

MSc Mathematics and SFM Manual 2017/18



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About this document

Goal

This document was written to assist VU students in choosing courses within the two mathematical master programs and their tracks:

- *Mathematics*, consisting of six tracks:
 - Algebra and Geometry
 - Analysis and Dynamical Systems
 - Stochastics
 - Biomedical Mathematics
 - Education
 - Teachers
- *Stochastics and Financial Mathematics*

This manual contains information on the overall structure of the Master programs, and lists courses offered in 2017/18 per track, indicating both their level and relevance. Also, several “suggested lines” are given. These are clusters of related courses that offer the possibility of going in depth into several specialisations.

We recommend that you discuss your program with the coordinator of the master programs (Corrie Quant) as early as possible.

Other sources of information

Detailed course descriptions can be found in the online [UvA](#) and [VU](#) study guides, and on the [Mastermath](#) website.

Non-standard programs

If you want to follow a non-standard program (e.g. a major/minor, a double master program, a free program, interdisciplinary program, or if you simply want to include certain courses that are not listed in the program below), then in most cases you will need to have your proposed program approved by the Examination Board. Contact the coordinator of the master program as soon as possible.

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* (commonly known by its Dutch abbreviation OER). You can find this on [VUNET](#).

Mathematics: Algebra and Geometry Track

Program outline

- **6EC:** [Master Seminar in Algebra and Geometry](#) (year 1)
 - **3EC:** [Scientific Writing in English](#) (year 1)
 - **36EC:** [Master Project Mathematics](#) (year 2)
 - **60EC:** Mathematics courses, consisting of
 - At least three courses out of:
 - * [Algebraic Geometry 1](#)
 - * [Algebraic Methods in Combinatorics](#)
 - * [Algebraic Topology](#)
 - * [Lie Groups and Lie Algebras](#)
 - * [Quivers](#)
 - * [Riemann Surfaces](#)
 - At least 2 advanced Algebra and Geometry courses
 - Remainder (about 30EC) mathematics courses (all tracks)
 - **15EC:** Free (must be master level; can be math, literature, ...)
-

Fall 2017

Master Seminar

- [Master Seminar in Algebra and Geometry](#) (@UvA)

Suggested basic courses

- [Algebraic Geometry 1](#) (Mastermath)
- [Algebraic Number Theory](#) (Mastermath)
- [Algebraic Topology](#) (Mastermath)
- [Commutative Algebra](#) (Mastermath)
- [Cryptography](#) (Mastermath)
- [Differential Geometry](#) (Mastermath)
- [Quivers](#) (UvA)

Advanced courses

- [Advanced Algebraic Geometry: Algebraic Surfaces](#) (Mastermath/WONDER)
- [Poisson Geometry](#) (Mastermath)
- [TFT and moduli spaces](#) (UvA, not every year)
- [Advanced Hamiltonian Dynamics](#) (Mastermath/WONDER)
- [Advanced Combinatorics](#) (Mastermath/WONDER)

Related courses

- [Functional Analysis](#) (Mastermath)
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Spring 2018

Master Seminar

- [Master Seminar in Algebra and Geometry](#) (@UvA)

Suggested basic courses

- [Algebraic Methods in Combinatorics](#) (Mastermath)
- [Coding and Cryptography](#) (VU)
- [Coding Theory](#) (Mastermath)
- [Elliptic Curves](#) (Mastermath)
- [Lie Groups and Lie Algebras](#) (Mastermath)
- [Modular Forms](#) (Mastermath)
- [Operator Algebras](#) (Mastermath)
- [Riemann Surfaces](#) (Mastermath)

Advanced courses

- [Algebraic Geometry 2](#) (Mastermath)
 - [Algebraic Topology 2](#) (Mastermath)
 - [Quantum Groups and Integrable Systems](#) (UvA, not every year)
 - [Topology in Physics](#) (Mastermath)
-

Suggested lines

Algebraic Geometry

- Basic: [Algebraic Geometry 1](#), [Commutative Algebra](#), [Riemann Surfaces](#)
- Advanced: [Algebraic Geometry 2](#), [Advanced Algebraic Geometry: Algebraic Surfaces](#)
- Related: [Algebraic Topology](#)

Differential Geometry

- Basic: [Differential Geometry](#), [Lie Groups and Lie Algebras](#), [Riemann Surfaces](#)
- Advanced: [Poisson Geometry](#)
- Related: [Algebraic Topology](#), [Topology in Physics](#)

Mathematical Physics

- Basic: [Algebraic Topology](#), [Differential Geometry](#), [Lie Groups and Lie Algebras](#)
- Advanced: [TFT and moduli spaces](#), [Quantum Groups and Integrable Systems](#), [Topology in Physics](#), [Foundations of General Relativity](#)
- Related: [Algebraic Geometry 1](#), [Functional Analysis](#), [Operator Algebras](#)

Number Theory

- Basic: [Algebraic Geometry 1](#), [Algebraic Number Theory](#), [Elliptic Curves](#), [Modular Forms](#), [Lie Groups and Lie Algebras](#)
 - Advanced: [Algorithmic Geometry of Numbers](#), [Algebraic Geometry 2](#)
 - Related: [Commutative Algebra](#), [Riemann Surfaces](#)
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Research staff in Algebra and Geometry

UvA

Raf Bocklandt, Kei Yuen Chan, Miranda Cheng, Gerard van der Geer, Lance Gurney, Arno Kret, Hans Maassen, Jan van Mill, Eric Opdam, Viresh Patel, Hessel Posthuma, Guus Regts, Nicolai Reshetikhin, Lex Schrijver, Sergey Shadrin, Mingmin Shen, Jasper Stokman, Lenny Taelman.

VU

Sander Dahmen, Oliver Fabert, Rob de Jeu, Federica Pasquotto, Jan Sanders, Rob van der Vorst.

Mathematics: Analysis and Dynamical Systems Track

Program outline

- **6EC:** [Master Seminar in Analysis and Dynamical Systems](#) (year 1)
 - **3EC:** [Scientific Writing in English](#) (year 1)
 - **36EC:** [Master Project Mathematics](#) (year 2)
 - **60EC:** Mathematics courses, consisting of
 - At least 3 courses out of
 - * [Functional Analysis](#)
 - * [Partial Differential Equations](#)
 - * [Dynamical Systems](#)
 - * [Finite Element Methods for Partial Differential Equations](#) (UvA, 18/19)
 - At least 2 advanced Analysis and Dynamical Systems courses
 - Remainder (about 30EC): mathematical courses (all tracks)
 - **15EC:** Free (must be master level; can be math, literature, . . .)
-

Fall 2017

Master Seminar

- [Master Seminar in Analysis and Dynamical Systems](#) (@UvA)

Suggested basic courses

- [Differential Geometry](#) (Mastermath)
- [Dynamical Systems](#) (Mastermath)
- [Functional Analysis](#) (Mastermath)
- [Mathematical Biology](#) (Mastermath)
- [Parallel Algorithms](#) (Mastermath)
- [Partial Differential Equations](#) (Mastermath)
- [Numerical Linear Algebra](#) (Mastermath)
- [Topics in Complex Analysis](#) (UvA)

Advanced courses

- [Advanced Hamiltonian Dynamics](#) (Mastermath/WONDER)
- [Poisson Geometry](#) (Mastermath)

Related courses

- [Measure Theoretic Probability](#) (Mastermath)

Spring 2018

Master Seminar

- [Master Seminar in Analysis and Dynamical Systems \(@VU\)](#)

Suggested basic courses

- [Continuum Mechanics](#) (Mastermath)
- [Introduction to Numerical Bifurcation Analysis of ODEs and maps](#) (Mastermath)
- [Riemann Surfaces](#) (Mastermath)
- [Stochastic Differential Equations](#) (Mastermath)

Advanced courses

- [Nonlinear Waves](#) (Mastermath)
- [Inverse Problems in Imaging](#) (Mastermath)

Related courses

- [Lie Groups and Lie Algebras](#) (Mastermath)

Suggested lines

Dynamical systems

- Basic: [Dynamical Systems](#), [Partial Differential Equations](#), [Introduction to Numerical Bifurcation Analysis of ODEs and maps](#)
- Advanced: [Advanced Hamiltonian Dynamics](#), [Nonlinear Waves](#)
- Related: [Functional Analysis](#), [Inverse Problems in Imaging](#), [Mathematical Biology](#), [Stochastic Differential Equations](#)

Numerical Analysis

- Basic: [Functional Analysis](#), [Numerical Linear Algebra](#), [Partial Differential Equations](#), [Finite Element Methods for Partial Differential Equations](#) (18/19)
- Advanced: [Inverse Problems in Imaging](#),
- Related: [Continuum Mechanics](#), [Parallel Algorithms](#)

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.

Mathematics: Stochastics Track

Program outline

- **6EC**: [Master Seminar in Stochastics](#) (two semesters, year 1)
 - **3EC**: [Scientific Writing in English](#) (year 1)
 - **36EC**: [Master Project Mathematics](#) (year 2)
 - **60EC**: Mathematics courses, consisting of
 - Compulsory courses:
 - * [Asymptotic Statistics](#)
 - * [Measure Theoretic Probability](#)
 - * [Stochastic Processes](#)
 - At least 2 advanced Stochastics courses
 - Remainder (about 30C): mathematics courses (all tracks)
 - **15EC**: Free (must be master courses; can be math, literature, ...)
-

Fall 2017

Master Seminar

- [Master Seminar in Stochastics](#) (@UvA)

Suggested basic courses

- [Applied Stochastic Modelling](#) (VU)
- [Asymptotic Statistics](#) (Mastermath)
- [Forensic Probability and Statistics](#) (Mastermath)
- [Functional Analysis](#) (Mastermath)
- [Machine Learning Theory](#) (Mastermath)
- [Measure Theoretic Probability](#) (Mastermath)
- [Partial Differential Equations](#) (Mastermath)
- [Simulation Methods in Statistics](#) (UvA)
- [Statistical Models](#) (VU)
- [Stochastic Optimization](#) (VU)
- [Stochastics Processes for Finance](#) (VU)
- [Stochastic Simulation](#) (UvA)

Advanced courses

- [Interest Rate Models](#) (UvA)
- [Portfolio Theory](#) (UvA)
- [Discrete Choice Analysis: Theory and Applications](#) (Mastermath/WONDER)

Related courses

- [Mathematical Biology](#) (Mastermath, 17/18)
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Spring 2018

Master Seminar

- [Master Seminar in Stochastics](#) (@VU)

Suggested basic courses

- [Stochastic Differential Equations](#) (Mastermath)
- [Stochastic Integration](#) (UvA)
- [Stochastic Processes](#) (Mastermath)
- [Time Series](#) (Mastermath)

Advanced courses

- [Queues & Levy Fluctuation Theory](#) (UvA)
- [Percolation: from introduction to frontiers of current research](#) (Mastermath/WONDER)
- [Statistical Theory for High- and Infinite-Dimensional Models](#) (Mastermath)
- [Statistics for High-dimensional Data](#) (VU)

Related courses

- [Optimization of Business Processes](#) (VU)
-

Suggested lines

Probability

- Basic: [Asymptotic Statistics](#), [Forensic Probability and Statistics](#), [Measure Theoretic Probability](#)
- Advanced: [Queues & Levy Fluctuation Theory](#), [Percolation: from introduction to frontiers of current research](#)
- Related: [Functional Analysis](#), [Stochastic Integration](#), [Time Series](#),

Statistics

- Basic: [Asymptotic Statistics](#), [Measure Theoretic Probability](#), [Statistical Models](#), [Time Series](#)
- Advanced: [Statistical Theory for High- and Infinite-Dimensional Models](#), [Statistics for High-dimensional Data](#), [Statistics for Networks](#) (18/19)
- Related: [Machine Learning Theory](#), [Forensic Probability and Statistics](#)

Financial Mathematics

- Basic: [Measure Theoretic Probability](#), [Stochastics Processes for Finance](#)
- Advanced: [Interest Rate Models](#), [Portfolio Theory](#)
- Related: [Functional Analysis](#), [Partial Differential Equations](#)

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, Harry van Zanten.

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, Klaas Slooten, Mark van de Wiel, Wessel van Wieringen.

Mathematics: Biomedical Mathematics Track

Program outline

- **6EC:** [Master Seminar in Analysis and Dynamical Systems](#) or [Master Seminar in Stochastics](#) (two semesters, year 1)
- **3EC:** [Scientific Writing in English](#) (year 1)
- **36EC:** [Master Project Mathematics](#) (year 2)
- **30EC:** Minor Biomedical Mathematics
- **36EC:** Mathematics courses, consisting of
 - Compulsory courses:
 - * [Statistical Models](#)
 - * [Dynamical Systems](#)
 - * [Mathematial Biology](#)
 - Remainder (about 30C): mathematics courses (all tracks)
- **9EC:** Free (must be master courses; can be math, literature, ...)

Minor Biomedical Mathematics

For this minor we suggest 5 life science courses (see below). The minor may also include an 18EC applied project for students who already followed the VU biomedical mathematics program in the bachelor.

The minor of the Master may include at most 18EC of the bachelor courses currently in the “Biomedische Wiskunde” variant of the bachelor at the VU, for students who did not yet follow those courses. Specifically: Biochemie, Medische Fysiologie, Principles of Systems Biology, Introductie Medische Beeldbewerking.

Fall 2017

Master Seminar

- [Master Seminar in Analysis and Dynamical Systems](#) (@UvA) or [Master Seminar in Stochastics](#) (@UvA)

Suggested Mathematics courses

- [Asymptotic Statistics](#) (Mastermath)
- [Dynamical Systems](#) (Mastermath)
- [Functional Analysis](#) (Mastermath)
- [Mathematial Biology](#) (Mastermath)
- [Introduction to Numerical Bifurcation Analysis of ODEs and maps](#) (Mastermath, not every year)
- [Partial Differential Equations](#) (Mastermath)
- [Statistical Models](#) (VU)

- [Statistics for Networks](#) (VU, 18/19)

Suggested life science courses in the Minor Biomedical Mathematics

- [From Molecule to Mind](#) (VU, period 1)
 - [Algorithms in Sequence Analysis](#) (VU, period 2)
 - [Mechanics and Thermodynamics in the Cell](#) (VU, period 2)
-

Spring 2018

Master Seminar

- [Master Seminar in Analysis and Dynamical Systems](#) (@VU) or [Master Seminar in Stochastics](#) (@VU)

Suggested Mathematics courses

- [Inverse Problems in Imaging](#) (Mastermath)
- [Nonlinear Waves](#) (Mastermath)
- [Stochastic Differential Equations](#) (Mastermath)
- [Statistics for High-Dimensional Data](#) (VU)
- [Stochastic Processes](#) (Mastermath)
- [Time Series](#) (Mastermath)

Suggested life science courses in the Minor Biomedical Mathematics

- [Basic Models of Biological Networks](#) (VU, period 4)
 - [Advanced Modeling in Systems Biology](#) (VU, period 6)
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Research staff in Mathematical Biology

VU

Jan Bouwe van den Berg, Frank Bruggeman, Mathisca de Gunst, Joost Hulshof, Bob Planqué, Mark van de Wiel, Wessel van Wieringen.

Mathematics: Education Track

Program outline

- **24EC:** [Master Project Mathematics \(T, E track\)](#) (year 2)
 - **60EC:** [Teaching qualification](#) (including internship)
 - **24EC:** Mathematics courses, from the MasterMath and local program. This excludes the MasterMath teacher courses.
 - **12EC:** Free (must be master courses, but may include the MasterMath teacher courses; can be math, literature, ...)
-

Alternative program for students with an Education Minor (30EC obtained earlier in the Bachelor)

- **24EC:** [Master Project Mathematics \(T, E track\)](#) (year 2)
- **33EC:** [Teaching qualification](#) (reduced: didaktiek, praktijk en onderzoek)
- **51EC:** Mathematics courses, of which at most 27EC from the elective courses in the third year of the bachelor, and at least 24EC courses from the MasterMath and local master program. This excludes the MasterMath teacher courses.
- **12EC:** Free (must be master courses, but may include the MasterMath teacher courses; can be math, literature, ...)

Mathematics: Teachers Track

This track has a special entry requirement: HBO students from the “lerarenopleiding wiskunde” with a “tweedegraadsbevoegdheid” can enter this track after having followed a premaster program (consisting of a specific selection of 30EC of first year bachelor courses). In the Teacher track, they follow a lot of mandatory courses (42EC) and must reach the exit level of the Education track.

Program outline

- **24EC:** [Master Project Mathematics \(T, E track\)](#) (year 2)
- **30EC:** [Teaching qualification](#) (reduced, including internship)
- **66EC:** Mathematics courses, consisting of
 - Compulsory courses:
 - * [Analyse 3](#) (given for the last time in 2017/18)
 - * [Complexe Analyse](#)
 - * [Dynamische Systemen](#)
 - * [Measure Theory](#)
 - * [Numerical Methods](#)
 - * [Statistical Data Analysis](#)
 - * [Statistics](#)
 - Remainder (24C): mathematics courses from the MasterMath and local master program. This excludes the MasterMath teacher courses.

Mathematics: Discrete Mathematics

There is no track in discrete mathematics, but there are a few recommended courses open to students from all three tracks. Several staff members at VU and UvA work in Discrete Mathematics and can supervise a Master Project in this area.

Fall 2017

Suggested basic courses

- [Probabilistic and Extremal Combinatorics](#) (Mastermath)
- [Discrete Optimization](#) (Mastermath)

Advanced courses

- [Advanced Combinatorics](#) (Mastermath/WONDER)
- [Discrete Choice Analysis: Theory and Applications](#) (Mastermath/WONDER)

Related courses

- [Algebraic Topology](#) (Mastermath)
 - [Commutative Algebra](#) (Mastermath)
 - [Measure Theoretic Probability](#) (Mastermath)
-

Spring 2018

Suggested basic courses

- [Algebraic Methods in Combinatorics](#) (Mastermath)
- [Coding Theory](#) (Mastermath)
- [Advanced Linear Programming](#) (Mastermath)
- [Computational Complexity](#) (UvA, Master of Logic)

Advanced courses

- [Algorithmic Geometry of Numbers](#) (Mastermath)
-

Research staff in Discrete Mathematics

UvA

Jan Brandts, Viresh Patel, Guus Regts, Lex Schrijver, Jacob Turner.

VU

Bram Gorissen,

Stochastics and Financial Mathematics

Program outline

- **6EC:** [Master Seminar in Stochastics](#) (year 1)
 - **3EC:** [Scientific Writing in English](#) (year 1)
 - **36EC:** [Master Project SFM](#) (year 2)
 - **63EC:** Designated SFM courses from the list below, consisting of
 - [Measure Theoretic Probability](#) (Mastermath)
 - at least 2 Financial Mathematics courses, out of
 - * [Computational Finance](#) (UvA master Computational Science)
 - * [Interest Rate Models](#)
 - * [Portfolio Theory](#)
 - * [Stochastics Processes for Finance](#)
 - at least 2 advanced SFM courses
 - **12EC:** Free (must be master courses; can be a designated SFM course, Math, literature, . . .)
-

Fall 2017

Master Seminar

- [Master Seminar in Stochastics](#) (@UvA)

Designated SFM courses

- [Applied Analysis: Financial Mathematics](#) (VU)
- [Applied Stochastic Modelling](#) (VU)
- [Asymptotic Statistics](#) (Mastermath)
- [Discrete Choice Analysis: Theory and Applications](#) (Mastermath/WONDER)
- [Forensic Probability and Statistics](#) (Mastermath)
- [Functional Analysis](#) (Mastermath)
- [Interest Rate Models](#) (UvA)
- [Machine Learning Theory](#) (Mastermath)
- [Measure Theoretic Probability](#) (Mastermath)
- [Partial Differential Equations](#) (Mastermath)
- [Portfolio Theory](#) (UvA)
- [Simulation Methods in Statistics](#) (UvA)
- [Statistical Models](#) (VU)
- [Stochastic Optimization](#) (VU)
- [Stochastics Processes for Finance](#) (VU)
- [Stochastic Simulation](#) (UvA)

Advanced SFM courses

- [Discrete Choice Analysis: Theory and Applications](#) (Mastermath/WONDER)
- [Interest Rate Models](#) (UvA)
- [Portfolio Theory](#) (UvA)
- [Statistics for Networks](#) (VU, 18/19)

Spring 2018

Master Seminar

- [Master Seminar in Stochastics](#) (@VU)

Designated SFM courses

- [Computational Finance](#) (UvA master Computational Science)
- [Optimization of Business Processes](#) (VU)
- [Percolation: from introduction to frontiers of current research](#) (Mastermath/WONDER)
- [Queueing Theory](#) (Mastermath)
- [Queues & Levy Fluctuation Theory](#) (UvA)
- [Stochastic Differential Equations](#) (Mastermath)
- [Statistical Theory for High- and Infinite-Dimensional Models](#) (UvA)
- [Statistics for High-dimensional Data](#) (VU)
- [Stochastic Integration](#) (UvA)
- [Stochastic Processes](#) (Mastermath)
- [Time Series](#) (Mastermath)

Advanced SFM courses

- [Queues & Levy Fluctuation Theory](#) (UvA)
- [Percolation: from introduction to frontiers of current research](#) (Mastermath/WONDER)
- [Statistical Theory for High- and Infinite-Dimensional Models](#) (Mastermath)
- [Statistics for High-dimensional Data](#) (VU)

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, Maria Remerova, Marjan Sjerps, Peter Spreij, Robin de Vilder, Erik Winands, Harry van Zanten.

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.

Final remarks

Free Masters

As prescribed in part A of the OER, students may apply to the Board of Examiners to do a “free master”, in which they are not bound to a track. This is not generally advised, unless there is a focus on some research area not represented in the tracks, such as mathematical logic or discrete mathematics. The criteria roughly are:

- **6EC:** One of the three Master Seminars
 - **3EC:** [Scientific Writing in English](#)
 - **36EC:** [Master Project Mathematics](#)
 - **36EC:** A coherent selection of Master courses in Mathematics or logic, offered in Amsterdam or in Mastermath. At least two of these should be advanced Master courses. The meaning of “coherent” is to be decided by the Board of Examiners.
 - **24EC:** Other mathematics courses offered locally and in MasterMath.
 - **15EC:** Free (must be master level; can be math, literature, . . .)
-

Interdisciplinary Masters

The Biomedical Mathematics track is an example of an interdisciplinary track. If a student would like to combine mathematics with another discipline, then the Board of Examiners can approve such a program. The criteria roughly are:

- **6EC:** One of the three Master Seminars
 - **3EC:** [Scientific Writing in English](#)
 - **36EC:** [Master Project Mathematics](#)
 - **30EC:** A Minor, consisting of a coherent selection of Master courses in a field that is (loosely) related to Mathematics. The meaning of “coherent” is to be decided the Board of Examiners.
 - **36EC:** Mathematics courses offered locally or in MasterMath. At least two of these should be advanced Master courses.
 - **9EC:** Free (must be master level; can be math, literature, . . .)
-

Other courses

Several courses that may be followed in the Master Mathematics or as elective courses in the Master SFM, do not fall explicitly under a track and hence were not mentioned in this document. For more details we refer to the online [UvA](#) and [VU](#) study guides, and the [Mastermath](#) website.