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

2019-2020

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 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, [applying 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 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 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 and Control,
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]

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

The degree programme has the following tracks:

- Computational Mathematics
- Systems and Control

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

The degree programme has the following tracks:

- Computational Mathematics
- Systems and Control

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 Computational Mathematics or the track Systems and Control.	**Track Computational Mathematics:** The following four modules are compulsory: - Computational Fluid Dynamics (annual) - Computational Mechanics 2 - Finite Element Methods for Fluid Dynamics (every two years, 2018-2019) (at least) one out of* - Numerical Bifurcation Analysis of Large Scale Systems (every two years, Mastermath, 2018 -2019) - Numerical Linear Algebra (annual, Mastermath) *i.e. at least 23 ects is accepted in this group **Track Systems and Control** The following five modules are compulsory: - Robust Control (annual) - Convex Optimization (every two years, 2018-2019) - Modeling and Identification (every two years, 2019-2020) - Modeling and Control of Complex Engineering Systems (annual) - Systems and Control (annual, Mastermath)	≥ 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 the Mastermath Programme, see elo.mastermath.nl In addition, students that follow the track Computational Mathematics can also choose one or more of these three courses from the following list of modules: - Programming in C/C++ Part 2 (RuG) - Scientific Visualisation (RuG) - Computational Quantum Physics (RuG) - Modeling and Simulation (RuG) - Courses from the Mastermath programme labelled with Num Wisk., see elo.mastermath.nl (in 2018-2019: Parallel Algorithms, Numerical Methods for Time-dependent PDEs, in addition in 2018-2019 Applied Finite Elements (labeled 4TU)) Students that follow the track Systems and Control can also choose one or more of these three courses from the following list of modules: - Analysis and Control of Smart Systems (MSc Industrial Engineering and Management RuG) - Robotis for IEM (idem) - Advanced Digital and Hybrid Control Systems (idem)	≥ 15
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 Exam Committee)	15
Master's Research Project	Research project in the specialization track	35
Internship	Internship in Applied Mathematics	15

The Applied Mathematics modules given at the University of Groningen are:

module	**Offered**	**ECTS**	**practical**
Computational Fluid Dynamics	Annual	5	x
Finite Element Methods for Fluid Dynamics	Every two years	5	x
Computational Mechanics 2	Annual	5	x
Modeling and Identification	Every two years	5	
Modeling and Control of Complex Nonlinear Engineering Systems	Annual	5	
Robust Control	Annual	5	
Convex Optimization	Every two years	5	
Mathematical Modeling Colloquium	Annual	5	x
Mathematics and its Environment	Annual	5	x
Complexity and Networks	Annual	5	
Master's Research Project	Annual	35	x
Internship	Annual	15	x

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 offered by the master's degree programme in Applied Mathematics see the Teaching and Examination Regulations of the corresponding programme.

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 (35 ECTS) and Internship (15 ECTS) is a successful completion of 45 ECTS of modules of the master's degree programme in Applied Mathematics.

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 Applied Mathematics:

- BSc Mathematics
- BSc Applied Mathematics

Appendix VII Transitional provisions (art. 7.1)

Course	May be replaced with
Modeling of Fluid Flow	Computational Mechanics 2

Appendix VIII
Application deadlines for admission (art. 2.6.1) and Decision deadlines (art. 2.6.3)

Msc Applied Mathematics	Deadline of application	Decision deadline
Start September 2020	1 May 2020	1 June 2020
Start February 2021	15 October 2020	15 November 2020

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Appendix IX Selection Criteria selective master's degree programmes

Not applicable