



## Stochastics and Financial Mathematics MSc

Vrije Universiteit Amsterdam - Faculteit der Exacte Wetenschappen - M Stochastics and Financial Mathematics - 2013-2014

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.

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## List of Courses

Each student has to choose 73 European credits (EC) optional courses.

- at least 30 EC from the courselist below and at least one Mastermath course (X\_400323, X\_418131, X\_400339, X\_400571)
- at most 28 EC can be chosen out of the programmes of Business Analytics and/or Econometrics and/or Mathematics
- at most 15 EC are free to choose

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

Vakken:

Naam	Periode	Credits	Code
<a href="#">Asymptotic Statistics</a>	Periode 1+2	8.0	X_400323
<a href="#">Ergodic Theory</a>	Periode 1+2	7.5	X_400606
<a href="#">Ergodic Theory and Fractals</a>	Periode 4+5	6.0	X_418132
<a href="#">Forensic Statistics and Graphical Models</a>	Periode 4+5	6.0	X_418018
<a href="#">Information Theoretical Learning</a>	Periode 4+5	6.0	X_418019
<a href="#">Interest Rate Models</a>	Periode 1+2	6.0	X_418091
<a href="#">Levy fluctuation theory, with applications in finance and OR</a>	Periode 1+2	6.0	X_418077
<a href="#">Levy processes and stochastic Volatility</a>	Periode 4+5	6.0	X_418090
<a href="#">Mixing times for Markov chains</a>	Periode 4+5	7.5	X_418087
<a href="#">Nonparametric Bayesian Statistics</a>	Periode 1+2	6.0	X_418124
<a href="#">Percolation Theory</a>	Periode 1+2	6.0	X_400259
<a href="#">Probabilistic and Extremal Combinatorics</a>	Periode 1+2	8.0	X_418118
<a href="#">Semiparametric Statistics</a>	Periode 1+2	6.0	X_400605
<a href="#">Simulation Methods in Statistics</a>	Periode 1+2	6.0	X_400258
<a href="#">Statistical Learning</a>	Periode 1+2	4.0	X_418081
<a href="#">Statistics for High-Dimensional Data</a>	Periode 4+5	6.0	X_405113
<a href="#">Stochastic Integration</a>	Periode 4+5	8.0	X_400470
<a href="#">Stochastic Optimization</a>	Periode 1+2	6.0	X_400336
<a href="#">Stochastic Processes</a>	Periode 4+5	8.0	X_400339
<a href="#">Stochastic Processes for Finance</a>	Periode 1+2	6.0	X_400352
<a href="#">Time series</a>	Periode 4+5	8.0	X_400571

<a href="#">Topics in stochastic networks</a>	Periode 1+2	6.0	X_418089
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## Compulsory Choice

Compulsory Choice (at least 1 out of 4)

Vakken:

Naam	Periode	Credits	Code
<a href="#">Asymptotic Statistics</a>	Periode 1+2	8.0	X_400323
<a href="#">Stochastic Processes</a>	Periode 4+5	8.0	X_400339
<a href="#">Time series</a>	Periode 4+5	8.0	X_400571

## Compulsory Courses

Beyond the compulsory courses mentioned in the list below, students have to choose at least 6 EC in academic skill (including the course Scientific Writing in English).

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

Vakken:

Naam	Periode	Credits	Code
<a href="#">Master Project Stochastics and Financial Mathematics</a>	Ac. Jaar (september)	36.0	X_400502
<a href="#">Measure Theoretical Probability</a>	Periode 1+2	8.0	X_400244
<a href="#">Scientific Writing in English</a>	Periode 4	3.0	X_400512

## Asymptotic Statistics

<b>Vakcode</b>	X_400323 (400323)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	8.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	500

### Inhoud vak

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>.

### Doelgroep

## Ergodic Theory

<b>Vakcode</b>	X_400606 (400606)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	7.5
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	500

### Inhoud vak

For course descriptions see:

<http://www.math.vu.nl/sto/onderwijs/sfm/Ergodic.html>

### Doelgroep

mSFM

### Overige informatie

This course will be given at the Universiteit Utrecht.

For VU and other elective students: course registration must also be done on the first day of lecture directly with the lecturer.

## Ergodic Theory and Fractals

<b>Vakcode</b>	X_418132 ()
<b>Periode</b>	Periode 4+5
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Niveau</b>	400

### Inhoud vak

This course is taught in Leiden as part of the SFM programme.

For more information please consult

<http://www.math.vu.nl/sto/onderwijs/sfm/courses.html>

### Overige informatie

Docenten en beoordelaars zijn Prof. Dr. E.A. Verbitskiy (Leiden) en Dr. C.C.C.J. Kalle (Leiden).

Locatie: Universiteit van Leiden

## Forensic Statistics and Graphical Models

<b>Vakcode</b>	X_418018 (418018)
<b>Periode</b>	Periode 4+5

<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Niveau</b>	500

#### Inhoud vak

This course is taught in Leiden as part of the SFM programme.

For more information please consult

<http://www.math.vu.nl/sto/onderwijs/sfm/courses.html>

#### Overige informatie

Docent en eerste beoordelaar is Prof. dr. R.D. Gill (Universiteit Leiden).

## Information Theoretical Learning

<b>Vakcode</b>	X_418019 (418019)
<b>Periode</b>	Periode 4+5
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Niveau</b>	500

#### Inhoud vak

The course description is available on:

<http://tinyurl.com/l6onvr4>

#### Doelgroep

mSFM

#### Overige informatie

This course will be given at Leiden University. For VU and other elective students: course registration must also be done at the first day of lecture directly with the lecturer.

## Interest Rate Models

<b>Vakcode</b>	X_418091 ()
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Docent(en)</b>	prof. dr. G.J.B. van den Berg
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	500

#### Inhoud vak

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/nl/c/14265.html>

**Doelgroep**  
mSFM, mMath

**Overige informatie**

Course registration is compulsory via <https://www.sis.uva.nl>

## Levy fluctuation theory, with applications in finance and OR

<b>Vakcode</b>	X_418077 ()
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	500

**Inhoud vak**

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/en/c/12428.html>

**Doelgroep**  
mSFM

**Overige informatie**

Course registration is compulsory via <https://www.sis.uva.nl>

## Levy processes and stochastic Volatility

<b>Vakcode</b>	X_418090 ()
<b>Periode</b>	Periode 4+5
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	500

**Inhoud vak**

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/nl/c/8873.html>

**Doelgroep**  
mSFM

**Overige informatie**

Course registration is compulsory via <https://www.sis.uva.nl>

## Master Project Stochastics and Financial Mathematics

<b>Vakcode</b>	X_400502 (400502)
<b>Periode</b>	Ac. Jaar (september)
<b>Credits</b>	36.0
<b>Voertaal</b>	Engels



<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	dr. F. Bijma
<b>Niveau</b>	600

### Doel vak

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.

### Inhoud vak

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).

### Onderwijsvorm

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

### Toetsvorm

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/>

### Literatuur

assigned individually

### Vereiste voorkennis

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

### Doelgroep

mSFM

### Overige informatie

If you are planning to start your external project within four months, please make an appointment with Annemieke van Goor ([vangoor@few.vu.nl](mailto: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

<b>Vakcode</b>	X_400244 (400244)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	8.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	400

### Inhoud vak

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>.

### Doelgroep

mMath

## Mixing times for Markov chains

<b>Vakcode</b>	X_418087 ()
<b>Periode</b>	Periode 4+5
<b>Credits</b>	7.5
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Niveau</b>	400

### Inhoud vak

For course descriptions see:

<http://www.math.vu.nl/sto/onderwijs/sfm/Markov.html>

### Doelgroep

mSFM

## Nonparametric Bayesian Statistics

<b>Vakcode</b>	X_418124 ()
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	500

### Inhoud vak

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/nl/c/7984.html>

### Doelgroep

mMath, mSFM

### Overige informatie

Course registration is compulsory via <https://www.sis.uva.nl>

## Percolation Theory

<b>Vakcode</b>	X_400259 (400259)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Niveau</b>	400

### Inhoud vak

The course description is available on:

<https://studiegids.leidenuniv.nl/courses/show/34723/percolation-theory-bm>

### Doelgroep

mSFM

### Overige informatie

This course will be given at the Universiteit Leiden. For VU and other elective students: course registration must also be done on the first day of lecture directly with the lecturer.

## Probabilistic and Extremal Combinatorics

<b>Vakcode</b>	X_418118 ()
<b>Periode</b>	Periode 1+2
<b>Credits</b>	8.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	400

### Inhoud vak

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>.

## Doelgroep

mMath

## Scientific Writing in English

<b>Vakcode</b>	X_400512 ()
<b>Periode</b>	Periode 4
<b>Credits</b>	3.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	M. van den Hoorn
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	400

### Doel vak

The aim of this course is to provide the writing student with the essential linguistic means for producing English academic texts which are effective, idiomatically and stylistically appropriate and grammatically correct.

### Inhoud vak

The initial focus in the course lies on the form of scientific texts in the Exact Sciences:

- Abstract (or summary)
- Introduction
- Methods
- Results
- Discussion

#### General course outline

Introducing the topics

- Academic and technical writing in English
- The characteristics of different kinds of scientific texts
- How scientific writing is judged and assessed
- Where do you find your information and how do you present it?
- How to avoid committing plagiarism

Who am I writing for? What do I want to say?

- Your readership
- Key parts of an academic article: title, abstract, introduction, methods, results and discussion

Writing the actual article

- Paragraph and sentence construction: how do I link paragraphs together?
- Writing simple and complex sentences. Active and passive sentences.
- Argumentation : how do I put an argument? How do I frame my own opinion?

Should I use "I" or "we"?

Writing correct English

- Use of apostrophes and colons
- Word order, verb tenses, time and tense
- Avoiding mistakes typically made by Dutch writers
- Common spelling mistakes

You will be making considerable use of peer assessment: examining fellow

students' written work and giving them feedback. This method provides useful insights into how a text might be improved. The process of providing someone else with feedback on their text is something that you will find very instructive.

### Onderwijsvorm

The course is focused on self-tuition. The plenary sessions concentrate on the process of writing and the product of writing. Homework is part of the course. With each topic, participants work through a phased series of exercises that usually conclude with the requirement to write a short piece of text. The instructor will append extensive written remarks to this text.

### Toetsvorm

There will be no examination. However, students will receive their credits only when they have participated in all classes (presence is obligatory) and also when they have handed in the assignments satisfactorily. Students will receive a 'pass' when they have finished the course.

### Literatuur

For this course you need the book Effective Scientific Writing: an advanced learner's guide to better English (A. Bolt & W. Bruins, ISBN 978 90 8659 6171). This book can be obtained at the VU bookstore, which is located in the VU main building. The costs are € 27,95 per book. For questions contact the Taalcentrum-VU at 020 - 598 9804.

### Vereiste voorkennis

Bachelor Exact Sciences

### Doelgroep

mBA, mSFM en mMath

## Semiparametric Statistics

<b>Vakcode</b>	X_400605 (400605)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	400

### Inhoud vak

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/en/c/8852.html>

### Doelgroep

mMath, mSFM

### Overige informatie

Course registration is compulsory via <https://www.sis.uva.nl>

## Simulation Methods in Statistics

<b>Vakcode</b>	X_400258 (400258)
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<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	400

#### Inhoud vak

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/en/c/170.html>

#### Doelgroep

mMath, mSFM

#### Overige informatie

Course registration is compulsory via <https://www.sis.uva.nl>

## Statistical Learning

<b>Vakcode</b>	X_418081 ()
<b>Periode</b>	Periode 1+2
<b>Credits</b>	4.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Niveau</b>	500

#### Inhoud vak

The course description is available on:

[https://studiegids.leidenuniv.nl/courses/show/34709/statistical\\_learning\\_theory](https://studiegids.leidenuniv.nl/courses/show/34709/statistical_learning_theory)

#### Doelgroep

mSFM

#### Overige informatie

This course will be given at the University of Leiden. For VU and other elective students: course registration must be done on the first day of lecture directly with the lecturer.

## Statistics for High-Dimensional Data

<b>Vakcode</b>	X_405113 ()
<b>Periode</b>	Periode 4+5
<b>Credits</b>	6.0
<b>Voertaal</b>	Nederlands
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	dr. M. van de Wiel
<b>Docent(en)</b>	dr. M. van de Wiel
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	400

**Doel vak**

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

**Inhoud vak**

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.

**Onderwijsvorm**

Lectures + practical exercises

**Toetsvorm**

Written exam

**Literatuur**

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

**Aanbevolen voorkennis**

Algemene statistiek, Statistical Data Analysis

**Doelgroep**

mMath, mSFM

## Stochastic Integration

<b>Vakcode</b>	X_400470 (400470)
<b>Periode</b>	Periode 4+5
<b>Credits</b>	8.0
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	400

**Inhoud vak**

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/en/c/173.html>

**Doelgroep**

mMath, mSFM

**Overige informatie**

Course registration is compulsory via <https://www.sis.uva.nl>

## Stochastic Optimization

<b>Vakcode</b>	X_400336 (400336)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	dr. S. Bhulai
<b>Docent(en)</b>	dr. S. Bhulai
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	400

**Doel vak**

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

**Inhoud vak**

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.

**Onderwijsvorm**

Lectures.

**Toetsvorm**

Programming and written exercises, final examination.

**Literatuur**

Lecture notes will be posted on BlackBoard

**Vereiste voorkennis**

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

**Aanbevolen voorkennis**

Stochastische Processen (X\_401026) and Wachtrijmodellen (X\_401061) or equivalent courses on Stochastic Processes en Queueing Theory and a programming language.

**Doelgroep**

mBA, mBa-D, mMath, mSFM

## Stochastic Processes

<b>Vakcode</b>	X_400339 (400339)
<b>Periode</b>	Periode 4+5



<b>Credits</b>	8.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	400

### Inhoud vak

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>

### Doelgroep

mMath

## Stochastic Processes for Finance

<b>Vakcode</b>	X_400352 (400352)
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. J. van den Berg
<b>Docent(en)</b>	prof. dr. J. van den Berg, dr. E.N. Belitser
<b>Lesmethode(n)</b>	Hoorcollege, Werkcollege
<b>Niveau</b>	400

### Doel vak

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.

### Inhoud vak

Financial institutions trade in risk, and it is therefore essential to measure and control such risks. Financial instruments such as options, swaps, forwards, caps and floors, 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 and other matters. Foremost, we develop the theory of no-arbitrage pricing of derivatives, which are basic tools for risk management.

### Onderwijsvorm

Lectures and exercises.

### Toetsvorm

Homework assignments / written examination.

### Literatuur

Shreve, S.E., Stochastic Calculus for Finance I: The Binomial Asset Pricing Model. Springer.

Shreve, S.E., Stochastic Calculus for Finance II: Continuous-time models. Springer.

In addition, it is useful to have the following book:

Bjork, T., Arbitrage Theory in Continuous Time, third edition. Oxford University Press.

### Vereiste voorkennis

Introductory probability theory and statistics, calculus.

### Aanbevolen voorkennis

Introductory probability theory and statistics, calculus.

### Doelgroep

mBA, mBA-D, mMath, mSFM, master Econometrics, Quantitative Finance

### Overige informatie

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 following this course (Stochastic processes for finance), 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

<b>Vakcode</b>	X_400571 (400571)
<b>Periode</b>	Periode 4+5
<b>Credits</b>	8.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Coördinator</b>	prof. dr. G.J.B. van den Berg
<b>Docent(en)</b>	prof. dr. A.W. van der Vaart
<b>Lesmethode(n)</b>	Hoorcollege
<b>Niveau</b>	500

**Inhoud vak**

This course is part of the Joint National Master Programme in Mathematics.

For schedules, course locations and course descriptions see <http://www.mastermath.nl>.

**Doelgroep**

mMath

**Topics in stochastic networks**

<b>Vakcode</b>	X_418089 ()
<b>Periode</b>	Periode 1+2
<b>Credits</b>	6.0
<b>Voertaal</b>	Engels
<b>Faculteit</b>	Faculteit der Exacte Wetenschappen
<b>Niveau</b>	500

**Inhoud vak**

The course description is available on:

<http://studiegids.uva.nl/web/uva/sgs/nl/c/14272.html>

**Doelgroep**

mSFM, mMath

**Overige informatie**

Course registration is compulsory via <https://www.sis.uva.nl>