university of groningen / faculty of science and engineering

Appendices to Teaching and Examination regulations: Master's degree programme in Mathematics

2018-2019

Appendix I Learning outcomes of the degree programme (art. 3.1)

Objectives of MSc Mathematics

As a consequence of the ongoing automation of society and the technological innovations that go along with it, the call of our society for mathematics is growing. Underneath virtually every form of automation lies a mathematical concept or model. In order to be able to respond to this development in society, it is important that mathematics is utilized in a proper and effective way. This requires that society has access to sufficiently many well qualified and highly trained mathematicians. The master's degree programme in Mathematics aims to train mathematicians who meet this profile.

The master's degree programme in Mathematics aims to impart knowledge, skills, understanding and an academic attitude in the field of mathematics by means of a broadly based curriculum building on a bachelor's degree in Mathematics, such that Master's graduates are able able to pursue an independent career as independent professionals and are also qualified for further training to become academic researchers in the field.

Learning outcomes MSc Mathematics

The above objective has been translated into a set of learning outcomes for the programme. The learning outcomes consist of general learning outcomes with respect to both knowledge and skills, which are applicable for all tracks of the programme, supplemented with track-specific learning outcomes. For each learning outcome a reference to the Dublin descriptors is given between brackets.

The master graduate in Mathematics:

A1. has an understanding of the most important concepts of the field, [knowledge and understanding]
A2. is able to contribute to the scientific advancement of a subfield of mathematics, [applying knowledge and understanding]
A3. is able to use abstract thinking and mathematical reasoning to get to the root of a problem and thus recognize whether existing methods are applicable, or to ascertain that new methods must be developed, [applying knowledge and understanding]
A4. is able to function in multidisciplinary teams, [applying knowledge and understanding]
A5. is familiar with the social and ethical aspects of applying mathematics in practice, [judgement]
A6. understands the scientific relevance of problem definitions and results, and the validity of the scientific method, [judgement]
A7. is able to describe solutions in both general and formal mathematical terms, [communication]
A8. is able to express him- or herself well both orally and in writing, [communication]
A9. is able to evaluate the scientific literature so as to keep their knowledge up to date. [learning]

In addition, the master graduate in Mathematics track Mathematics and Complex Dynamical Systems or track Statistics and Big Data

P1. has specialized knowledge of theories, methods and techniques in at least one of the following subfields of mathematics: [knowledge and understanding]
    a. Algebra & Geometry
    b. Dynamical Systems and Analysis
    c. Statistics and Probability

P2. has experience with formulating ideas and problems in the mathematical language and with interpreting the mathematical results in the light of the original, non-mathematical problem, [applying knowledge and understanding]
P3. is able to apply scientific results and insights to concrete problems in mathematics or in related fields (natural sciences or applied mathematics), [applying knowledge and understanding]
P4. is familiar with and experiences mathematics as a coherent organic unit. [judgement]

Whereas the master graduate in Mathematics track Science, Business and Policy:
M1. Has an understanding of the way in which businesses and policy organisations are functioning (governments and nongovernmental organisations, NGO's)[knowledge and understanding]
M2. Understands the connections between natural science research, business, and policy [knowledge and understanding]
M3. Is able to integrate aspects of natural science, business and management [applying knowledge and understanding]
M4. Has developed his/her social and communicative skills, is able to work project-based, and is capable of taking professional responsibility [communication, judgement]

Appendix II Tracks/Specializations of the degree programme (art. 3.5)

The degree programme has three tracks:
- Mathematics and Complex Dynamical Systems
- Statistics and Big Data
- Science, Business and Policy

Appendix III Content of the degree programme (art. 3.6)

Mathematics and Complex Dynamical Systems, and the Statistics and Big Data track

The master programme comprises 120 ECTS.

The requirements on the programme are the following.

Parts	*Constraints*	*ECTS*
Group of three compulsory modules, followed jointly by all Master students Mathematics and Applied Mathematics	The following three modules are compulsory: - Mathematics and its Environment - Mathematical Modeling Colloquium - Complexity and Networks	15

Group of five modules either from the track Mathematics and Complex Dynamical Systems or the track Statistics and Big Data.	**Track Mathematics and Complex Dynamical Systems:** Five modules from the following list of modules should be chosen: - Caput Dynamical Systems and Chaos (annual) - Caput Mathematical Physics (every two years, 2019-2020) - Hamiltonian Mechanics (annual) - Caput Algebra and Geometry (annual) - Caput Differential Geometry (annual) - Geometry and Topology (every two years, 2019-2020) - Geometry and Differential Equations (every two years, 2018-2019) - Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners) **Track Statistics and Big Data:** The following five modules are compulsory: - Contemporary Statistics with Applications (every two years, 2018-2019) - Statistical Genomics (every two years, 2019-2020) - Statistical Consulting (annual) - Advanced Asymptotic Statistics (annual, local Master course) or Asymptotic Statistics (Mastermath) - Introduction to Data Science (annual)	≥ 25
A group of three modules of 'guided choice'.	Three modules have to be chosen from the lists of compulsory modules of any of the tracks in Mathematics and Applied Mathematics or from the Mastermath Programme, see elo.mastermath.nl. For the Track Statistics and Big Data the following courses are of specific interest: a. Statistics and Probability related - Courses from the Mastermath programme labelled with STAR see elo.mastermath.nl, in addition in 2018-2019 the course Probabilistic and Extremal Combinatorics, Forensic Probability and Statistics, and Applied Statistics - Pattern Recognition (INMPR-08) - Machine Learning (KIM.ML09) - Statistical Signal Processing (STMASP-12) - Neural Networks and Computational Intelligence (WMCS15001) b. Data Science related - Web and Cloud Computing (INMWCC-12)	15

	Scientific Visualization (INMSV-08) Scalable Computing (WMCS16003) Visual Analytics for Big Data (WMCS16000) c. Applied Mathematics Robust Control (WIRC-09) Computational Fluid Dynamics (WICFD-03) Modeling and Control of Complex Nonlinear Engineering Systems (WIMCCNES12)	
A group of three modules of 'free choice'	Free choice out of modules on Master level, relevant for the master Mathematics (at the discretion of the Board of Examiners)	15
Master's Research Project	Research project in the specialization area.	50

Science, Business and Policy track

The master programme comprises 120 ECTS and consists of a mathematical component (60 ECTS) and a Business and Policy component (60 ECTS)

The requirements on the programme are the following.

Mathematical component (60 ECTS)		
Parts	*Constraints*	*ECTS*
Group of two compulsory modules, followed jointly by all Master students Mathematics and Applied Mathematics	The following three modules are compulsory: Mathematics and its Environment Complexity and Networks	10
Group of four modules, within either the track Mathematics and Complex Dynamical Systems or the track Statistics and Big Data.	Three modules from either the track Mathematics and Complex Dynamical Systems or the track Statistics and Big Data should be chosen. All three modules should be chosen within the specific specialization area of the student: **Track Mathematics and Complex Dynamical Systems:** Caput Dynamical Systems and Chaos (annual) Caput Mathematical Physics (every two years, 2019-2020) Hamiltonian Mechanics (annual) Caput Algebra and Geometry (annual) Caput Differential Geometry (annual)	20

	☐ Geometry and Topology (every two years) ☐ Geometry and Differential Equations (every two years, 2018-2019) ☐ Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners) **Track Statistics and Big Data:** At least three out of ☐ Contemporary Statistics with Applications (every two years, 2018-2019) ☐ Statistical Genomics (every two years, 2019-2020) ☐ Statistical Consulting (annual) ☐ Advanced Asymptotic Statistics (annual, local Master course) or Asymptotic Statistics (annual, Mastermath) ☐ Introduction to Data Science (annual) ☐ Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners) At most one out of ☐ Pattern Recognition ☐ Visual Analytics for Big Data ☐ Machine Learning ☐ Neural Networks and Computational Intelligence ☐ Statistical Signal Processing	
Mathematical Research Project	Research project in the specialization area	30

Business and Policy component (60 ECTS)		
Parts	*Constraints*	*ECTS*
Module Science and Business		10
Module Science and Policy		10
Internship Science, Business and Policy		40

For information on the modules of the Mastermath programme see http://elo.mastermath.nl.

For information on the modules of programmes of the University of Groningen other than the ones offered by the master's degree programme in mathematics see the Teaching and Examination Regulations of the corresponding programme.

Double master's degree in Physics and Mathematics
For students who want to combine the master's programme in Physics and Mathematics the following programme is in place. In case the student is enrolled in both programmes, the student is awarded a master's degree in both Physics and Mathematics after completing the total programme. The total programme comprises (at least) 160 ects, (at least) 90 ects of courses and 70 ects of research, and is feasible within 2 ½ year of study.

Master Physics	**Master Mathematics**
Core Physics (20 ects) - Advanced Quantum Mechanics - Computational Physics - Statistical Mechanics - Mathematical Methods of Physics - Scientific Integrity (0 ects) - General Physics Colloquium (0 ects)	*Three modules followed jointly by all Master students Mathematics and Applied Mathematics (15 ects):* - Mathematics and its Environment - Mathematical Modeling Colloquium - Complexity and Networks
Core QU (20 ects) - General Relativity - Particle Physics Phenomenology - Electrodynamics of Radiation Processes - Student Seminar Quantum Universe	*Five modules from the track Mathematics and Complex Dynamical Systems (25 ects)* - Caput Algebra and Geometry (annual) - Geometry and Topology (every two years, 2019-2020) - Geometry and Differential Equations (every two years, 2020-2021) - Caput Differential Geometry (annual) - Caput Dynamical Systems and Chaos (annual) - Caput Mathematical Physics (every two years, 2019-2020) - Hamiltonian Mechanics (annual) - Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners)
Optional Courses QU (10 ects) - two optional courses QU which are not part of the individual mathematics programme of the student	*Free Choice (10 ects)* - Free choice out of modules on Master level, relevant for the master Mathematics (at the discretion of the Board of Examiners)
Joint Research Project (70 ects)	Joint Research Project (70 ects)

For information about the courses of the master's degree programme Physics and a list of optional courses QU see the Teaching and Examination Regulations of the master's degree programme in Physics.

The Mathematics modules given at the University of Groningen are (for the entry requirements see Appendix V)

Module	**offered**	**ECTS**	**practical**
Caput Algebra and Geometry	annual	5	
Geometry and Topology	every two years	5	
Geometry and Differential Equations	every two years	5	
Caput Differential Geometry	annual	5	x
Caput Dynamical Systems and Chaos	annual	5	
Caput Mathematical Physics	every two years	5	x
Hamiltonian Mechanics	annual	5	
Statistical Genomics	every two years	5	x
Advanced Asymptotic Statistics	annual	5	
Statistical Consulting	annual	5	x
Contemporary Statistics with Applications	every two years	5	x
Mathematical Modeling Colloquium	annual	5	x
Mathematics and its Environment	annual	5	x
Complexity and Networks	annual	5	
Joint Research Project	annual	70	x
Master's Research Project	annual	50	x
Mathematical Research Project	annual	30	x

For information on the modules of the Mastermath programme see http://elo.mastermath.nl

The modules of the Business and Policy component are

Module	**offered**	**ECTS**	**practical**
Introduction Science and Business	annual	10	x
Introduction Science and Policy	annual	10	x
Internship Science, Business and Policy	annual	40	x

Appendix IV Electives (art. 3.7)

See Appendix III.

Appendix V Entry requirements and compulsory order of examinations (art. 4.4)

The entry requirement for the Final Research Project (50 ECTS) is a successful completion of 45 ECTS of modules of the master's degree programme in Mathematics.

The entry requirement for the internship Science, Business and Policy is a successful completion of the module Introduction Science and Business (10 ECTS), the module Introduction Science and Policy (10 ECTS), the 60 ECTS mathematical component of the programme (including mathematical research project (30 ECTS)), and the module Acquisition Tools & Career Management (0 ECTS).

Appendix VI Admission to the degree programme and different specializations (art. 2.1.1 + art. 2.2)

Holders of the following Bachelor's degree from the University of Groningen are considered to have sufficient knowledge and skills and will be admitted to the Master's degree programme in Mathematics on that basis:

- BSc Mathematics
- BSc Applied Mathematics

Appendix VII Transitional provisions (art. 7.1)

Course	May be replaced with	Reason
Geometry and Differential Equations (WMMA14002)	Symmetries and Conservation Laws (Mastermath)	The local course is not offered in 2018-2019

Appendix VIII
Application deadlines for admission (art. 2.6.1)

Deadline of Application	Non-EU students	EU students
Nanoscience	February 1st 2019	May 1st 2019
All other FSE Masters	May 1st 2019	May 1st 2019

Decision deadlines (art. 2.6.3)

Deadline of Decision	Non-EU students	EU students
All FSE Masters	June 1st 2019	June 1st 2019