Appendices Bachelor's degree programme Astronomy

Appendix I Learning outcomes of the degree programme (artikel 1.3)

A. Generic learning outcomes – Knowledge

A1. Bachelor's graduates have general knowledge of the foundations and history of mathematics, natural sciences and technology, in particular those of their own discipline.

A2. Bachelor's graduates have mastered the basic concepts of their own discipline (see Appendix 1 for further specification) to a certain extent and are familiar with the interrelationships of these concepts within their own discipline as well as with other disciplines.

A3. Bachelor's graduates have in-depth knowledge of several current topics within their own discipline.

A4. Bachelor's graduates are familiar with the quantitative character of the fields of mathematics and natural sciences and have an understanding of the methods used in these fields, and particularly within their own discipline, including computer-aided methods.

A5. Bachelor's graduates have sufficient knowledge and understanding of mathematics and natural sciences to successfully complete a follow-up Master's degree programme in their own discipline.

A6. Bachelor's graduates are aware of the societal, ethical and social aspects involved in the fields of mathematics and natural sciences.

B. Generic learning outcomes – Skills

B1 (Research) Bachelor's graduates are able to draw up a research question, design, plan and conduct research and report on it with a reasonable level of supervision. Bachelor's graduates are able to evaluate the value and limitations of their research and assess its applicability outside their own field.

B2 (Designing) Bachelor's graduates 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.

B3 (Gathering information) Bachelor's graduates are able to gather relevant information using both modern and conventional means of communication and to critically interpret this information.

B4 (Collaborating) Bachelor's graduates are able to collaborate in teams (including multidisciplinary teams) on technical-scientific problems.

B5 (Communicating) Bachelor's graduates are able to communicate orally and in writing in academic and professional contexts, with both colleagues and others. They are familiar with the relevant means of communication.

B6 (Reflecting) Bachelor's graduates 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) Bachelor's graduates 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.

B8 Additional subject-specific skills are listed in Appendix 2.

Appendix 1 Degree programme-specific learning outcomes - Basic Knowledge

The Bachelor's graduate in Astronomy

1. has some knowledge of the historical development of the astronomical worldview
2. is familiar with the principles of positional astronomy,
3. has mastered the basic astrophysics of planets, stars, galaxies, and interstellar medium,
4. knows the basic principles concerning conducting astronomical observations in different wavelength regimes and processing the obtained observational data,
5. has a thorough knowledge of theoretical astrophysics,
6. has a thorough knowledge of general mathematics (calculus, linear algebra, complex analysis, error analysis, and statistics).
7. has a thorough knowledge of general physics (classical mechanics, relativity, electromagnetism, quantum physics, thermodynamics, statistical physics, wave phenomena, oscillations and optics, matter: structure and interactions)
8. (Minor) has a deeper knowledge of subjects within their own discipline or a broad general knowledge of a different discipline.

Appendix 2 Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Astronomy

1. is on an elementary level able to obtain, analyse, and presents observations in different wavelength regimes of objects like stars, galaxies, and star forming regions,
2. is able to conduct basic astronomical observations with an optical telescope,
3. is familiar with the use of computers and computing in astronomy research:
    - has experience in working with astronomical observations and/or astronomical simulations
    - is able to write software in a common programming language.

Appendix II Follow-on Master's degree programmes (Article 1.5)

The Bachelor's degree programme will grant unconditional admission to the following Master's degree programmes at the University of Groningen:

- Astronomy
- Education and Communication in Mathematics and Natural Sciences
- Energy and Environmental Sciences

Appendix III Majors and Minors in the degree programme (Article 2.1.2)

The programme consists of the Major Astronomy (90 ECTS) and a Minor (30 ECTS).
The student can participate in either the Minor Astronomy or the Minor Instrumentation & Informatics or a Faculty or University Minor.

Appendix IV Course units in the propaedeutic phase

- **List of course units; Article 3.1.1**
- **Course units with one or more practicals; Article 3.2**
- **Form of examinations; Article 7.4**

Course unit	ECTS	Assessment mode	practical
Calculus 1	5	Written exam, test mathematical skills	x
Physics Laboratory 1	5	Written exam, practical assessment (preparation, experimental skills, lab journal, reports, discussion of results)	x
Choice: ▪ Kaleidoscope Modern Physics ▪ Molecules: structure, reactivity and function ▪ Introduction Mathematics	5	 ▪ written exam ▪ written exam, practical assessment ▪ written exam	 x
Thermodynamics	5	Written exam	
Mechanics and Relativity 1	5	Written exam	
Linear Algebra 1	5	written exam, practical assessment	x
Mechanics and Relativity 2	5	written exam, practical assessment	x
Calculus 2	5	Written exam	
Choice: ▪ Introduction Astronomy ▪ Physics of Modern Technology ▪ Introduction NExT ▪ Physics of life ▪ Introduction Energy and Environment	5	 ▪ homework, mid-exam, written exam, report, mandatory attendance Introduction Research ▪ written exam, presentation, essay, mandatory attendance Introduction Research ▪ written exam, mandatory attendance Introduction Research ▪ oral exam, mandatory attendance Introduction Research ▪ written exam, mandatory attendance Introduction Research	 x x x x
Calculus 3	5	Written exam	
Electricity and Magnetism 1	5	written exam, practical assessment	x
Introduction to programming and numerical methods	5	Mid-term exam, assignments, reports, poster presentation	x

Appendix V Course units in the post-propaedeutic phase

- **List of course units; Article 6.1**
- **Course units with one or more practicals; Article 6.2**
- **Compulsory order of examinations; Article 7.2**
- **Form of examinations; Article 7.4**

Course unit	ECTS	Assessment mode	practical	prerequisites
Observational Astronomy	5	Written exam, presentation, practical assessment	x	
Electricity and Magnetism 2	5	Written exam		
Quantum Physics 1	5	Written exam		
Statistical Physics	5	Written exam		
Waves and Optics	5	Written exam, practical assessment	x	
Complex Analysis	5	Written exam		
Structure of Matter 1	5	Written exam		
Science and Society	5	Written exam, performance, essay, presentation, compulsory attendance		
Statistical and Numerical Methods	5	Written exam, practical assessment	x	
Physics of Stars	5	Written exam, mid-term exams		
Quantum Physics 2	5	Written exam		
Physics of Galaxies	5	Written exam		
Minor	30	Depending on the Minor	Depending on the Minor	Depending on the Minor
Astroparticle physics	5	Written exam		
Interstellar Medium	5	Written exam, open book exam, homework assignments		
Astrophysical Hydrodynamics	5	Written exam, homework assignments		
Bachelor Research Project	15	performance, presentation, report	x	Passed 135 ECTS of the Bachelor's degree programme

Minor Astronomy

The Minor comprises 30 ECTS and is a coherent and deepening package of course units

Course unit	ECTS	Assessment method	practical	Prerequisites
Cosmology	5	Written exam, homework		
Choice: ▪ Virtual observations (biennial, 2014-2015) ▪ Stellar structure and evolution (biennial 2014-2015) ▪ High energy and astrophysics (biennial 2013-2014) ▪ Formation and evolution of galaxies	5	▪ as indicated in appendix V of the year 2014-2015 ▪ as indicated in appendix V of the year 2014-2015 ▪ Lecture, Presentation, project assignment ▪ written examination	x x	
Choice from the Bachelor's degree programme (Applied) Physics	5	See Appendix IV and V of the teaching and examination regulations (OER) of the relevant programme	See Appendix IV and V of the OER of the relevant programme	See Appendix IV and V of the OER of the relevant programme
Choice: ▪ Cosmic structure formation (biennial, 2014-2015) ▪ Space Mission Technology (biennial, 2013-2014) ▪ Statistical signal processing	5	▪ as indicated in appendix V of the year 2014-2015 ▪ written exam ▪ written exam, assignments	x	
Electromagnetics and radiative processes	5	Written exam		
Advanced Mechanics	5	Written exam, numerical homework assignments	x	

Minor Instrumentation and Informatics

Course unit	ECTS	Assessment mode	practical	prerequisites
Basic Detection Techniques	5	written exam, report about experiments	x	
Materials Science and Design	5	written exam, assignments	x	
Control Engineering	5	written exam, reports	x	
Space Mission Technology	5	written exam		
Principles of Measurement Systems	5	Written exam, homework assignments		
Statistical Signal Processing	5	written exam, assignments		

Appendix VIII Admission to the post-propaedeutic phase

The following candidates will be admitted to the post-propaedeutic phase:

- Holders of a propaedeutic certificate of the degree programme in Astronomy