.

Course reading
Effective Scientific Writing: An Advanced Learner's guide to Better English, 3rd edition (June 2013) (A. Bolt & W. Bruins, ISBN 978 90 8659 617 1). VU bookstore: €27.95.

Target group
This course is only open to students of the two-year Master's programmes Business Analytics, Mathematics and Stochastics and Financial Mathematics of the Faculty of Sciences. These students are only eligible to the course if they have already conducted scientific research (e.g. for their Bachelor's thesis) or if they will be working on a research project when taking Scientific Writing in English.

Remarks
- To do well, students are expected to attend all lessons. Group schedules are to be found at VUnet and on Blackboard.
- A VUnet registration for this course automatically gives access to the corresponding Blackboard site. Group registration only takes place via

Blackboard (general groups: registration by students following FEW programmes offering this course; groups assigned to specific studies: registration through programme and course coordinator).
- Make sure Scientific Writing in English does not overlap with another course.
- If you have registered for a group in Blackboard, you are expected to attend all sessions. If you decide to withdraw from the course, do so in time in VUnet. This all will avoid a 'fail' on your grade list for not taking part in this course and allows other students to fill in a possible very wanted group spot.
- For specific Blackboard matters concerning this course, please contact onderwijsbureau.beta@vu.nl.

Seminar Mathematics

Course code	X_405024 (405024)
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. O. Fabert
Examinator	dr. O. Fabert
Teaching staff	dr. B.T. Knapik
Teaching method(s)	Lecture
Level	400

Course objective
The aim of this course is to learn to read papers at a research level, organise the material for the framework of a seminar talk, and practice presentation skills for such a talk. At the end of the course, the student will be able to acquire the prerequisites for reading and understanding a paper by researching the literature on his own, understand the logic of a paper, and to critically evaluate a paper. He will be able to extract and condense the material for a talk of a fixed length.

Course content
We will read papers from a wide range of areas of mathematics. Students will have a choice from a list.

Form of tuition
Seminar talks by students, individual coaching, group discussion, self study.

Type of assessment
Seminar talk

Course reading
Various; will be announced in the seminar

Target group
mMath, mSFM

Remarks

This course will have three variants: 'Analysis' given by dr. O. Fabert (VU), 'Geometry' given by dr. H. Posthuma (UvA), and 'Stochastics' given by dr. B. Knapik (VU). More details at http://www.few.vu.nl/~bkk320/semmath.html. Course registration is compulsory. VU students register at the VU and UvA students at the UvA (https://www.sis.uva.nl). Note: presence at all meetings is compulsory.

Simulation Methods in Statistics

Course code	X_400258 (400258)
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Level	400

Course content
http://studiegids.uva.nl/xmlpages/page/2015-2016/zoek-vak/vak/14991

Target group
mMath, mSFM

Remarks
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Statistics for High-Dimensional Data

Course code	X_405113 ()
Period	Period 4+5
Credits	6.0
Language of tuition	Dutch
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. M. van de Wiel
Examinator	dr. M. van de Wiel
Teaching staff	dr. M. van de Wiel
Teaching method(s)	Lecture
Level	400

Course objective
Teaching students the adjustments to classical statistical methodology, necessary to tackle high-dimensional data.

Course content
This course gives an overview of statistical methods that are used for analyzing high-dimensional data sets in which many variables (often thousands) have been measured for a limited number of subjects. This type of data arises in genomics, where genetic information is measured for many thousands of genes simultaneously, in functional MRI imaging of the brain, and also in economic applications. The course covers some of

the most important statistical issues for high-dimensional data, including: a) initial processing of the data; b) model-based statistical inference for Gaussian and count data (classical and Bayesian methods); c) multiple testing (family-wise error rate and false discovery rate control); d) prediction of binary endpoints (e.g. recurrence of a tumor) and survival; e) clustering of samples (e.g. to find tumor subtypes). Several specific types of high-dimensional data will be discussed and used during the course. In terms of applications the course focuses on cancer genomics, but theoretical aspects will apply to other fields as well.

Form of tuition
Lectures + practical exercises

Type of assessment
Written exam

Course reading
Tutorial in biostatistics: multiple hypothesis testing in genomics" by Goeman & Solari (article in Statistics in Medicine) plus handouts provided by the lecturer

Recommended background knowledge
Algemene statistitiek, Statistical Data Analysis

Target group
mMath, mSFM

Stochastic Integration

Course code	X_400470 (400470)
Period	Period 4+5
Credits	8.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Level	400

Course content
The course description is available on:
http://studiegids.uva.nl/xmlpages/page/2015-2016/zoek-vak/vak/14994

Target group
mMath, mSFM

Remarks
This course is offered at the UvA. For more information contact: FNWI Education Service Centre, Science Park 904, servicedesk-esc-science@uva.nl, +31 (0)20 525 7100.
Enrolment via https://m.sis.uva.nl/vakaanmelden is required.

Stochastic Optimization

Course code	X_400336 (400336)
Period	Period 1+2
Credits	6.0

Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. S. Bhulai
Examinator	dr. S. Bhulai
Teaching staff	dr. S. Bhulai
Teaching method(s)	Lecture
Level	400

Course objective
The goal of the course is to discuss techniques from the field of stochastic optimization and their applications.

Course content
This course deals with the theory and algorithms for stochastic optimization with an application to controlled stochastic systems (e.g., call center management, inventory control, optimal design of communication networks). We discuss aspects of semi-Markov decision theory and their applications in certain queueing systems. In a programming assignment, students learn to implement optimization algorithms and experiment with them. Experience with and insight into the more theoretical subject is obtained through homework exercises.

Form of tuition
Lectures.

Type of assessment
Programming and written exercises, final exam.

Course reading
Lecture notes will be posted on BlackBoard

Entry requirements
Stochastische Methoden (400391) or equivalent and a programming language.

Recommended background knowledge
Stochastische Processen (X_401026) and Wachtrijmodellen (X_401061) or equivalent courses on Stochastic Processes and Queueing Theory and a programming language.

Target group
mBA, mBa-D, mMath, mSFM

Stochastic Processes

Course code	X_400339 (400339)
Period	Period 4+5
Credits	8.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. B.W. Rink
Examinator	dr. B.W. Rink
Teaching method(s)	Lecture

Level	400

Course content
This course is part of the joint national master programme in Mathematics.
For schedules, course locations and course descriptions see http://www.mastermath.nl.

Target group
mMath

Registration procedure
You have to register your participation in each Mastermath course via http://www.mastermath.nl/registration/
Registration is mandatory and absolutely necessary for transferring your grades from Mastermath to the administration of your univesity.

Stochastic Processes for Finance

Course code	X_400352 (400352)
Period	Period 1+2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. E.N. Belitser
Examinator	dr. E.N. Belitser
Teaching staff	dr. E.N. Belitser
Teaching method(s)	Lecture
Level	400

Course objective
Learn basics of stochastic processes in continuous time, including the concepts of martingales and stochastic integration; apply these concepts to price options on stocks and interest rates by the no-arbitrage principle.

Course content
Financial institutions trade in risk, and it is therefore essential to measure and control such risks. Financial instruments such as options, swaps, forwards, etc. play an important role in risk management, and to handle them one needs to be able to price them. This course gives an introduction to the mathematical tools and theory behind risk management.
A "stochastic process" is a collection of random variables, indexed by a set T. In financial applications the elements of T model time, and T is the set of natural numbers (discrete time), or an interval in the positive real line (continuous time). "Martingales" are processes whose increments over an interval in the future have zero expectation given knowledge of the past history of the process. They play an important role in financial calculus, because the price of an option (on a stock or an interest rate) can be expressed as an expectation under a so-called martingale measure. In this course we develop this theory in discrete and continuous time. Most models for financial processes in continuous time are based on a special Gaussian process, called Brownian

motion. We discuss some properties of this process and introduce "stochastic integrals" with Brownian motion as the integrator. Financial processes can next be modeled as solutions to "stochastic differential equations". After developing these mathematical tools we turn to finance by applying the concepts and results to the pricing of derivative instruments. Foremost, we develop the theory of no-arbitrage pricing of derivatives, which are basic tools for risk management.

Form of tuition
Lectures and exercises.

Type of assessment
Assignments and written examination.

Course reading
Lecture notes.
In addition, it is useful to have the following books:
Shreve, "Stochastic Calculus for Finance I: The Binomial Asset Pricing Model", Springer;
Shreve, "Stochastic Calculus for Finance II: Continuous-time models", Springer.

Entry requirements
Probability (X_400622) and Analysis 1 (X_400005), or their equivalents.

Recommended background knowledge
Measure Theory.

Target group
mBA, mBA-D, mMath, mSFM, master Econometrics.

Remarks
A significant part of the course is used to introduce mathematical subjects and techniques like Brownian motion, stochastic integration and Ito calculus. In view of this, the course is NOT meant for students who already followed the master course "Stochastic Integration". On the other hand, after completing this course, students may be motivated to follow the other one (Stochastic Integration) to study the above mentioned mathematical subjects in a deeper and more rigorous way.

Time series

Course code	X_400571 (400571)
Period	Period 4+5
Credits	8.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. B.W. Rink
Teaching method(s)	Lecture
Level	500

Course content
This course is part of the Joint National Master Programme in Mathematics.
For schedules, course locations and course descriptions see

http://www.mastermath.nl.

Target group
mMath

Registration procedure
You have to register your participation in each Mastermath course via http://www.mastermath.nl/registration/
Registration is mandatory and absolutely necessary for transferring your grades from Mastermath to the administration of your univesity.