



university of
 groningen

faculty of science
 and engineering

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

2017-2018



Appendix I Learning outcomes of the degree programme (art. 1.3)

The learning outcomes consist of general learning outcomes with respect to both knowledge and skills, which are applicable for both the research profile and the Science, Business and Policy profile, supplemented with profile-specific learning outcomes. For each learning outcome a reference to the Dublin descriptors is given between brackets.

The master graduate in Mathematics:

1. has an understanding of the most important concepts of the field, [knowledge and understanding]
2. is able to contribute to the scientific advancement of a subfield of mathematics, [applying knowledge and understanding]
3. is able to use abstract thinking and mathematical modeling 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]
4. is able to function in multidisciplinary teams, [applying knowledge and understanding]
5. is familiar with the social and ethical aspects of applying mathematics in practice, [judgement]
6. understands the scientific relevance of problem definitions and results, and the validity of the scientific method, [judgement]
7. is able to describe solutions in both general and formal mathematical terms, [communication]
8. is able to express him- or herself well both orally and in writing, [communication]
9. is able to evaluate the scientific literature so as to keep their knowledge up to date. [learning]

In addition, the master graduate in Mathematics with a research profile

1. 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. Analysis
 - c. Dynamical Systems
 - d. Mathematical Physics
 - e. Statistics and Probability
2. has experience with the mathematical modeling of non-mathematically formulated ideas and problems and with interpreting the mathematical results in the light of the original, non-mathematical problem, [applying knowledge and understanding]
3. 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]
4. is familiar with and experiences mathematics as a coherent organic unit. [judgement]



Whereas the master graduate in Mathematics with the profile Science, Business and Policy:

1. Has an understanding of the way in which businesses and policy organisations are functioning (governments and nongovernmental organisations, NGO's)[knowledge and understanding]
2. Understands the connections between natural science research, business, and policy [knowledge and understanding]
3. Is able to integrate aspects of natural science, business and management [applying knowledge and understanding]
4. 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. 2.2)

The degree programme has three tracks:

- Mathematics and Complex Dynamical Systems
- Statistics and Big Data
- Science, Business and Policy

The track Mathematics and Complex Dynamical Systems covers the specialisation areas Analysis, Dynamical Systems, Mathematical Physics, Algebra and Geometry. The track Statistics and Big Data covers Statistics and Probability Theory.



Appendix III Content of the degree programme (art. 2.3)

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

The track Mathematics and Complex Dynamical Systems covers the specialisation areas Analysis, Dynamical Systems, Mathematical Physics, Algebra and Geometry.

The track Statistic and Big Data covers Statistics and Probability Theory.

The master programme comprises 120 ECTS.

The requirements on the programme are the following.

<i>Parts</i>	<i>Constraints</i>	<i>ECTS</i>
Group of three compulsory modules, followed jointly by all Master students Mathematics and Applied Mathematics	The following three modules are compulsory: <ul style="list-style-type: none"><input type="checkbox"/> Mathematics and its Environment<input type="checkbox"/> Mathematical Modeling Colloquium<input type="checkbox"/> Complexity and Networks	15



<p>Group of five modules either from the track Mathematics and Complex Dynamical Systems or the track Statistics and Big Data.</p>	<p>Track Mathematics and Complex Dynamical Systems:</p> <p>Five modules from the following list of modules should be chosen:</p> <ul style="list-style-type: none"><input type="checkbox"/> Caput Dynamical Systems and Chaos (annual)<input type="checkbox"/> Caput Mathematical Physics (every two years, 2017-2018)<input type="checkbox"/> Hamiltonian Mechanics (annual)<input type="checkbox"/> Caput Algebra and Geometry (annual)<input type="checkbox"/> Caput Differential Geometry (annual)<input type="checkbox"/> Geometry and Topology (every two years, 2017-2018)<input type="checkbox"/> Geometry and Differential Equations (every two years, 2018-2019)<input type="checkbox"/> Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners) <p>Track Statistics and Big Data:</p> <p>The following five modules are compulsory:</p> <ul style="list-style-type: none"><input type="checkbox"/> Contemporary Statistics with Applications (every two years, 2018-2019)<input type="checkbox"/> Statistical Genomics (every two years, 2017-2018)<input type="checkbox"/> Statistical Consulting (annual)<input type="checkbox"/> Advanced Asymptotic Statistics (annual, local Master course) or Asymptotic Statistics (Mastermath)<input type="checkbox"/> Introduction to Data Science (annual)	<p>≥ 25</p>
<p>A group of three modules of ‘guided choice’.</p>	<p>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.</p> <p>For the Track Statistics and Big Data the following courses can be chosen as well:</p> <p>a. Statistics specialization</p> <ul style="list-style-type: none"><input type="checkbox"/> Measure-Theoretic Probability (Mastermath)<input type="checkbox"/> Percolation (Mastermath)<input type="checkbox"/> Pattern Recognition (INMPR-08)<input type="checkbox"/> Machine Learning (KIM.ML09)<input type="checkbox"/> Statistical Signal Processing (STMASP-12)<input type="checkbox"/> Neural Networks and Computational Intelligence (WMCS15001) <p>b. Data Science</p> <ul style="list-style-type: none"><input type="checkbox"/> Web and Cloud Computing (INMWCC-12)<input type="checkbox"/> Scientific Visualization (INMSV-08)<input type="checkbox"/> Scalable Computing (WMCS16003)	<p>15</p>



	<ul style="list-style-type: none"> <input type="checkbox"/> Visual Analytics for Big Data (WMCS16000) c. Applied Mathematics <ul style="list-style-type: none"> <input type="checkbox"/> Robust Control (WIRC-09) <input type="checkbox"/> Computational Fluid Dynamics (WICFD-03) <input type="checkbox"/> 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)		
<i>Parts</i>	<i>Constraints</i>	<i>ECTS</i>
Group of three compulsory modules, followed jointly by all Master students Mathematics and Applied Mathematics	The following three modules are compulsory: <ul style="list-style-type: none"> <input type="checkbox"/> Mathematics and its Environment <input type="checkbox"/> Mathematical Modeling Colloquium <input type="checkbox"/> Complexity and Networks 	15
Group of three 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: <ul style="list-style-type: none"> <input type="checkbox"/> Caput Dynamical Systems and Chaos (annual) <input type="checkbox"/> Caput Mathematical Physics (every two years, 2017-2018) <input type="checkbox"/> Hamiltonian Mechanics (annual) <input type="checkbox"/> Caput Algebra and Geometry (annual) <input type="checkbox"/> Caput Differential Geometry (annual) <input type="checkbox"/> Geometry and Topology (every two years, 2017-2018) 	15



	<ul style="list-style-type: none"> <input type="checkbox"/> Geometry and Differential Equations (every two years, 2018-2019) <input type="checkbox"/> Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners) <p>Track Statistics and Big Data: At least two out of</p> <ul style="list-style-type: none"> <input type="checkbox"/> Contemporary Statistics with Applications (every two years, 2018-2019) <input type="checkbox"/> Statistical Genomics (every two years, 2017-2018) <input type="checkbox"/> Statistical Consulting (annual) <input type="checkbox"/> Advanced Asymptotic Statistics (annual, local Master course) or Asymptotic Statistics (annual, Mastermath) <input type="checkbox"/> Introduction to Data Science (annual) <input type="checkbox"/> Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners) <p>At most one out of</p> <ul style="list-style-type: none"> <input type="checkbox"/> Pattern Recognition <input type="checkbox"/> Visual Analytics for Big Data <input type="checkbox"/> Machine Learning <input type="checkbox"/> Neural Networks and Computational Intelligence <input type="checkbox"/> Statistical Signal Processing 	
Mathematical Research Project	Research project in the specialization area	30
<i>Business and Policy component (60 ECTS)</i>		
<i>Parts</i>	<i>Constraints</i>	<i>ECTS</i>
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
<p><i>Core Physics (20 ects)</i></p> <ul style="list-style-type: none"> - Advanced Quantum Mechanics - Computational Physics - Statistical Mechanics - Mathematical Methods of Physics - Scientific Integrity (0 ects) - General Physics Colloquium (0 ects) 	<p><i>Three modules followed jointly by all Master students Mathematics and Applied Mathematics (15 ects):</i></p> <ul style="list-style-type: none"> - Mathematics and its Environment - Mathematical Modeling Colloquium - Complexity and Networks
<p><i>Core QU (20 ects)</i></p> <ul style="list-style-type: none"> - General Relativity - Particle Physics Phenomenology - Electrodynamics of Radiation Processes - Student Seminar Quantum Universe 	<p><i>Five modules from the track Mathematics and Complex Dynamical Systems (25 ects)</i></p> <ul style="list-style-type: none"> - Caput Algebra and Geometry (annual) - Geometry and Topology (every two years, 2017-2018) - Geometry and Differential Equations (every two years, 2018-2019) - Caput Differential Geometry (annual) - Caput Dynamical Systems and Chaos (annual) - Caput Mathematical Physics (every two years, 2017-2018) - Hamiltonian Mechanics (annual) - Relevant courses from the Mastermath Programme, see elo.mastermath.nl (at the discretion of the Board of Examiners)
<p><i>Optional Courses QU (10 ects)</i></p> <ul style="list-style-type: none"> - two optional courses QU which are not part of the individual mathematics programme of the student 	<p><i>Free Choice (10 ects)</i></p> <ul style="list-style-type: none"> - Free choice out of modules on Master level, relevant for the master Mathematics (at the discretion of the Board of Examiners)
<p>Joint Research Project (70 ects)</p>	<p>Joint Research Project (70 ects)</p>

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

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

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
Science, Business and Policy	annual	20	
Internship Science, Business and Policy	annual	40	



Appendix IV Electives (art. 2.4)

See Appendix III.

Appendix V Entry requirements and compulsory order of examinations (art. 3.4)

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 Science and Business (10 ECTS), the module Science and Policy (10 ECTS), the 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. 5.1.1 + art. 5.2)

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)

No transitional provisions are in place

Appendix VIII Application deadlines for admission (art. 5.6.1)

Deadline of Application	Non-EU students	EU students
Nanoscience	February 1st 2018	May 1st 2018
Behavioural and Cognitive Neurosciences	May 1st 2018	May 1st 2018
Biomolecular Sciences (topprogramme)	May 1st 2018	May 1st 2018
Evolutionary Biology (topprogramme)	May 1st 2018	May 1st 2018
Remaining FSE Masters (amongst which Mathematics)	May 1st 2018	May 1st 2018

Decision deadlines (art. 5.6.3)

Deadline of Decision	Non-EU students	EU students
Nanoscience	June 1st 2018	June 1st 2018
Behavioural and Cognitive Neurosciences	June 1st 2018	June 1st 2018
Biomolecular Sciences (topprogramme)	June 1st 2018	June 1st 2018
Evolutionary Biology (topprogramme/EM)	June 1st 2018	June 1st 2018
Remaining FSE Masters (amongst which Mathematics)	November 1st 2018	November 1st 2018