Assessment plan for the curriculum of the Bachelor's degree programme in Applied Mathematics, 2022-2023

Introduction

This assessment plan is a systematic description of the testing and assessment modes for all study components in the curriculum of the Bachelor's degree programme in Applied Mathematics, 2022-2023. The plan is based on the assessment policy of the Faculty of Science and Engineering, as set out in the 2016-2017 version of the FMNS Quality Assurance Manual (Chapter 6: Assessment) and the protocol setting out the duties and powers of the Faculty's Board of Examiners (December 2013).

The assessment plan for the curriculum consists of the following parts:

1. objective(s) of the degree programme
2. the learning outcomes of the degree programme
3. descriptions of the study components, as set out in the appendices to the Teaching and Examination Regulations 2021-2022 of the degree programme
4. descriptions of the content of each study component in Ocasys, the online course catalogue. The following elements are relevant in this context:
   - objectives
   - description of content
   - lecturers
   - assessment mode(s) and calculation of final mark
   - mode(s) of instruction.
5. An overview of the examiners and a detailed assessment mode for each study component. This overview is based on the curriculum approved by the Programme Committee, as set out in the appendices to the Teaching and Examination Regulations 2021-2022 for the degree programme.
6. A matrix showing the relationship between the study components and the detailed learning outcomes for each competence area.

Parts 3 and 4 are not included in this document. For the descriptions of the study components, see the Appendix to the Teaching and Examination Regulations 2022-2023 for the degree programme in Applied Mathematics. Descriptions of the content of each study component can be found in Ocasys, the online course catalogue (http://www.rug.nl/ocasys/).

In 2022-2023 the curriculum has been slightly adjusted. The 2022-20023 curriculum is largely based on the curriculum that was introduced in 2018-2019. The current assessment plan applies to the cohorts 2018-2019 and later. The assessment plan for the cohorts 2017-2018 and earlier is part of the assessment plan 2019-2020. As the assessment plan for the cohorts 2017-2018 is not altered, it is not described again here; a systematic description of the testing and assessment modes for all study components in the curriculum before 2018-2019 can be found in the assessment plan 2019-2020.

Objectives of BSc Applied Mathematics

As a consequence of the ongoing automation of society and the technological innovations that go along with this, 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 (applied) mathematicians.

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

The Bachelor's graduate must be able to progress to the follow-on Master's degree programme in Applied Mathematics. Graduates of the Bachelor's degree programme in Applied Mathematics should also be able to take the Master's degree programme in Mathematics or in Education and Communication.

Learning outcomes BSc Applied Mathematics

The above aim has been translated into a set of learning outcomes which consists of generic learning outcomes complemented with specified learning outcomes with respect to both Knowledge and Skills.

A. Generic learning outcomes – Knowledge

Bachelor's graduates in Applied Mathematics

A1. have general knowledge of the foundations and principle branches of (applied) mathematics.

A2. have mastered the basic concepts of applied mathematics (see Appendix I for further specification) to a certain extent and are familiar with the interrelationships of these concepts within mathematics and applied mathematics as well as with other disciplines (e.g. in science and engineering).

A3. have in-depth knowledge of several current topics within applied mathematics.

A4. are familiar with the quantitative character of applied mathematics and have an understanding of the mathematical methods used in various areas of application, particularly including computer-aided methods.

A5. have sufficient knowledge and understanding of applied mathematics to successfully complete a follow-up Master's degree programme in Applied Mathematics.

A6. are aware of the societal, ethical and social aspects involved in the field of applied mathematics.

B. Generic learning outcomes – Skills

Bachelor's graduates in Applied Mathematics

B1 (Research) are able to draw up a research question, design, plan and conduct research and report on it independently with a certain degree of supervision and to evaluate the value and limitations of their research and assess its applicability outside their own field. See Appendix II for further specification.

B2 (Designing and Modelling) are able to translate a problem, in particular a design problem, into a plan of approach and – taking into account requirements and/or technical preconditions – find a solution.

B3 (Gathering information) are able to gather relevant information using modern means of communication and to critically interpret this information.

B4 (Collaborating) are able to collaborate in teams on technical-scientific problems, are able to work on (interdisciplinary) projects, taking responsibility for their (mathematical) contributions.

B5 (Communicating) are able to communicate orally and in writing in academic and professional contexts, in English, and are able to interact with mathematicians as well scientists and engineers. They are familiar with the relevant means of communication.

B6 (Reflecting) are able to assess their own actions and those of others in a natural sciences and engineering context, bearing in mind the social/societal and ethical aspects.

B7 (Learning skills) are able to apply learning skills that enable them to pursue a follow-up degree and acquire knowledge in new fields with a high level of autonomy.

Appendix I Specified basic knowledge related learning outcomes

Bachelor's graduates in Applied Mathematics

1.1. have mastered the basic concepts and techniques of mathematics, in particular single and multivariable calculus, linear algebra, analysis, ordinary differential equations, probability theory, statistics and algebra.
1.2. have knowledge of more advanced subjects within the fields of applied analysis, numerical mathematics, dynamical systems and systems theory.
1.3. have knowledge of more advanced topics in the fields of Computational Mathematics, and Systems and Control.
1.4. have gained knowledge of and experience in the 'heart' of mathematics, i.e., the truth and value of exact mathematical proof.
1.5. have knowledge of basic sciences at a level necessary to apply mathematical methods, and are aware of the wider multidisciplinary context of science and engineering
1.6. are able to use mathematical software packages in an effective way or, if necessary, modify programs themselves.

Appendix II Specified skills related learning outcomes

Bachelor's graduates in Applied Mathematics

Research
2.1 have an academic attitude, which means they are curious, critical, creative and dare to show initiative.
2.2 are able to formulate (relatively simple) problems in the mathematical language, pose relevant mathematical questions and address them in an exact way, and if necessary, adapt the problem to make it mathematically tractable.

2.3 are able to articulate assumptions, understand the importance of detailed definitions, and are able to think in an organized way, to apply exact logical arguments when solving problems, and to generalize and abstract.
2.4 are able to model, analyse and abstract simple problems that are outside the scope of their own study programme and to independently acquire new knowledge to this end.

Designing and modelling
2.5 are able, under supervision and from the perspective of their field of interest, to translate a problem into a relevant mathematical problem definition and to this end formulate and evaluate a solution based on source research.
2.6 are able to formulate concrete problems from application areas as mathematical problems, and are able to discuss the assumptions underlying their mathematical model.
2.7 are able to approach mathematical problems on the basis of a certain logical system and with determination to find the right method of approach and are aware of the limitations of the chosen method.
2.8 are aware of the importance of researching specific cases and examples and have the attitude and skills necessary to critically evaluate the solutions found, test them for correctness and interpret them.
2.9 are able, by abstracting and modelling, to delve into the root of a problem and determine whether existing methods can be applied or new methods must be developed.
2.10 are able to conduct searches of literature, to critically use scientific databases and other sources of information, or to consult specialists to carry out numerical simulations and mathematical analysis in order to study problems in science and engineering.

6. Relationship between course units and details of the learning outcomes

In this section the relation between the course units and the learning outcomes is given in the following set of tables.

The following notation is used:

1 : the course makes a limited contribution to the specified learning outcome
2: the course makes a substantial contribution to the specified learning outcome

Year 1 as described in this section is offered for the first time in 2022-2023.

Year 1

		Calculus 1	Sets and Numbers	Introduction to Graph Theory	Linear Algebra 1	Analysis	Elective: Intro to Logic/ Mechanics and Relativity for Math	Calculus 2	Linear Algebra 2	Scientific Programming	Linear Systems	Probability Theory	Elective: First-year Project Mathematics/ Applied Mathematics
A1						1						1	
A2	1.1	2	2	2	2	2		2	2		1	2	
	1.2												
	1.3												
	1.4	1	2	2	1	1	(1)	1	1		1	1	
	1.5						1				1		(1)
	1.6				1					1			(1)
A3													
A4					1		1			1			1
A5													
A6													
B1	2.1	1	1	1	1	1	1	1	1	1	1	1	1
	2.2	1		1				1		1	1	1	1
	2.3		1	1		1			1			1	
	2.4												
B2	2.5									1	1		1
	2.6						(1)			1	1		1
	2.7				1				1				
	2.8				1				1			1	1
	2.9												
	2.10												1
B3													1
B4										1			1
B5													1
B6													1
B7													1

Year 2

		Group Theory	Partial Differential Equations	Statistics	Complex Analysis	Multivariable Analysis	Project Systems Theory	Dynamical Systems	Differential Equations in Science and Engineering	Metric and Topological Spaces	Mathematical Modeling	Functional Analysis	Numerical Mathematics 1
A1		1		1									1
A2	1.1	2	2	2	2	2							
	1.2							2	2	2		2	2
	1.3	1					2	1	1	1		1	
	1.4	1	1	1	1	1	1	1	1	1		1	1
	1.5		1	1			1	1			1		1
	1.6			2									2
A3							1	2			1		
A4				1			1	1			1	1	1
A5									1	1	1	1	
A6											1		
B1	2.1	1	1	1	1	1	1	1	1	1		1	1
	2.2	1	1	1	1	1	1	1	1	1	1	1	1
	2.3		1	1			1	1	1			1	
B2	2.4		1	1	1		1	1	2		1		
	2.5						2		1		1		
	2.6		1	1		1	1	1		1	1		
	2.7		1		1	1		1	1	1			1
	2.8											1	
B3							1						
B4							1						
B5							1				1		
B6											1		
B7							1		1		1		
											1		

Year 3

		Computational Methods of Science	Introduction to Optimization	Project Mathematical Modelling	Advanced Systems Theory*	Numerical Mathematics 2*	Statistical Modeling*	Mathematics & Society: Ethical and Professional Aspects	Preparation Bachelors Project	Bachelor Research Project (15 ECTS)	2 Electives (10 ETCS in total)**
A1			1					2	1		
A2	1.1										
	1.2	1		2	1	1	1			1	
	1.3		1	1	2	2	2			1	
	1.4			1						1	
	1.5									1	
	1.6	2								1	
A3			2	2	1	1	1		1	1	
A4										1	
A5				1	1	1	1			1	
A6								2	1	1	
B1	2.1			1				1		1	
	2.2			1						1	
	2.3	1	1	1	1	1	1			1	
	2.4			2						1	
B2	2.5			1	1				1	1	
	2.6								1	1	
	2.7	1	1	1	1	1	1			1	
	2.8	1	1		1	1	1			1	
	2.9			1					1	1	
	210	1		1	1				1	1	
B3				1	1	1	1	1	1	1	
B4					1	1	1	1	1	1	
B5		1		1	1		1	1	1		
B6								2	1		
B7									1	1	

*Two out of:
Advanced Systems Theory, Numerical Mathematics 2, Statistical Modelling

** Elective course units can be chosen from the post-propaedeutic courses of the Bachelor's programme in Mathematics and Applied Mathematics as long as they are not otherwise part of the student's programme. In addition, the electives may be chosen out of:

One out of: - Imperative Programming - C++ fundamentals
Programming in C++
Mechatronics
Electronics & Signal Processing
Astrophysical Hydrodynamics
Physics of Fluids
Philosophy of Science
Introduction to Science and Education (Dutch)

5. Overview of examiners and testing and assessment modes for study components

In this section, an overview of the examiners and a detailed assessment mode for each study component is given. This overview is based on the curriculum approved by the Programme Committee, as set out in the appendices to the Teaching and Examination Regulations 2020-2021 for the degree programme.

The abbreviations for the relevant modes of assessment:

- Written exam with open questions (WE)
- Oral exam (OR)
- Assignment (AST)
- Practical Work (PR)
- Presentation (P)
- Report (R)
- Interim test (IT)

If, as a result of the corona pandemic, a written exam cannot proceed, it may be converted into an open book online take-home exam, where
- Students have to sign a pledge swearing that the work has been completed autonomously and using only the allowed tools and aids;
- The first examiner/examiners can have short online discussions with (an unannounced selection of) students after the exam to check for possible fraud.

Alternatively, WE may also be replaced by OR if a written exam cannot proceed.

Course unit name	ECTS	First Examiner(s)	Second Examiner (if necessary)	Practical	Mode of assessment
Year 1					
Calculus 1	5	dr. T.F. Görbe	dr. H. Jardon Kojakhmetov	x	AST, IT, WE, PR
Linear Algebra 1	5	prof.dr. M.K. Camlibel	prof.dr. S. Trenn	x	AST, IT, WE, PR
Sets and Numbers	5	prof. dr. J. Top dr. R. van der Veen			WE, IT
Calculus 2	5	prof.dr. H. Waalkens	dr. T.F. Görbe		AST, IT, WE
Introduction to Graph Theory	5	tba	prof.dr. T. Müller		AST, WE
Analysis	5	dr. A.E. Sterk	prof.dr. J.G. Peypouquet		AST, WE
Scientific Programming	5	dr. C.A. Bertoglio dr. R. Luppes		x	PR, WE
Linear Algebra 2	5	prof.dr. J. Top dr. H. van Waarde			AST, IT, WE
Analysis	5	dr. A.E. Sterk	prof.dr. J.G. Peypouquet		AST, WE
Linear Systems	5	dr.ir. B. Besselink	dr. A.E. Sterk		
Probability Theory	5	dr. G. Bonnet	prof.dr. T. Müller		AST, WE
Electives Year 1					
First-year Project Mathematics/Applied Mathematics	5	dr. O. Lorscheid	dr. N. Martynchuk	x	PR, P, R
Introduction to Logic	5	See BSc AI			AST, WE, IT
Mechanics & Relativity for Maths	5	prof.dr. D. Roest	prof.dr.ir. R.W.C.P. Verstappen		AST, WE

Course unit name	ECTS	First Examiner(s)	Second Examiner (if necessary)	Practical	Mode of assessment
Year 2					
Partial Differential Equations	5	dr. A.M.S. Waters	dr. M. Seri		AST, WE
Statistics	5	prof.dr. M.A. Grzegorczyk	dr. W.P. Krijnen		AST, WE
Complex Analysis	5	dr. O. Lorscheid	dr. T.F. Görbe		AST, IT, WE
Group Theory	5	dr. P. Kilicer dr. M.W. Lüdtke			AST, WE
Metric and Topological Spaces	5	dr. A.V. Kiselev	prof.dr. T. Müller		AST, WE
Numerical Mathematics 1	5	dr. C.A. Bertoglio	dr. F. Wubs	x	PR, WE
Functional Analysis	5	dr. A.E. Sterk	prof.dr. J.G. Peypouquet		AST, WE
Multivariable Analysis	5	dr. H. Jardon Kojakhmetov	dr. N. Martynchuk		AST, WE
Dynamical Systems	5	prof. dr. H. Waalkens	dr. M. Seri		AST, WE
Differential Equations in Science and Engineering	5	dr. J. Koellermeier	prof.dr.ir. R.W.C.P. Verstappen		AST,WE
Project Systems Theory	5	prof.dr. S. Trenn dr. H. van Waarde			P, R
Mathematical Modelling	5	prof.dr. S. Trenn prof.dr.ir. R.W.C.P. Verstappen			AST

Course unit name	ECTS	First Examiner(s)	Second Examiner (if necessary)	Practical	Mode of assessment
Year 3					
Project Mathematical Modelling	5	dr. R. Luppes	prof.dr.ir. R.W.C.P. Verstappen		AST, P, R
Computational Methods of Science	5	dr. F.W. Wubs	dr. C.A. Bertoglio	x	PR, WE
Introduction to Optimization	5	prof.dr. J.G. Peypouquet	dr. A.M.S. Waters		AST, WE, PR
Advanced Systems Theory	5	prof.dr. M.K. Camlibel	prof.dr. S. Trenn		AST, WE
Numerical Mathematics 2	5	dr.ir. F.W. Wubs	dr. C.A. Bertoglio	x	PR, WE
Statistical Modelling	5	prof.dr. M.A. Grzegorczyk dr. W.P. Krijnen		x	AST, WE
Mathematics and Society: Ethical and Professional Aspects	5	drs. J. Zevenberg	dr. M van Rijssel		AST, P,R
Preparation Bachelor’s Project	5	prof.dr. C. Salgado dr. A.M.S. Waters			AST, P,R
Bachelor Project	15	See list below	See list below	x	PR, P, R
Electives year 3					
Electives from other degree programmes, see assessment plan of the BSc degree programme that provides the course.					

Examiners for Bachelor Project

dr. C.A. Bertoglio
dr. ir. B. Besselink
dr. G. Bonnet
prof.dr. M.K. Camlibel
dr. T.K. Gebretekle
dr. T.F. Görbe
prof.dr. M.A. Grzegorczyk
dr. H. Jardon Kojakhmetov
dr. P. Kilicer
dr. A.V. Kiselev
dr. J. Koellermeier
dr. W.P. Krijnen
dr. O. Lorscheid
dr. M.W. Lüdtke
dr.ir. R. Luppes
dr. A. Mali
dr. J.S. Müller
prof.dr. T. Müller
dr. N. Martynchuk
prof.dr. J.G. Peypouquet
prof.dr. C. Salgado
dr. M. Seri
dr. A.E. Sterk
dr. P. Tibboel
prof.dr. P. Trapman
prof.dr. J. Top
prof.dr. S. Trenn
dr. R. van der Veen
dr. H. van Waarde

prof.dr. E.A. Verbitskiy
prof.dr.ir. R.W.C.P. Verstappen
prof.dr. H. Waalkens
dr. A.M.S. Waters
dr. F.W. Wubs

On an individual basis the Board of Examiners can allow examiners of other degree progammes to act as examiner for the Bachelor Project of the Bachelor's degree programme in Applied Mathematics as well.