university of groningen

Appendices for the Bachelor's degree programme(s) in Mathematics

2025-2026

I. Learning outcomes of the Bachelor's degree programme
II. Majors and Minors
III. Course units in the first year of the degree programme
IV. Course units in the second and third year of the degree programme
V. Contact hours
VI. Additional Requirements Open Degree Programmes
VII. Transitional provisions

Appendix I Learning outcomes of the Bachelor's degree programme (Article 3.1)

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 utilised in a proper and effective way. This requires that society has access to sufficiently many well qualified and highly trained mathematicians.

The Bachelor'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 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 Mathematics. Graduates of the bachelor's degree programme in Mathematics should also be able to take the Master's degree programme in Applied Mathematics or in Education and Communication. In addition, Bachelor's graduates who have taken the 'Educatieve Minor' (teacher-training minor) gain a Grade Two teaching qualification in mathematics.

Learning outcomes BSc Mathematics specialisation General Mathematics

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

A. Generic learning outcomes – Knowledge

Bachelor's graduates in Mathematics specialisation General Mathematics:

A1. have general knowledge of the foundations and principal branches of mathematics.

A2. have mastered the basic concepts of mathematics (see Appendix I for further specification) to a certain extent and are familiar with the interrelationships of these concepts within mathematics as well as with other disciplines (e.g., physics, logic, or philosophy).

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

A4. are familiar with the quantitative character of mathematics and have an understanding of the methods used in this field.

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

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

B. Generic learning outcomes – Skills

Bachelor's graduates in Mathematics specialisation General 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. Bachelor's graduates are able to evaluate the value and limitations of their research and assess its applicability outside their own field. See Appendix II for further specification.

B2 (Problem Solving) are able to identify, apply, and choose among several potentially appropriate mathematical methods, persist in the face of difficulty, emphasise the importance of clarity and precision, and present solutions that include appropriate justification for their reasoning. See Appendix II for further specification.

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 intellectually and creatively in diverse contexts, while applying mathematical reasoning as well as emphasising its importance.

B5 (Communicating) are able to communicate orally and in writing in academic and professional contexts, with both colleagues and others, in English. 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 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 Mathematics specialisation General 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 algebra, geometry, analysis, numerical mathematics, dynamical systems, probability and statistics.
1.3. have specific knowledge of one of the fields of Pure Mathematics.
1.4. have gained knowledge of and experience in the 'heart' of mathematics, i.e., understand the basic rules of logic, appreciate the role of mathematical proof, proficiently construct logical arguments and rigorous proofs, formulate and solve abstract mathematical problems.
1.5. recognize connections between different branches of mathematics, understand the connections between theory and applications, and have knowledge of various applications of mathematics.
1.6. are able to use mathematical software packages in an effective way or, if necessary, modify programs themselves.

Appendix II Degree programme-specific learning outcomes – Skills

Bachelor's graduates in Mathematics specialisation General 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 mathematical questions and problems in an exact way and if necessary, adapt them to make them tractable.

2.3 are able to articulate assumptions, understand the importance of detailed definitions, and are able to think in an organised way, to apply exact logical arguments when solving problems, and to generalise and abstract.

2.4 are able to analyse and abstract simple problems that are outside the scope of their own study programme and to independently acquire new knowledge to this end.

Problem solving

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 distinguish a coherent argument from a fallacious one, make vague ideas precise by formulating them in the mathematical language, recognize real-world problems that are amenable to mathematical analysis, and use fundamental mathematical concepts and methods to study these problems.

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.

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 reasoning, to delve into the root of a problem and determine whether existing methods can be applied or new methods must be developed.

Learning outcomes BSc Mathematics specialisation Probability and Statistics

This specialisation differs in the following learning outcomes from the specialisation General Mathematics

A2'. have mastered the basic concepts of mathematics, probability and statistics (see Appendix I' for further specification) to a certain extent and are familiar with the interrelationships of these concepts within mathematics as well as with other disciplines (e.g., econometrics, life sciences, physics).

B2' (Problem Solving, Modelling) are able to identify, apply, and choose among several potentially appropriate mathematical methods, present solutions that include appropriate justification for their reasoning, and are able to translate a problem, in particular a design problem, into a plan of approach and – taking into account the requirements of the client and/or technical preconditions – find a solution. See Appendix II' for further specification.

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 with scientists who apply statistical methods. They are familiar with the relevant means of communication.

Appendix I Specified basic knowledge related learning outcomes

Bachelor's graduates in Mathematics specialisation Probability and Statistics:

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 and statistics, and algebra.
1.2. have knowledge of more advanced subjects within the fields of algebra, geometry, analysis, numerical mathematics, dynamical systems, probability and statistics.
1.3. have specific knowledge of one of the fields of Pure Mathematics and Statistics.
1.4. have gained knowledge of and experience in precise (both mathematical and statistical) reasoning and mathematical proof.
1.5. recognize connections between different branches of mathematics, recognize the connections between theory and applications, and have knowledge of basic sciences at a level necessary to apply statistical or mathematical methods, and are aware of the wider multidisciplinary context of (life) science and engineering.
1.6. are able to use mathematical software packages in an effective way or, if necessary, modify programs themselves.

Appendix II Degree programme-specific learning outcomes – Skills

Bachelor's graduates in Mathematics specialisation Probability and Statistics:

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 mathematical questions and problems in an exact way and if necessary, adapt them to make them tractable
2.3 are able to articulate assumptions, understand the importance of detailed definitions, and are able to think in an organised way, to apply exact logical arguments when solving problems, and to generalise and abstract.
2.4 are able to analyse and abstract simple problems that are outside the scope of their own study programme and to independently acquire new knowledge to this end.

Problem solving, 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 make vague ideas precise by formulating them in the mathematical language, recognize real-world problems that are amenable to mathematical/statistical analysis, and are able to discuss the assumptions underlying their mathematical/statistical model, use mathematical/statistical concepts and methods to study these models.
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 modelling, abstracting and reasoning, 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 statistical and mathematical analysis in order to study problems in (life) science and engineering.

Appendix II Majors and Minors of the degree programme (Article 3.7 and 7.1.3)

The degree programme has the following two specialisations (150 ECTS):

- General Mathematics
- Probability and Statistics

The degree programme has the following choices in Minors (30 ECTS):

- Minor Mathematics (see Appendix IV)
- Faculty-wide deepening minors
- University-wide broadening minors
- Minor abroad
- Education minor
- Personal minor, based on an individual choice of course units to be approved by the Board of Examiners.

To obtain two Bachelor's degrees in both Mathematics and Physics a subspecialisation of the Mathematics specialisation General Mathematics can be combined with a subspecialisation of the Physics specialisation Particle Physics. The workload of this combination is 250 ECTS. Details can be found in Appendices III and IV.

university of groningen

Appendix III Course units in the first year of the degree programme

- **List of course units (Article 4.1.1)**
- **Compulsory order of examinations (Article 9.3)**

First year degree programme Mathematics
The first year of the Bachelor's degree programme in Mathematics with specialisations in General Mathematics and Probability and Statistics comprises a compulsory joint programme of 60 ECTS.

Course unit name	**Course code**	**ECTS**	**Entry requirements**
Calculus 1	WBMA003-05	5	
Linear Algebra 1	WBMA020-05	5	
Sets and Numbers	WBMA051-05	5	
Analysis	WBMA012-05	5	
Introduction to Graph Theory	WBMA052-05	5	
Calculus 2	WBMA029-05	5	
Scientific Programming	WBMA053-05	5	
Linear Algebra 2	WBMA035-05	5	
Mechanics and Relativity for Mathematicians	WBMA060-05	5	
Linear Systems	WBMA043-05	5	
Probability Theory	WBMA046-05	5	
One out of: - First-year Project Mathematics - First-year Project Applied Mathematics	 WBMA041-05 WBMA040-05	5	

university of groningen

First year Double degree in Mathematics and Physics

A student who desires to obtain a Bachelor's degree in both Mathematics and Physics has to be enrolled in both degree programmes. The learning outcomes of both programmes are met by combining a subspecialization of the Mathematics specialisation General Mathematics with a subspecialization of the Physics specialisation Particle Physics. The first year of this combination has a workload of 80 ECTS.

Course unit name	**Course code**	**ECTS**	**Math major**	**Math minor**	**Phys major**	**Phys minor**
Calculus 1	WBMA003-05	5	5		5	
Linear Algebra 1	WBMA020-05	5	5		5	
Physics Lab: Skills	WBPH077-05	5			5	
Mechanics and Relativity	WBPH001-10	10	5		10	
Analysis	WBMA012-05	5	5			
Introduction to Graph Theory	WBMA052-05	5	5			
Physics of the Quantum Universe	WBPH028-05	5			5	
Electricity and Magnetism	WBPH033-10	10			10	
Calculus 2	WBMA029-05	5	5		5	
Computational Methods 1	WBPH064-05	5	5		5	
Linear Algebra 2	WBMA035-05	5	5			
Linear Systems	WBMA043-05	5	5			
Probability Theory	WBMA046-05	5	5			
Physics Lab: Research Project	WBPH076-05	5	5		5	
Total ECTS		80	55		55	

university of groningen

Appendix IV Course units in the second and third year of the degree programme

- **List of course units (Article 7.1.1)**
- **Compulsory order of examinations (Article 9.3)**

Second and third year Bachelor's programme in Mathematics
The second and third year of the programme consists of common compulsory courses (70 ECTS), specialisation specific compulsory courses (20 ECTS) and a minor (30 ECTS).

Common compulsory courses

Course unit name	Course code	ECTS	Entry requirements
Group Theory	WBMA005-05	5	
Metric and Topological Spaces	WBMA036-05	5	
Statistics	WBMA009-05	5	
Complex Analysis	WBMA018-05	5	
Multivariable Analysis	WBMA022-05	5	
Geometry	WBMA034-05	5	
Functional Analysis	WBMA033-05	5	
Numerical Analysis	WBMA062-05	5	
Partial Differential Equations	WBMA008-05	5	
Mathematics & Society: Ethical and Professional Aspects	WBMA049-05	5	
Preparation Bachelor's Project	WBMA056-05	5	
Bachelor's Project Mathematics	WBMA902-15	15	Passed 150 EC of the Bachelor's programme in Mathematics, including Preparation Bachelor's Project. Approval of study programme by BOE, approval of Career Portfolio and enrolment Bachelor's Project Mathematics in Progress.

Specialisation specific compulsory courses

Course unit name	Course code	ECTS	Entry requirements
Specialisation General Mathematics			
Dynamical Systems	WBMA031-05	5	
Algebraic Structures	WBMA039-05	5	
One out of: - Introduction to Coding Theory (25/26) - Project Chaos Theory (26/27)	 WBMA065-05 WBMA025-05	5	
1 elective (see below)		5	
Specialisation Probability and Statistics			
Discrete Mathematics	WBMA025-05	5	
Probability and Measure	WBMA024-05	5	
Project Statistical Reasoning (25/26)	WBMA038-05	5	
1 elective (see below)		5	

Minor space
The degree programme has the following choices in Minors (30 ECTS):

- Minor Mathematics (see table below for details)
- Faculty-wide deepening minors
- University-wide broadening minors
- Minor abroad
- Education minor
- Personal minor, based on an individual choice of course units to be approved by the Board of Examiners.

The Minor Mathematics (30 ECTS) consists of the following course units:

Course unit name	Course code	ECTS	Entry requirements
Both specialisations			
1 elective (see below)		5	
Three out of:		15	
- Project Number Theory	WBMA064-05		
- Percolation Theory	WBMA059-05		
- Algebraic Topology	WBMA058-05		
- Introduction to Optimization	WBMA054-05		
Specialisation General Mathematics			
Two out of:		10	
- Analysis on Manifolds	WBMA013-05		
- Advanced Algebraic Structures	WBMA011-05		
- Discrete Mathematics	WBMA019-05		
- Stochastic Processes	WBMA048-05		
- Philosophy of Mathematics	FI213BK		
Specialisation Probability & Statistics			
- Stochastic Processes	WBMA048-05	5	
- Statistical Modelling	WBMA028-05	5	

Elective course units General Mathematics & Probability and Statistics
Elective course units can be chosen from the specialisation specific courses General Mathematics, the specialisation specific courses Probability and Statistics, the compulsory Applied Mathematics courses and the Minor Mathematics as long as they are not otherwise part of the student's programme.

Course unit name	Course code	ECTS	Entry requirements
Project Systems Theory	WBMA027-05	5	
Differential Equations in Science and Engineering	WBMA061-05	5	
Project Mathematical Modelling	WBMA055-05	5	
Mathematical Modelling	WBMA007-05	5	
Computational Methods of Science	WBMA004-05	5	
Advanced Systems Theory	WBMA001-05	5	
Numerical Linear Algebra	WBMA063-05	5	

Discrete Mathematics	WBMA019-05	5	
Probability and Measure	WBMA024-05	5	
Stochastic Processes	WBMA048-05	5	
Project Statistical Reasoning (25/26)	WBMA038-05	5	
Statistical Modelling	WBMA028-05	5	
Dynamical Systems	WBMA031-05	5	
Algebraic Structures	WBMA039-05	5	
Introduction to Coding Theory (25/26)	WBMA065-05	5	
Project Chaos Theory (26/27)	WBMA025-05	5	
Analysis on Manifolds	WBMA013-05	5	
Advanced Algebraic Structures	WBMA011-05	5	
Project Number Theory	WBMA064-05	5	
Percolation Theory	WBMA059-05	5	
Algebraic Topology	WBMA058-05	5	
Introduction to Optimization	WBMA054-05	5	
One out of: - Oriëntatie op Onderwijs in de Bètawetenschappen (in Dutch) - Introduction to Science Communication	 WBEC002-05 WBEC001-05	5	

Elective course units General Mathematics
In addition, in the specialisation General Mathematics the elective course units can be chosen from:

Course unit name	**Course code**	**ECTS**	**Entry requirements**
One out of: - Functional Programming - C++ fundamentals	 WBCS002-05 WBCS033-05	5	
Programming in C++	WBCS034-05	5	
One out of: - Object-Oriented Programming (for CS) - Object-Oriented Programming (for AI)	 WBCS028-05 WBAI045-05	 5 5	
Symmetry in Physics	WBPH047-05	5	
Quantum Physics 1	WBPH014-05	5	

Elective course units Probability and Statistics
In addition, in the specialisation Probability and Statistics the elective course units can be chosen from:

Course unit name	Course code	ECTS	Entry requirements
One out of: - Functional Programming - C++ fundamentals	 WBCS002-05 WBCS033-05	5	
One out of: - Object-Oriented Programming (for CS) - Object-Oriented Programming (for AI)	 WBCS028-05 WBAI045-05	5 5	
Programming in C++	WBCS034-05	5	
Dynamic Econometrics	EBB813A05	5	
Game Theory	EBB872A05	5	
Risk Insurance	EBB863A05	5	
Statistical Signal Processing	WBAS009-05	5	
One out of: - Life Insurance - Introduction to Econometrics	 EBB827B05 EBB828A05	5	

Second and third year of the Double Bachelor's degree in Mathematics and Physics
A student who desires to obtain a Bachelor's degree in Mathematics as well as a Bachelor's degree in Physics can combine a subspecialization of the Mathematics specialisation General Mathematics with a subspecialization of the Physics specialisation Particle Physics. The second and third year of this combination has a workload of 170 ECTS:

Course unit name	Course code	ECTS	Math major	Math minor	Phys major	Phys minor
Group Theory	WBMA005-05	5	5			5
Metric and Topological Spaces	WBMA036-05	5	5			
Statistics	WBMA009-05	5	5			5
Complex Analysis	WBMA018-05	5	5		5	
Multivariable Analysis	WBMA022-05	5	5			
Geometry	WBMA034-05	5	5			5
Functional Analysis	WBMA033-05	5	5			
Numerical Analysis	WBMA062-05	5	5			
Partial Differential Equations	WBMA008-05	5	5		5	
Dynamical Systems	WBMA031-05	5	5			
One out of: • Project Chaos Theory (26/27) • Introduction to Coding Theory (25/26) • Project Systems Theory	 WBMA025-05 WBMA065-05 WBMA027-05	5	5			
Algebraic Structures	WBMA039-05	5	5			
Analysis on Manifolds	WBMA013-05	5	5			
Advanced Algebraic Structures	WBMA011-05	5	5			
Thermal Physics	WBPH002-10	10		10	10	
Computational Methods 2	WBPH065-05	5			5	
Quantum Physics 1	WBPH014-05	5			5	
Waves and Optics	WBPH032-05	5			5	
From Atoms to Solids	WBPH085-10	10		10	10	
Subatomic physics: concepts and experiments	WBPH088-05	5			5	
Fundamentals of Electronics	WBPH070-05	5		5	5	
Physics Lab: Advanced Experiments 1	WBPH074-05	5		5	5	
Quantum Physics 2	WBPH052-05	5			5	
Advanced Electrodynamics	WBPH079-05	5			5	
Advanced Mechanics	WBPH017-05	5				5
Relativistic Quantum Mechanics	WBPH045-05	5				5
Symmetry in Physics	WBPH047-05	5				5
One out of: • Mathematics & Society: Ethical and Professional Aspects • Physics, Astronomy & Society: Ethical and Professional Aspects	 WBMA049-05 WBPH053-05	5	5		5	
Bachelor Research Project (double BSc Physics+Maths)	WBPH901-20	20	20		20	
Total ECTS		170	95	30	95	30

Entry requirements Bachelor Research Project: passed courses of the Bachelor programme in Mathematics and the Bachelor programme in Physics having a total workload of at least 150 EC for each, approval of Career Portfolio (Mathematics programme), approval of study programmes by the Board of Examiners of both programmes.

Appendix V Contact hours (Article 3.6)

Degree programme year 1	
Structure contact hours	**Contact hours per year**
Lectures	352
Tutorials	320
Practicals	24
Computer practicals	32
Study support/mentor groups	70
Supervision during an internship	
Examinations	50
Misc. contact hours (seminars and symposia)	20

Degree programme year 2 and 3	
Structure contact hours	**Contact hours per year**
Lectures	384
Tutorials	384
Practicals	48
Computer practicals	64
Study support/mentor groups	
Supervision during an internship	
Examinations	40
Misc. contact hours (seminars and symposia)	20

Note: contact hours in year 2 and 3 might deviate from the table above due to choices of the Minor and elective courses.

university of groningen

Appendix VI Additional Requirements Open Degree Programmes (Article 7.3)

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 Mathematics must include the common compulsory courses of the first, second and third year of the programme and at least 25 ECTS is to be taken from specialisation-specific compulsory courses (see App. IV for details).

Appendix VII Transitional provisions (Article 12.1)

Since the TER for this academic year is applicable to all students registered in the Bachelor's degree programme in Mathematics, regardless of the starting date of students, transitional provisions are in place. Students who have already completed a discontinued course are excluded from taking the respective replacement course.

Discontinued elective courses
The course Philosophy of Science (FI180WET) is no longer offered by the Faculty of Philosophy from academic year 2024-2025 onwards. Students who passed this course before 1 September 2024 may still include this course as an elective in their programme. The course has been replaced by Philosophy of Mathematics (FI213BK).

The course Advanced Logic (WBAI017-05) can formally no longer be chosen as an elective because the mandatory prerequisite course Introduction to Logic (WBAI012-05) is no longer included as an elective in the first-year. Students who passed the course Advanced Logic (WBAI017-05) before 1 September 2024 may still include this course as an elective in their programme.

For cohort 2023-2024 and earlier
In 2024-2025, the courses Mechanics and Relativity for Mathematicians and Calculus 2 will be scheduled in different blocks. As a result of this change, there is no longer the possibility to choose the course Introduction to Logic as an elective. Students from the cohort 2023-2024 and earlier may replace a discontinued course according to the table below, provided the discontinued course was passed before September 1, 2024.

In 2025-2026 the courses Numerical Mathematics 1 and 2 will be changed into the new courses Numerical Analysis and Numerical Linear Algebra, respectively. In 2025-2026 the course Project Security and Coding will be replaced by Introduction to Coding Theory. In 2025-2026 the course Elementary Number Theory will be replaced by Project Number Theory. Students from the cohort 2023-2024 and earlier may replace a discontinued course according to the table below, provided the discontinued course was passed before September 1, 2025.

Old course	**New course**
Introduction to Logic	Mechanics and Relativity for Mathematicians
Numerical Mathematics 1	Numerical Analysis
Numerical Mathematics 2	Numerical Linear Algebra
Project Security and Coding	Introduction to Coding Theory
Elementary Number Theory	Project Number Theory
Philosophy of Science	Philosophy of Mathematics

Double degree Mathematics & Physics: cohort 2024-2025 and earlier
In the academic year 2025-2026 the number of choices in the double-degree programme will be limited in order to make the programme more feasible from an organisational point of view. The table below indicates which of the new mandatory courses can be replaced by older optional courses provided these were passed before 1 September 2025.

New mandatory course(s)		**Replacement course(s)**	
Introduction to Graph Theory	WBMA052-05	Sets and Numbers	WBMA051-05
Computational Methods 1	WBPH064-05	Scientific Programming	WBMA053-05

Physics Lab: Research Project	WBPH07605	First-year Project Mathematics	WBMA041-05
Analysis on Manifolds	WBMA013-05	Orientatie op Onderwijs in de Bètaweten- schappen	WBEC002-05
Advanced Algebraic Structures	WBMA011-05		WBMA019-05
		Discrete Mathematics	WBMA048-05
		Stochastic Processes	
Advanced Electrodynamics	WBPH079-05	Atoms & Molecules	WBPH003-05
Subatomic Physics: concepts and experiments	WBPH088-05	Cosmology	WBAS001-05
From Atoms to Solids	WBPH085-10	Structure of Matter	WBPH034-10

For cohort 2021-2022 and earlier
In 2022-2023, three new compulsory course units were introduced in the first year: Sets and Numbers, Scientific Programming and Introduction to Graph Theory. In addition, the elective course Mechanics and Relativity for Mathematicians was introduced. Four courses (Kaleidoscope Mathematics, Mechanics and Relativity 1, Mechanics and Relativity 2 and Computer-Aided Problem Solving) were discontinued. Students from the cohort 2021/22 and earlier may replace a discontinued course according to the table below, provided the discontinued course was passed before September 1, 2022.

Old course	**New course**
Kaleidoscope Mathematics	Sets and Numbers
Mechanics and Relativity 1	Introduction to Graph Theory
Mechanics and Relativity 2	Mechanics and Relativity for Mathematicians
Computer-Aided Problem Solving	Scientific Programming

In the second and third year, the following substitutions are allowed (provided the discontinued course is passed before September 1, 2022):

Old course	**New course**
Fluid Dynamics	Differential Equations in Science and Engineering
Bachelor's Workgroup Mathematics	Preparation Bachelor's Project
Calculus of Variation and Optimal Control	Introduction to Optimization
Project Modelling	Project Mathematical Modelling
Imperative Programming	Functional Programming or C++ Fundamentals

Additionally, in the second and third year of the specialisation Probability and Statistics, the following substitutions are allowed (provided the discontinued course is passed before September 1, 2022):

Old course	**New course**
Stochastic Models One out of: – Introduction to Actuarial Sciences – Introduction to Econometrics	Multivariable Analysis Geometry
Asymptotic Statistics	Elective (see App IV for optional courses in Probability and Statistics)

Several courses within the degree programme Physics have changed name, but their contents remain the same. The following table lists the relevant substitutions:

Old course	**New course**
Computational Methods in Science and Technology	Computational Methods 2
Electronics and Signal Processing	Fundamentals of Electronics
Astroparticle Physics	Advanced Electrodynamics
Physics Laboratory 1	Physic Lab: Skills
Physics Laboratory 2	Physic Lab: Research Project
Physics Laboratory 3	Physic Lab: Advanced Experiments 1
Physics Laboratory 4	Physic Lab: Advanced Experiments 2

A course within the degree programme Econometrics has changed name, but their contents remain the same. The following table lists the relevant substitutions:

Old course	**New course**
Introduction to Actuarial Science	Life Insurance

See also the transitional arrangements in the appendices TER of previous years. For information on transitional arrangements for courses offered by other degree programmes, see also the Teaching and Examination Regulations of the corresponding programme.