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Appendices for the Master's degree programme(s) in Applied Mathematics

2025-2026

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

Objective of MSc Applied 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 Applied Mathematics aims to train mathematicians who meet this profile.

The master's degree programme in Applied 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 Applied Mathematics, such that Master's graduates are able to pursue an independent career as independent professionals and are also qualified for further training to become academic researchers or designer in the field.

Learning outcomes MSc Applied 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 the Master's degree programme in Mathematics as well) which are supplemented with programme-specific learning outcomes. For each learning outcome a reference to the Dublin descriptors is given between brackets.

The master graduate in Applied 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 applied mathematics, [applying knowledge and understanding]
A3. is able to use abstract thinking and mathematical modelling 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 communicate effectively ideas, problems and solutions with the mathematical, science and engineering communities. [communication]
A8. is able to express themselves 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 Applied Mathematics:

T1. has general knowledge of the theories, methods and techniques in the field of applied mathematics, [knowledge and understanding]
T2. has specialized knowledge in at least one of the following subfields of applied mathematics: [knowledge and understanding]
    a. Computational Mathematics
    b. Systems, Control and Optimization
    c. Statistics

T3. has wide experience with the mathematical modelling of problems from actual practice, [applying knowledge and understanding]
T4. has extensive experience with using the relevant mathematical tools. [applying knowledge and understanding]

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Appendix II Tracks/Specializations (art. 3.6)

The degree programme has the following specializations

1. Computational Mathematics
2. Systems and Optimization
3. Statistics and Data Science

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Appendix III Content of the degree programme (art. 3.8)

The Master's degree programme in Applied Mathematics has a workload of at least 120 ECTS and it should not be possible to remove 1 course and still have more than 120 ECTS. The Master's programme comprises a compulsory specialization independent course set with a workload of 65 ECTS and a specialization specific part.

Compulsory joint programme

Course unit	Course code	ECTS	Entry requirements
Mathematics and its Environment	WMMA013-05	5	
Student Colloquium	WMMA029-05	5	
Research Seminar in Applied Mathematics	WMMA050-05	5	
Master Research Project in Applied Mathematics	WMMA901-35	35	See Appendix V
Internship Applied Mathematics	WMMA001-15	15	See Appendix V

Specialization Computational Mathematics

The Computational Mathematics programme is composed of compulsory course units (≥25 ECTS) and electives. The compulsory courses are listed below, the electives can be found in App. IV.

Compulsory courses Computational Mathematics

Course unit	Course code	ECTS	Entry requirements
Computational Fluid Dynamics	WMMA012-05	5	
Finite Element Methods and Applications	WMMA051-05	5	
≥ 15 ECTS out of: - Iterative Algorithms - Coupled Problems (26/27) - Numerical Simulation of Turbulence (25/26) - Topics in Numerical Mathematics A (25/26) - Topics in Numerical Mathematics B (26/27)	 WMMA057-05 WMMA052-05 WMMA063-05 WMMA064-05 WMMA065-05	 5 5 5 5 5	

Specialization Systems and Optimization
The Systems and Optimization programme is composed of compulsory course units (≥ 25 ECTS) and electives. The compulsory courses are listed below, the electives can be found in App. IV.

Compulsory courses Systems and Optimization

Course unit	Course code	ECTS	Entry requirements
Robust Control	WMMA021-05	5	
Iterative Algorithms	WMMA057-05	5	
≥ 15 ECTS out of:			
- Convex Analysis (26/27)	WMMA060-05	5	
- Model Reduction for Control (26/27)	WMMA062-05	5	
- Nonlinear Control Systems	WMSC003-05	5	
- Calculus of Variations and Optimal Control (25/26)	WMMA056-05	5	
- Evolution Equations (25/26)	WMMA059-05	5	
- Data-based Analysis and Control (25/26)	WMMA058-05	5	
- Systems and Control (Mastermath)	WMMA003-06	6	

Specialization Statistics and Data Science
The Statistics and Data Science programme is composed of compulsory course units (≥ 25 ECTS) and electives. The compulsory courses are listed below, the electives can be found in App. IV.

Compulsory courses Statistics and Data Science

Course unit	Course code	ECTS	Entry requirements
≥ 25 ECTS out of:			
- Statistical Consulting	WMMA024-05	5	
- Topics in Probability and Statistics	WMMA039-05	5	
- Contemporary Statistics with Applications (26/27)	WMMA015-05	5	
- Statistical Genomics (25/26)	WMMA008-05	5	
- Introduction to Data Science	WMCS002-05	5	
- Statistical Signal Processing	WMAS011-05	5	
- Fitting dynamical models to data	WMIE007-05	5	
- Mathematical modelling and statistical analysis of the spread of infectious diseases (25/26)	WMMA061-05	5	

Possibility of double master degrees

It is possible to study the MSc Applied Mathematics in parallel to other master programmes. Individual courses can then count for both programmes, however in order to obtain two degrees at least 180 distinct ECTS have to be obtained. Furthermore, an internship/design project as well as a master research project can only be used for one of the degree programmes, unless the Board of Examiners allows a joint internship or research project.

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Appendix IV Electives (art. 3.9.1)

This appendix sets out the optional course units of the Master's degree programme in Applied Mathematics. Based on a well-founded request by a student, the Board of Examiners may grant permission to choose electives other than those listed here (from the University of Groningen or another university in the Netherlands or abroad). The programme or a part of it must in any case be coherent and of master level (at the discretion of the Board of Examiners).

External electives

The Departments of Mathematics of the Dutch universities organise a joint Mastermath programme consisting of about 60 Master's courses; see http://elo.mastermath.nl for details. The degree programme may contain elective modules of Mastermath. Because the workload of these modules is not 5 ECTS, but 6 or 8 ECTS, it may be that the total size of the programme is not exactly equal to 120 ECTS. If so, the size must be at least 120 ECTS and it should not be possible to remove 1 course and still have more than 120 ECTS; hence the total workload of the degree programme can be at most 124 ECTS. As long as there is no significant overlap with a local course any Mastermath course can be chosen as an elective. Furthermore, at the discretion of the Board of Examiners, courses may be added as extracurricular.

The degree programme in Applied Mathematics may also contain courses from other degree programmes. For information on the modules offered by other degree programmes at the University of Groningen, see also the Teaching and Examination Regulations of the corresponding programme.

Specialization Computational Mathematics

The electives in the track Computational Mathematics have a workload of 30-34 ECTS, of which 0-8 ECTS can be chosen freely (modules on Master level, relevant for Applied Mathematics, at the discretion of the Board of Examiners), the remaining electives must be chosen from the remaining compulsory courses Computation Mathematics (see above) or from the list below.

Guided Choice Computational Mathematics

Course unit	Course code	ECTS	Entry requirements
Computational Solid Mechanics	WMME028-05	5	
Advanced Machine Learning	WMAI030-05	5	
Neural Networks and Computational Intelligence	WMCS010-05	5	
Introduction to Data Science	WMCS002-05	5	
Image Processing	WMCS008-05	5	
Fitting Dynamical Models to Data	WMIE007-05	5	
Mastermath courses		6/8	

Contemporary Statistics with Applications (26/27)	WMMA015-05	5	
Statistical Consulting	WMMA024-05	5	
Nonlinear Control Systems	WMSC003-05	5	
Data-driven Optimization	WMME011-05	5	
Robust Control	WMMA021-05	5	
Model Reduction for Control (26/27)	WMMA062-05	5	
Data-based Analysis and Control (25/26)	WMMA058-05	5	
Neem Regie*	TEM0110-24	10	

*Note: The course Neem Regie (TEM0110-24) offers students the possibility to get acquainted with the work of a high school Mathematics teacher in the Netherlands. The course is taught in Dutch. Upon successful completion of the course students have the possibility to follow the post-master degree programme 'Leraar Voorbereidend Hoger Onderwijs in de Betawetenschappen' (LVHO) where they only still have to follow 50 ECTS, instead of the normal 60 ECTS.

Specialization Systems and Optimization
The electives in the specialization Systems and Optimization have a workload of 30-34 ECTS ECTS, of which 0-8 ECTS can be chosen freely (modules on Master level, relevant for Applied Mathematics, at the discretion of the Board of Examiners), the remaining elective(s) must be chosen from the remaining compulsory courses Systems and Optimization (see above) or from the list below.

Guided Choice Systems and Optimization

Course unit	Course code	ECTS	Entry requirements
Analysis and Control of Smart Systems	WMIE015-05	5	
Robotics for IEM	WMIE005-05	5	
Data-driven Optimization	WMME011-05	5	
Computational Fluid Dynamics	WMMA012-05	5	
Finite Element Methods and Applications	WMMA051-05	5	
Introduction to Data Science	WMCS002-05	5	
Contemporary Statistics with Applications (26/27)	WMMA015-05	5	
Statistical Consulting	WMMA024-05	5	
Fitting Dynamical Models to Data	WMIE007-05	5	
Mastermath courses		6/8	
Neem Regie*	TEM0110-05	10	

* See corresponding note at specialization Number Theory and Algebraic Geometry

Specialization Statistics and Data Science
The electives in the specialization Statistics and Data Science have a workload of 30-34 ECTS, of which 0-8 ECTS can be chosen freely (modules on Master level, relevant for Applied Mathematics, at the discretion of the Board of Examiners), the remaining electives must be chosen from the remaining compulsory courses Statistics and Data Science (see above) or from the list below.

Guided Choice Statistics and Data Science

Course unit	Course code	ECTS	Entry requirements
Pattern Recognition	WMCS011-05	5	
Advanced Machine Learning	WMAI030-05	5	
Neural Networks and Computational Intelligence	WMCS010-05	5	
Cloud Computing and Cloud-based Applications	WMCS032-05	5	
Astronomical Data Science	WMAS007-05	5	
Statistical Signal Processing	WMAS011-05	5	
Fitting dynamical models to data	WMIE007-05	5	
Big Data & Applications in Biomedicine	WMBM025-05	5	
Data Science in Biomedicine	WMBM023-05	5	
Robust Control	WMMA021-05	5	
Computational Fluid Dynamics	WMMA012-05	5	
Nonlinear Control Systems	WMSC003-05	5	
Finite Element Methods and Applications	WMMA051-05	5	
Data-based Analysis and Control (25/26)	WMMA058-05	5	
Data-driven Optimization	WMME011-05	5	
Mastermath courses		6/8	
Neem Regie*	TEM0110-05	10	

* See corresponding note at specialization Number Theory and Algebraic Geometry

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

Course unit	ECTS	Entry requirements
Master's Research Project Applied Mathematics	35	- Successful completion of 35 ECTS of modules of the Master's degree programme in Applied Mathematics - Enrolment in progress for the research project course - Approval of research plan including project schedule by supervisors and Master Project coordinator.
Internship Applied Mathematics	15	- Successful completion of 35 ECTS of modules of the Master's degree programme in Applied Mathematics - Enrolment in progress for the internship - Approval of internship including schedule by supervisors and the Internship coordinator.

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Appendix VI Admission to the degree programme (art. 2.1A.1 + 2.1B.1)

Holders of the following Bachelor's degrees from the University of Groningen are considered to have sufficient knowledge and skills and will be admitted to the master's degree programme in Applied Mathematics:

- BSc Mathematics
- BSc Applied Mathematics

The above degrees from other Dutch universities are considered equivalent to the corresponding UG degrees.

Appendix VII Pre-master programmes

Board of Admissions decides:

a. The content and the student workload of a tailormade Pre-Master's programme.
   or
b. Admission is not accepted.

Appendix VIII Transitional provisions (art. 7.1)

Since the TER for this academic year is applicable to all students registered in the Master's degree programme in Applied Mathematics, regardless of the starting date of students, transitional arrangements are in place.

For cohort 2024-2025 and earlier
The mandatory ECTS per specialization specific courses has been reduced from 35 to 25 ECTS in all three specializations; in case students have already completed more than 25 ECTS of mandatory courses, then 25 ECTS of these count as mandatory courses and the remaining courses count as electives.

The courses WMMA055-05 "Numerical Bifurcation Analysis", WMMA054-05 "Multiscale Numerical Methods" and WMMA053-05 "Model Reduction for PDEs" are discontinued, but if successfully completed in the past, can still be used as one of the compulsory courses for the specialization "Computational Mathematics" or as a corresponding elective.

For cohort 2023-2024 and earlier
The names of the following courses have been changed and hence are considered equivalent. Therefore, students are not allowed to include both the old and new course in their programme.

Old course	**New Course**
Modeling and Identification (WMMA007-05)	Model Reduction for Control (26/27) (WMMA062-05)
Modelling and Control of Complex Nonlinear Engineering Systems (WMMA020-05)	Nonlinear Control Systems (WMSC003-05)
Machine Learning (WMAI010-05)	Advanced Machine Learning (WMAI030-05)
Basiscursus Master Lerarenopleiding (Dutch) (TEM0105) Masterstage 1 (Dutch) (TEM0205)	Neem Regie (TEM0110-24)

For cohort 2022-2023 and earlier
In 2023/24 the tracks Computational Mathematics and Systems and Control were discontinued. Students who were enrolled in these tracks can finish these tracks according to the TER MSc Applied Mathematics 2022/23**.**

Appendix IX Additional Requirements Open Degree Programmes (Art. 3.10)

In exceptional circumstances, students wishing to pursue an open degree programme may file a request with the Board of Examiners. An Open Degree Programme must always be approved in advance by the Board of Examiners. The Board of Examiners will evaluate whether the proposed curriculum meets the learning outcomes of the degree programme and can determine further conditions in their rules and regulations.

The Open Degree Programme in Applied Mathematics must include the compulsory joint programme mentioned in App. III and at least 35 ECTS is to be taken from the lists of compulsory courses of the specializations, see App. III for details.