About this document

This document was written to assist UvA students in assembling their program, formally called Personal Education Program (PEP), within:

- the MSc Mathematics, consisting of four specializations:
  - Algebra and Geometry
  - Analysis and Dynamical Systems
  - Mathematical Physics
  - Stochastics
- the MSc Stochastics and Financial Mathematics

It summarizes the requirements of the Teaching and Examinations Regulations (TER) 2019-2020 of the programs, and lists courses offered in 2019-2020 per specialization. Moreover, suggestions for courses within certain topics of interest within each specialization are given.

The role of the MSc-coordinator and the Examinations Board

In all cases you are obliged to discuss your intended Personal Education Plan with your MSc-coordinator at the earliest convenience. If you intend to adhere to all requirements as laid out in this mini-manual, this will be a short but reassuring discussion, and approval of your PEP by the Examinations Board is generally a formality.

In case you intend to follow a non-standard program by doing a major, or a double master program, or a program not in agreement with the requirements as detailed below, this discussion with your MSc-coordinator is indispensable: the coordinator will assist you in drawing up a motivated formal request, containing all relevant information about any exceptions you might wish for, that should be submitted to the Examination Board for approval.

As approval is not guaranteed, you should get it before taking irreversible action!

Other sources of information

Detailed course descriptions can be found in the online UvA and VU study guides, and on the Mastermath website. The master guide book and the canvas page “Mathematical Masters” contains practical information regarding for instance your program, your Master Project, the SPA digital environment for submitting your Personal Education Plan, and the master room.

Legal disclaimer

No rights can be derived from this document, the only legally binding source regarding your master degree is the Teaching and Examination Regulations (TER). You can find this on the Canvas page “Mathematical Masters”.

For suggestions or corrections please contact Jan Brandts (J.H.Brandts@uva.nl).
Some highlights/changes in the 2019-20 edition


As a result of changes in those TERs, it contains
• possibly adapted formal requirements for both programs
• updated lists of courses you may take
• updated suggestions for assembling a coherent Personal Education Plan

Double master program with Econometrics

There exists a new document specifying a double masters program Econometrics and Mathematics/SFM. See Double Masters programs on page 21.

MSc Mathematics highlights

Hands-On course "Quantum in Business and Society"

This year we offer for the first time the Hands-On course “Quantum in Business and Society”. Although suggested specifically for the specializations Algebra and Geometry and Mathematical Physics, it is accessible for any MSc Mathematics student who has the prerequisites to follow the course.

Please keep an eye on the course description and/or contact its examinator for questions on the required prerequisites if necessary.

MSc Stochastics and Financial Mathematics highlights

Summer Internship in SFM

We would like to draw special attention to the Internship Stochastics and Financial Mathematics taking place at the beginning of summer 2020. If you are interested, please contact your MSc coordindinator to find yourself an internship as soon as possible.

Specializations indicated within SFM

The Restricted-choice elective courses within SFM have been subdivided into three specializations, just for your convenience:
• Financial Mathematics
• Data Analysis
• Applied Probability and Decision Making
These specializations have as of yet no formal status.
MSc Mathematics: Algebra and Geometry

Program requirements

You assemble a program consisting of at least 120 EC, of which:

- **6EC**: Master Seminar in Algebra, Geometry and Mathematical Physics (year 1)
- **36EC**: Master Project Mathematics (year 2)
- **66EC or more**: Restricted-choice elective courses (see below for the restrictions)
- **12EC or more**: Free-choice elective courses (any MSc course in any discipline)

### Including a Minor

You may include one of the three 30EC Minors (Tesla, Teaching (in Dutch) or Science for Sustainability) in your program: if so, your MSc Project reduces to 24EC and your Restricted-choice elective courses requirement reduces to 48 EC or more.

### Restricted-choice elective courses requirements

The Restricted-choice elective courses for the specialization Algebra and Geometry must satisfy the following requirements:

- **They contain at least three** of the following basic courses:
  - Additive Combinatorics
  - Algebraic Geometry 1
  - Algebraic Number Theory
  - Algebraic Topology 1
  - Commutative Algebra
  - Differential Geometry
  - Lie Algebras
  - Lie Groups
  - Modular Forms
  - Quivers
  - Riemann Surfaces

- **They contain at least two** of the following specialized courses:
  - Advanced Algebraic Geometry
  - Advanced Combinatorics: Zeros of Graph Polynomials, Markov Chains and Algorithms
  - Algebraic Geometry 2
  - Algebraic Topology 2
  - Blowing Ups and Deformations: an Introduction to the Theory of Singularities
  - Elliptic Curves
  - Poisson Geometry
  - Selected Areas in Cryptology
  - Symplectic Geometry
  - Topology of Algebraic Varieties

- **Further restricted-elective choice courses** should be taken from the Appendix of this document until they add up to 66EC. **You are not restricted to courses indicated by AG.** This indication is only there to emphasize that they belong naturally to the specialization.
Beware: Any exception from these requirements that you may wish, should be approved by the Examinations Board in advance. Please provide as much motivation and information as possible to support your request, but only after consulting your MSc-coordinator!

Restricted-choice elective courses related to the Specialization

Fall 2019
- Advanced Algebraic Geometry (Mastermath)
- Algebraic Geometry 1 (Mastermath)
- Algebraic Number Theory (Mastermath)
- Algebraic Topology 1 (Mastermath)
- Category Theory and Topos Theory (Mastermath)
- Commutative Algebra (Mastermath)
- Cryptology (Mastermath)
- Differential Geometry (Mastermath)
- Discrete Optimization (Mastermath)
- Functional Analysis (Mastermath)
- Lie Groups (Mastermath)
- Poisson Geometry (Mastermath)
- Quivers (UvA)
- Set Theory (Mastermath)

Spring 2020
- Additive Combinatorics (Mastermath)
- Advanced Linear Programming (Mastermath)
- Algebraic Geometry 2 (Mastermath)
- Algebraic Topology 2 (Mastermath)
- Advanced Combinatorics: Zeros of Graph Polynomials, Markov Chains and Algorithms (UvA)
- Blowing Ups and Deformations: an Introduction to the Theory of Singularities (UvA)
- Coding and Cryptography (VU)
- Elliptic Curves (Mastermath)
- Lie Algebras (Mastermath)
- Machine Learning Theory (Mastermath)
- Model Theory (Mastermath)
- Modular Forms (Mastermath)
- Operator Algebras (Mastermath)
- Probabilistic and Extremal Combinatorics (Mastermath)
- Quantum Computing (Mastermath)
- Quantum Information Theory (Mastermath)
- Riemann Surfaces (Mastermath)
- Selected Areas in Cryptology (Mastermath)
- Symplectic Geometry (Mastermath)
- Topological Data Analysis (Mastermath)
- Topology of Algebraic Varieties (Mastermath)
- Topos Theory (Mastermath)
- Quantum in Business and Society (UvA)
Courses per topic

Note: We list now the courses that are related to specific topics within the specialization direction. These lists are purely meant to guide the student in compiling a coherent program. They do not have an official status; in particular, the specialization requirements as given in the TER and outlined above, should always be fullfilled.

Algebraic Geometry
- Basic: Algebraic Geometry 1, Commutative Algebra
- Advanced: Advanced Algebraic Geometry, Algebraic Geometry 2, Topology of Algebraic Varieties
- Related: Elliptic Curves, Riemann Surfaces, Blowing Ups and Deformations: an Introduction to the Theory of Singularities

Differential Geometry
- Basic: Differential Geometry, Lie Algebras, Lie Groups, Riemann Surfaces
- Advanced: Symplectic Geometry, Poisson Geometry
- Related: Algebraic Topology 1, Algebraic Topology 2, Blowing Ups and Deformations: an Introduction to the Theory of Singularities, Functional Analysis

Number Theory
- Basic: Algebraic Number Theory, Elliptic Curves, Modular Forms
- Related: Algebraic Geometry 1, Commutative Algebra

Representation Theory
- Basic: Lie Algebras, Lie Groups, Quivers
- Advanced: Operator Algebras
- Related: Algebraic Geometry 1, Algebraic Topology 1, Differential Geometry, Quantum Information Theory

Cryptography
- Basic: Cryptology, Elliptic Curves
- Advanced: Algebraic Number Theory, Coding and Cryptography, Selected Areas in Cryptology, Quantum Information Theory

Discrete Mathematics
- Basic: Advanced Linear Programming, Advanced Combinatorics: Zeros of Graph Polynomials, Markov Chains and Algorithms, Cryptology
- Advanced: Coding and Cryptography, Selected Areas in Cryptology
- Related: Commutative Algebra, Discrete Optimization, Parallel Algorithms, Probabilistic and Extremal Combinatorics

Note: for more probabilistic courses in discrete mathematics, also consider the Possible Specialization Path of discrete mathematics in the specialization Stochastics.
Mathematical and Quantum Logic

- Basic: Set Theory, Category Theory and Topos Theory, Model Theory, Quantum Computing
- Advanced: Topos Theory, Quantum Information Theory
- Related: Machine Learning Theory

Research staff in Algebra and Geometry

**UvA**

**VU**
Magnus Botnan, Sander Dahmen, Oliver Fabert, Rob de Jeu, Federica Pasquotto, Jan Sanders, Rob van der Vorst.
MSc Mathematics: Analysis and Dynamical Systems

Program requirements

You assemble a program consisting of at least 120 EC, of which:

- **6EC**: Master Seminar in Analysis and Dynamical Systems (year 1)
- **36EC**: Master Project Mathematics (year 2)
- **66EC or more**: Restriced-choice elective courses (see below for the restrictions)
- **12EC or more**: Free-choice elective courses (any MSc course in any discipline)

**Including a Minor**: You may include one of the three 30EC Minors (Tesla, Teaching (in Dutch) or Science for Sustainability) in your program: if so, your MSc Project reduces to 24EC and your Restriced-choice elective courses requirement reduces to 48 EC or more.

Restriced-choice elective courses requirements

The Restriced-choice elective courses for the specialization Analysis and Dynamical Systems must satisfy the following requirements:

- **They contain at least three** of the following basic courses:
  - Complex Dynamical Systems
  - Differential Geometry
  - Dynamical Systems
  - Functional Analysis
  - Numerical Linear Algebra
  - Numerical Methods for Stationary PDEs
  - Partial Differential Equations

- **They contain at least two** of the following specialized courses:
  - Advanced Topics in Stochastic Analysis
  - Calculus of Variations
  - Introduction to Numerical Bifurcation Analysis of ODEs and Maps
  - Inverse Problems in Imaging
  - Operator Algebras
  - Parallel Algorithms
  - Symplectic Geometry
  - Uncertainty Quantification and Data Assimilation

- **Further restricted-elective choice courses** should be taken from the Appendix of this document until they add up to 66EC. **You are not restricted to courses indicated by AD.** This indication is only there to emphasize that they belong naturally to the specialization.

**Beware**: Any exception from these requirements that you might wish, should be approved by the Examinations Board in advance. Please provide as much motivation and information as possible to support your request, but only after consulting your MSc-coordinator!
Restricted-choice elective courses related to the Specialization

Fall 2019

- Advanced Topics in Stochastic Analysis (UvA)
- Continuous Optimization (Mastermath)
- Differential Geometry (Mastermath)
- Dynamical Systems (Mastermath)
- Functional Analysis (Mastermath)
- Lie Groups (Mastermath)
- Mathematical Biology (Mastermath)
- Measure Theoretic Probability (Mastermath)
- Numerical Linear Algebra (Mastermath)
- Numerical Methods for Stationary PDEs (UvA)
- Parallel Algorithms (Mastermath)
- Partial Differential Equations (Mastermath)
- Uncertainty Quantification and Data Assimilation (UvA)

Spring 2020

- Advanced Linear Programming (Mastermath)
- Applied Finite Elements (Mastermath)
- Calculus of Variations (Mastermath)
- Complex Dynamical Systems (UvA)
- Introduction to Numerical Bifurcation Analysis of ODEs and Maps (Mastermath)
- Inverse Problems in Imaging (Mastermath)
- Lie Algebras (Mastermath)
- Operator Algebras (Mastermath)
- Riemann Surfaces (Mastermath)
- Stochastic Integration (Mastermath)
- Symplectic Geometry (Mastermath)

Courses per topic

Note: We list now the courses that are related to specific topics within the specialization direction. These lists are purely meant to guide the student in compiling a coherent program. They do not have an official status; in particular, the specialization requirements as given in the TER and outlined above, should always be fulfilled.

Dynamical systems

- Basic: Complex Dynamical Systems, Dynamical Systems, Introduction to Numerical Bifurcation Analysis of ODEs and Maps, Numerical Methods for Stationary PDEs, Mathematical Biology, Partial Differential Equations
- Related: Functional Analysis

Numerical Analysis

Equations
• Related: Functional Analysis, Parallel Algorithms, Uncertainty Quantification and Data Assimilation

Geometric Analysis
• Basic: Differential Geometry, Functional Analysis, Lie Algebras, Lie Groups
• Advanced: Symplectic Geometry
• Related: Riemann Surfaces

Functional Analysis
• Basic: Differential Geometry, Functional Analysis
• Advanced: Operator Algebras
• Related: Calculus of Variations, Partial Differential Equations

Stochastic Analysis
• Basic: Measure Theoretic Probability, Uncertainty Quantification and Data Assimilation
• Advanced: Advanced Topics in Stochastic Analysis,
• Related: Functional Analysis, Numerical Methods for Stationary PDEs, Stochastic Integration

Research staff in Analysis and Dynamical Systems

UvA
Jan Brandts, Daan Crommelin, Ale Jan Homburg, Han Peters, Rob Stevenson, Chris Stolk, Jan Wiegerinck.

VU
Jan Bouwe van den Berg, Frank Bruggeman, Oliver Fabert, Ale Jan Homburg, Joost Hulshof, Rien Kaashoek, Federica Pasquotto, Bob Planqué, André Ran, Bob Rink, Jan Sanders, Rob van der Vorst.
MSc Mathematics: Stochastics

Program requirements

You assemble a program consisting of at least 120 EC, of which:

- **6EC**: Master Seminar in Stochastics (year 1)
- **36EC**: Master Project Mathematics (year 2)
- **66EC or more**: Restricted-choice elective courses (see below for the restrictions)
- **12EC or more**: Free-choice elective courses (any MSc course in any discipline)

**Including a Minor**: You may include one of the three 30EC Minors (Tesla, Teaching (in Dutch) or Science for Sustainability) in your program: if so, your MSc Project reduces to 24EC and your Restricted-choice elective courses requirement reduces to 48 EC or more.

Restricted-choice elective courses requirements

The Restricted-choice elective courses for the specialization Stochastics must satisfy the following requirements:

- **They contain**
  - Measure Theoretic Probability (Mastermath)
- **They contain at least three** of the following basic courses:
  - Asymptotic Statistics
  - Machine Learning Theory
  - Simulation Methods in Statistics
  - Stochastic Networks
  - Stochastic Integration
  - Stochastic Simulation
- **They contain at least two** of the following specialized courses:
  - Advanced Topics in Stochastic Analysis
  - Data-Driven Decision Making in Operations Research
  - Complex Networks
  - Interest Rate Models
  - Nonparametric Statistics
  - Portfolio Theory
  - Random Walks
  - Statistics for Stochastic Processes
  - Stochastic Processes
  - Topological Data Analysis
  - Uncertainty Quantification and Data Assimilation
  - Queues & Levy Fluctuation Theory

**Further restricted-elective choice courses** should be taken from the Appendix of this document until they add up to 66EC. **You are not restricted to courses indicated by ST**. This indication is only there to emphasize that they belong naturally to the specialization.
Beware: Any exception from these requirements that you may wish, should be approved by the Examinations Board in advance. Please provide as much motivation and information as possible to support your request, but only after consulting your MSc-coordinator!

Restricted-choice elective courses related to the Specialization

Fall 2019

- Advanced Topics in Stochastic Analysis (UvA)
- Applied Stochastic Modelling (VU)
- Advanced Machine Learning (VU)
- Asymptotic Statistics (Mastermath)
- Discrete Optimization (Mastermath)
- Forensic Probability and Statistics (Mastermath)
- Functional Analysis (Mastermath)
- Interest Rate Models
- Machine Learning Theory (Mastermath)
- Measure Theoretic Probability (Mastermath)
- Probabilistic and Extremal Combinatorics (Mastermath)
- Portfolio Theory (UvA)
- Random Walks (Mastermath)
- Simulation Methods in Statistics (UvA)
- Statistical Models (VU)
- Stochastic Networks (UvA)
- Stochastic Optimization (VU)
- Stochastic Processes for Finance (VU)
- Stochastic Simulation (UvA)
- Uncertainty Quantification and Data Assimilation (UvA)

Spring 2020

- Advanced Linear Programming (Mastermath)
- Complex Networks (Mastermath)
- Computational Complexity (UvA/ILLC)
- Data-Driven Decision Making in Operations Research (UvA)
- Nonparametric Statistics (Mastermath)
- Optimization of Business Processes (VU)
- Percolation: from Introduction to Frontiers of Current Research (Mastermath)
- Queueing Theory (Mastermath)
- Queues & Levy Fluctuation Theory (UvA)
- Scheduling (Mastermath)
- Statistics for Life Sciences (Mastermath)
- Statistics for Stochastic Processes (Mastermath)
- Stochastic Integration (UvA)
- Stochastic Processes (Mastermath)
- Topological Data Analysis (Mastermath)
**Courses per topic**

**Note:** We list now the courses that are related to specific topics within the specialization direction. These lists are purely meant to guide the student in compiling a coherent program. They do not have an official status; in particular, the specialization requirements as given in the TER and outlined above, should always be fulfilled.

### Stochastics & Probability
- **Basic:** Stochastic Integration, Stochastic Processes, Stochastic Simulation
- **Advanced:** Advanced Topics in Stochastic Analysis, Queues & Levy Fluctuation Theory
- **Related:** Forensic Probability and Statistics,

### Statistics
- **Basic:** Asymptotic Statistics, Machine Learning Theory, Simulation Methods in Statistics, Statistical Models
- **Advanced:** Advanced Machine Learning, Nonparametric Statistics
- **Related:** Functional Analysis, Forensic Probability and Statistics

### Networks
- **Basic:** Stochastic Networks
- **Advanced:** Queues & Levy Fluctuation Theory
- **Related:** Probabilistic and Extremal Combinatorics, Queueing Theory

### Applied Stochastics & Operations Research
- **Basic:** Applied Stochastic Modelling, Data-Driven Decision Making in Operations Research, Stochastic Simulation
- **Related:** Advanced Linear Programming, Forensic Probability and Statistics, Queueing Theory, Scheduling

### Discrete Mathematics
- **Basic:** Discrete Optimization, Probabilistic and Extremal Combinatorics, Stochastic Networks
- **Related:** Advanced Linear Programming, Computational Complexity (jointly with MSc Logic), Scheduling, Percolation: from Introduction to Frontiers of Current Research

**Note:** for more algebraic courses in discrete mathematics, also consider the Possible Specialization Path of discrete mathematics in the specialization Algebra & Geometry.

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### Research staff in Stochastics

**UvA**

Arnoud den Boer, Sonja Cox, Daan Crommelin, Jan-Pieter Dorsman, Bert van Es, Asma Khedher, Chris Klaassen, Bas Kleijn, Michel Mandjes, Sindo Núñez Queija, Marjan Sjerps, Peter Spreij, Erik Winands.
René Bekker, Eduard Belitser, Rob van den Berg, Sandjai Bhulai, Federico Camia, Elenna Dugundji, Bram Gorissen, Mathisca de Gunst, Wouter Kager, Ger Koole, Ronald Meester, Rob van der Mei, Klaas Slooten, Mark van de Wiel, Wessel van Wieringen, Harry van Zanten.
MSc Mathematics: Mathematical Physics

Program requirements

You assemble a program consisting of at least 120 EC, of which:

- **6EC**: Master Seminar in Algebra, Geometry and Mathematical Physics (year 1)
- **36EC**: Master Project Mathematics (year 2)
- **66EC or more**: Restricted-choice elective courses (see below for the restrictions)
- **12EC or more**: Free-choice elective courses (any MSc course in any discipline)

**Including a Minor**: You may include one of the three 30EC Minors (Tesla, Teaching (in Dutch) or Science for Sustainability) in your program: if so, your MSc Project reduces to 24EC and your Restricted-choice elective courses requirement reduces to 48 EC or more.

Restricted-choice elective courses requirements

The Restricted-choice elective courses for the specialization Mathematical Physics must satisfy the following requirements:

- **They contain at least three** of the following basic Mathematics courses:
  - Algebraic Geometry 1
  - Algebraic Topology 1
  - Differential Geometry
  - Functional Analysis
  - Lie Algebras
  - Lie Groups
  - Riemann Surfaces
  - Topology in Physics

- **They contain at least two** of the following specialized Mathematics courses:
  - Advanced Combinatorics: Zeros of Graph Polynomials, Markov Chains and Algorithms
  - Algebraic Geometry 2
  - Algebraic Topology 2
  - Blowing Ups and Deformations: an Introduction to the Theory of Singularities
  - Operator Algebras
  - Percolation: from Introduction to Frontiers of Current Research
  - Poisson Geometry
  - Random Walks
  - Symplectic Geometry
  - Quantum Computing
  - Quantum Information Theory

- **They contain at least one** of the following Physics courses:
  - Quantum Field Theory
  - Statistical Physics and Condensed Matter Theory 1
  - String Theory

- **Further restricted-elective choice courses** should be taken from the Appendix of this document until they add up to 66EC. **You are not restricted to courses indicated by MP.** This indication is only there to emphasize that they belong naturally to the specialization.
Beware: Any exception from these requirements that you may wish, should be approved by the Examinations Board in advance. Please provide as much motivation and information as possible to support your request, but only after consulting your MSc-coordinator!

Restricted-choice elective courses related to the Specialization

Fall 2019

- Advanced Combinatorics: Zeros of Graph Polynomials, Markov Chains and Algorithms (UvA)
- Advanced Machine Learning (VU)
- Algebraic Geometry 1 (Mastermath)
- Algebraic Topology 1 (Mastermath)
- Differential Geometry (Mastermath)
- Functional Analysis (Mastermath)
- Lie Groups (Mastermath)
- Machine Learning Theory (Mastermath)
- Partial Differential Equations (Mastermath)
- Poisson Geometry (Mastermath)
- Quantum Field Theory (UvA)
- Quivers (UvA)
- Statistical Physics and Condensed Matter Theory 1 (UvA)

Spring 2020

- Algebraic Geometry 2 (Mastermath)
- Algebraic Topology 2 (Mastermath)
- Advanced Algebraic Geometry (Mastermath)
- Blowing Ups and Deformations: an Introduction to the Theory of Singularities (UvA)
- Computational Complexity (UvA)
- Lie Algebras (Mastermath)
- Operator Algebras (Mastermath)
- Percolation: from Introduction to Frontiers of Current Research (Mastermath)
- Quantum Computing (Mastermath)
- Quantum in Business and Society (UvA)
- Quantum Information Theory (Mastermath)
- Random Walks (Mastermath)
- Riemann Surfaces (Mastermath)
- String Theory (Mastermath)
- Symplectic Geometry (Mastermath)
- Topological Data Analysis (Mastermath)
- Topology in Physics (Mastermath)
Courses per topic

Note: We list now the courses that are related to specific topics within the specialization direction. These lists are purely meant to guide the student in compiling a coherent program. They do not have an official status; in particular, the specialization requirements as given in the TER and outlined above, should always be fullfilled.

Topological and Geometric Aspects
- Basic: Algebraic Geometry 1, Algebraic Topology 1, Differential Geometry
- Related: Lie Algebras, Lie Groups, Riemann Surfaces, String Theory, Topological Data Analysis

Analytic Aspects
- Basic: Differential Geometry, Functional Analysis, Riemann Surfaces
- Advanced: Operator Algebras, Symplectic Geometry
- Related: Algebraic Topology 1, Lie Algebras, Lie Groups

Quantum Theory
- Advanced: Operator Algebras, Poisson Geometry, Symplectic Geometry, Quantum Field Theory
- Related: Algebraic Topology 1, Partial Differential Equations, Riemann Surfaces, Quantum in Business and Society

Quantum Computing & Quantum Information
- Basic: Machine Learning Theory, Quantum Computing, Statistical Physics and Condensed Matter Theory 1
- Advanced: Quantum Information Theory
- Related: Advanced Machine Learning, Coding and Cryptography, Computational Complexity, Quantum in Business and Society

Note: by including courses in quantum computing & quantum information theory in your study program, it might be possible to do a master project at the research institute QuSoft, see also the QuSoft program

Research staff in Mathematical Physics

UvA

VU
Oliver Fabert, Federica Pasquotto, Jan Sanders, Rob van der Vorst.
MSc Stochastics and Financial Mathematics

Program requirements

You assemble a program consisting of at least 120 EC, of which:

- **3EC**: Master Seminar Stochastics and Financial Mathematics (year 1)
- **36EC**: Master Project Stochastics and Financial Mathematics (year 2)
- **69EC or more**: Restricted-choice elective courses (see below for the restrictions)
- **12EC or more**: Free-choice elective courses (any MSc course in any discipline)

**Including a Minor**: You may include one of the three 30EC Minors (Tesla, Teaching (in Dutch) or Science for Sustainability) in your program: if so, your MSc Project reduces to 24EC and your Restricted-choice elective courses requirement reduces to 51 EC or more.

Restricted-choice elective courses requirements

The Restricted-choice elective courses for the MSc Stochastics and Financial Mathematics must satisfy the following requirements:

- **They contain**
  - Measure Theoretic Probability (Mastermath)

- **They contain at least two** of the following courses in Financial Mathematics:
  - Computational Finance (UvA MSc Computational Science)
  - Interest Rate Models (UvA)
  - Portfolio Theory (UvA)
  - Stochastic Processes for Finance (VU)

- **or at least two** of the following courses in Data Analytics and Decision making:
  - Asymptotic Statistics
  - Data-Driven Decision Making in Operations Research
  - Machine Learning Theory
  - Stochastic Simulation
  - Simulation Methods in Statistics

- **They contain at least two** of the following specialized courses (excluding those courses you chose to satisfy the requirement above):
  - Advanced Machine Learning
  - Advanced Topics in Stochastic Analysis
  - Data-Driven Decision Making in Operations Research
  - Interest Rate Models
  - Portfolio Theory
  - Queues & Levy Fluctuation Theory
  - Stochastic Networks
  - Stochastic Simulation

- **Further restricted-elective choice courses** should be taken from the Appendix of this document until they add up to 69EC. **You are restricted to courses indicated by SFM and Computational Finance and Internship Stochastics & Financial Mathematics.** See page 25.
**Beware:** Any exception from these requirements that you may wish, should be approved by the Examinations Board in advance. Please provide as much motivation and information as possible to support your request, but only after consulting your MSc-coordinator!

**Recommended Free-choice elective courses**

The following courses are recommendations for the Free-choice elective courses:

- Advanced Game Theory
- Financial Econometrics
- Macroeconomics

They belong to the MSc Econometrics at UvA.

**Restricted-choice elective courses in the master SFM**

The Restricted Choice Elective Courses within SFM have been subdivided into three specializations, just for your convenience:

- (D) Data Analysis
- (F) Financial Mathematics

These specializations have as of yet no formal status.

**Fall 2019**

- **D** F P Advanced Machine Learning (VU)
- **F** P Advanced Topics in Stochastic Analysis (UvA)
- **D** F P Applied Stochastic Modelling (VU)
- **D** F P Asymptotic Statistics (Mastermath)
- **D** P Forensic Probability and Statistics (Mastermath)
- **D** F P Functional Analysis (Mastermath)
- **F** Interest Rate Models (UvA)
- **D** F P Machine Learning Theory (Mastermath)
- **D** P Mathematical Optimization (VU)
- **D** F P Measure Theoretic Probability (Mastermath)
- **D** F P Partial Differential Equations (Mastermath)
- **F** Portfolio Theory (UvA)
- **P** Probabilistic and Extremal Combinatorics (Mastermath)
- **P** Random Walks (Mastermath)
- **D** F P Simulation Methods in Statistics (UvA)
- **D** P Statistical Models (VU)
- **P** Stochastic Networks (UvA)
- **P** Stochastic Optimization (VU)
- **F** P Stochastic Processes for Finance (VU)
- **D** F P Stochastic Simulation (UvA)
- **D** P Uncertainty Quantification and Data Assimilation (UvA)
### Spring 2020

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</table>

### Research staff in SFM

**UvA**

Arnoud den Boer, Sonja Cox, Jan-Pieter Dorsman, Bert van Es, Asma Khedher, Chris Klaassen, Bas Kleijn, Michel Mandjes, Sindo Núñez Queija, Marjan Sjerps, Peter Spreij, Robin de Vilder, Erik Winands.

**VU**

René Bekker, Eduard Belitser, Rob van den Berg, Sandjai Bhulai, Federico Camia, Elenna Dugundji, Bram Gorissen, Mathisca de Gunst, Wouter Kager, Ger Koole, Ronald Meester, Rob van der Mei, Harry van Zanten.
Double Master programs

It is possible to combine two master programs in order to be awarded two Master’s degrees: one in Mathematics or SFM and one in a different field. There are three double master programs that are conducted relatively often:

- Econometrics and Mathematics
- Econometrics and SFM
- Mathematics and Theoretical Physics

See TER 2019/2020 for details on other possible combinations.

Econometrics and Mathematics or SFM

For the two double master programs with Econometrics the following rules apply, since the master Econometrics is a one-year Master program (60EC):

1. the total study load of the program of the candidate should amount to at least 150 EC;
2. the candidate’s work for the Master’s program (lectures, research work etc.) is of such a standard that all exit qualifications of each of the two programs have been met;
3. the candidate has conducted an integrated research project Master Project Econometrics and Mathematics (36 EC), replacing Master Project Mathematics. This must be supervised by staff members from the two study programs; both staff members must assess the work as a pass, according to the standards for a research project in their respective master degrees;
4. the Examinations Boards of both study programs must approve the student’s double Master’s program before the student commences on the double Master’s program.

TER-supplement: As of 2019/2020 a detailed document exists that supplements the requirements given in TER 2019-2020. This document formalizes which combinations of courses of both disciplines can be taken, and provides information on mutual coherences.

See the AZ-List under Double Master Programs for this document.

Mathematics and Theoretical Physics

Program requirements
You assemble a program consisting of at least 180 EC, of which:

- 6EC: Master Seminar in Algebra, Geometry and Mathematical Physics
- 6EC: Student Seminar Theoretical Physics
- 72EC: Master Project Mathematics
- 84EC or more: Restricted-choice elective courses (see below for the restrictions)
- 12EC or more: Free-choice elective courses (any MSc course in any discipline)

Restricted-choice elective courses requirements
The Restricted-choice elective courses for the specialization Stochastics must satisfy the following requirements:
Double Master programs

- They contain the Math-Phys course
  - Topology in Physics,
  - the Physics courses
  - Quantum Field Theory
  - Statistical Physics and Condensed Matter Theory 1,
  - and the Mathematics courses
  - Differential Geometry
  - Lie Groups
- And they contain at least two 12EC in Physics & Astronomy (as in appendix 2 of the TER of Physics & Astronomy) different from Group Theory and Mathematical Methods in Theoretical Physics, at least 6EC from the track Theoretical Physics
- They contain at least two courses from the list of specialized courses of the Algebra & Geometry specialization
- They contain at least one out of
  - Algebraic Geometry 1
  - Algebraic Topology 1
  - Riemann Surfaces

Restricted-choice elective courses Related to the Double Master Mathematics & Theoretical Physics

Note: For the complete list of elective courses in Mathematics and Theoretical Physics please consult the TER's of both programs (for Mathematics they are also listed in the appendix of the minimanual).

Fall 2019

Courses in Mathematics
- Algebraic Geometry 1 (Mastermath)
- Algebraic Topology 1 (Mastermath)
- Differential Geometry (Mastermath)
- Functional Analysis (Mastermath)
- Lie Groups (Mastermath)
- Poisson Geometry (Mastermath)
- Quivers (UvA)

Courses in Theoretical Physics
- Advanced Topics in Theoretical Physics 1 (UvA)
- Statistical Physics and Condensed Matter Theory 1)
- General Relativity (UvA)
- Quantum Field Theory (UvA)
- Particle Physics I (UvA)
- Statistical Physics and Condensed Matter Theory 1 (UvA)
Spring 2020

Courses in Mathematics

- Algebraic Geometry 2 (Mastermath)
- Algebraic Topology 2 (Mastermath)
- Blowing Ups and Deformations: an Introduction to the Theory of Singularities (UvA)
- Lie Algebras (Mastermath)
- Operator Algebras (Mastermath)
- Quantum Computing (Mastermath)
- Quantum Information Theory (Mastermath)
- Riemann Surfaces (Mastermath)
- Symplectic Geometry (Mastermath)

Courses in Theoretical Physics

- Advanced Quantum Field Theory (UvA)
- Advanced Topics in Theoretical Physics 2 (UvA)
- Particle Physics II (UvA)
- String Theory (UvA)

Research staff in Mathematical Physics

UvA

VU
Oliver Fabert, Federica Pasquotto, Jan Sanders, Rob van der Vorst.
Minor and major programs

Minor programs

There are three possibilities to include a Minor in your program. These choices and their effects on the requirements within your program are given earlier in this document under your specialization within the MSc Mathematics or under the MSc SFM.

Major programs

There are three possible majors: Teaching, Science in Society and Science Communication. The generic program outline is as follows:

Program outline

- **36EC**: Constraint electives in Mathematics (year 1)
- **24EC**: Master Project Mathematics (year 1)
- **60EC**: Major program as below (year 2)

Major Teaching

This program is given in Dutch. Successful completion results in a ‘eerstegraads lesbevoegdheid’.

- Compulsory courses:
  - Pedagogiek en Algemene Didactiek A (3EC, period 1)
  - Onderwijspraktijk A (6EC, period 1)
  - Pedagogiek en Algemene Didactiek B (3EC, period 2)
  - Onderwijspraktijk B (9EC, period 2 and 3)
  - Vakdidactiek 1 (9EC, semester 1)
  - Onderwijspraktijk C (15EC, semester 2)
  - Educatief Ontwerpen (9EC, semester 2)
  - Vakdidactiek 2 (3EC, period 5)

- One elective course out of
  - Pedagogische Ethiek (3EC, period 4)
  - Leerling-Leerkracht Interactie (3EC, period 4)
  - Leerlingbegeleiding en Passend Onderwijs (3EC, period 4)
  - Democratie, actualiteit en controverse in de klas (3EC, period 4)(3EC, period 1)
  - Vernieuwend onderwijs: alles moet anders!? (3EC, period 1)

Major Science Communication and Major Science in Society

These major programs are given at the VU. For the program outline of these majors, please consult the VU studyguide.
Appendix: Restricted-choice elective courses

On the next two pages we list all the Restricted-choice elective courses as given in

- TER part B 2019-2020 for the MSc Mathematics
- TER part B 2019-2020 for the MSc SFM

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**MSc Stochastics and Financial Mathematics**

If you are registered as an MSc SFM student, only courses in the list with at least one of the indications D F P may be a Restricted Choice Elective Course, under the condition that you satisfy the requirements for SFM detailed earlier in this document.

In addition, in Spring 2020, you are also allowed to take

- F : Computational Finance
- D F P: Internship Stochastics & Financial Mathematics
- D F P: Planning and Reinforcement learning

The indication SFM corresponds exactly to the list given under the heading “Restricted Elective Courses in the master SFM” on pages 19-20.

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**MSc Mathematics**

If you are registered as an MSc Mathematics student, any course in the list, regardless of the indications AG, AD, ST, MP, can be taken as a Restricted Choice Elective Course, under the condition that you satisfy the requirements for your specific specialization as detailed earlier in this document.

The indications AG, AD, ST, and MP correspond exactly to the lists given under the heading “Restricted Elective Courses related to the Specialization” on pages 5,9,12 and 16.
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