



**university of
 groningen**

faculty of science
 and engineering

physics

Appendices to the Teaching and Examination Regulations

2018-2019

Bachelor's degree programme in Physics



Appendix I Learning outcomes of the Bachelor's degree programme (Article 1.3.a)

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 Physics.

A2. Bachelor's graduates have mastered the basic concepts of Physics (see Appendix 1 for further specification) 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 Physics.

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 Physics, 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 Physics.

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 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.

B2. (Designing and Modeling) 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 modern 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.



Degree programme-specific learning outcomes – Basic Knowledge

The Bachelor's graduate in Physics has:

- 1.1. knowledge of the most important subjects in the field of:
 - a. Classical Mechanics / Mechanics
 - b. Electromagnetism
 - c. Quantum Physics
 - d. Thermodynamics
 - e. Statistical Physics
 - f. Wave phenomena, Oscillations and Optics
 - g. Materials: structure and interactions
 - h. Calculus and Linear Algebra
- 1.2. knowledge of topics in at least one of the following research fields:
 - a. Particle Physics
 - b. Nanophysics
 - c. Energy and Environment
 - d. Life and Health
- 1.3. achieved in the Minor, a deeper knowledge of subjects within their own discipline or a broad general knowledge of a different discipline.

Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Physics is able to:

- 2.1. estimate the orders of magnitude of various physical processes;
- 2.2. use specific software, such as a programming language or a (symbolical) software package;
- 2.3. setup and carry out an experiment, while taking into account the safety and environmental issues;
- 2.4. analyze experimental data in a proper and ethical manner, including an error analysis.



Appendix II Majors and Minors of the degree programme (Article 2.1.4)

The total programme consists of a core part, mandatory for all Physics students, and a specialization part, which provides the track specialization (major) and a minor.

1. The Bachelor's degree programme of Physics offers the following four tracks:
 - Biological & Medical Physics (BM)
 - Energy & Environmental Physics (EE)
 - Nanophysics (NP)
 - Particle Physics (PP)

2. The Bachelor's degree programme of Physics offers the following deepening minor:
 - Quantum Materials & Radiation

3. The Bachelor's degree programme of Physics offers the following university minor:
 - Einstein's physics: Space-time and Parallel Worlds



Appendix III Course units in the propaedeutic phase

- **List of course units; Article 3.1.1**
- **Course units with one or more practicals; Article 3.2**
- **Compulsory order of examinations; Article 8.2**

The assessment method(s) of the courses below can be found in the assessment plan of the degree programme and on Ocasys.

Course unit name	ECTS	Practical	Remarks ¹
Mechanics and Relativity	10	X	
Physics Laboratory 1	5	X	
Calculus 1	5	X	
Choice: <ul style="list-style-type: none">- Physics of the Quantum Universe- Physics of Modern Technology- Introduction to Energy & Environment 1- Medical Physics- Introduction to Astronomy	5		
Linear Algebra 1	5	X	
Electricity and Magnetism	10	X	
Calculus 2	5		
Choice: <ul style="list-style-type: none">- Nanophysics- Introduction to Energy & Environment 2- Biophysics	5		
Mathematical Physics	5		
Physics Laboratory 2	5	X	

¹ Indicated if track specific.



Appendix IV Course units in the post-propaedeutic phase

- **List of course units; Article 6.1.1**
- **Course units with one or more practicals; Article 6.2.1**
- **Compulsory order of examinations; Article 8.2**

The assessment method(s) of the courses below can be found in the assessment plan of the degree programme and on Ocasys.

To follow the Education minor (30 ECTS) track specific courses may be substituted, as indicated below.

In case of a double degree Physics and Mathematics a combined research of 20 ECTS is done and the total number of credits of the combined degree must add up to 240 ECTS.

Course unit name	ECTS	Practical	Remarks
Thermodynamics & Statistical Physics	10		
Computational Methods in Science and Technology	5	X	
Quantum Physics 1	5		
Waves and optics	5	X	
Statistical Physics	5		
Electronics and signal processing	5	X	
Structure of Matter	10		
Science, Ethics, Technology, and Society	5		
Physics Laboratory 3	5	X	
Track specific courses <ul style="list-style-type: none"> - Biological & Medical Physics - Energy & Environmental Physics - Nanophysics - Particle Physics 	40 ²		
Minor	15 ³		
Bachelor Research Project (Physics)	15	X	Requires 150 ECTS of the Bachelor's degree programme completed.

² In case of Education minor this is 25 ECTS.

³ In case of Education minor this is 30 ECTS.



Track: Biological & Medical Physics (BM)

Course unit name	ECTS	Practical	Remarks
Molecular Biophysics	5		
Structural Biology	5	X	
Physics Laboratory 4	5	X	Not with Education minor
Imaging Techniques in Radiology	5	X	Not with Education minor
Choice: - Nanophysics and Nanotechnology - Principles of Measurement Systems - Onderwijs en communicatie ⁴	5		Not with Education minor
Biochemistry	5	X	
Cellular Chemistry	5	X	
Physics of Fluids	5		

Track: Energy & Environmental Physics (EE)

Course unit name	ECTS	Practical	Remarks
Geo-energy	5	X	
Climate System and Atmosphere	5		
Physics Laboratory 4	5	X	Not with Education minor
Air Pollution	5		Not with Education minor
Choice: - Principles of Measurement Systems - Onderwijs en communicatie ⁵	5		Not with Education minor
Energy from Gas	5		
Molecular Spectra and Structure	5		
Physics of Fluids	5		

⁴ Additional programme specific requirements apply.

⁵ Additional programme specific requirements apply.



Track: Nanophysics (NP)

Course unit name	ECTS	Practical	Remarks
Complex Analysis	5		
Quantum Physics 2	5		
Nano-probing and Nano-fabrication	5		
Device Physics	5		
Materials Design: Theoretical Methods	5		
Nanophysics and Nanotechnology	5		Not with Education minor
Solid State Physics 1	5		Not with Education minor
Choice: - Physics Laboratory 4 - Principles of Measurement Systems - Onderwijs en communicatie ⁶	5		Not with Education minor

Track: Particle Physics (PP)

Course unit name	ECTS	Practical	Remarks
Complex Analysis	5		
Quantum Physics 2	5		
Astroparticle physics	5		
Symmetry in Physics	5		
Subatomic Physics	5		Not with Education minor
Choice - Relativistic Quantum Mechanics - Experimental Particle Physics	5		
Choice - Physics Laboratory 4 - Advanced Mechanics	5		Not with Education minor
Choice - Principles of Measurement Systems - Chaos Theory - Onderwijs en communicatie ⁷	5		Not with Education minor

⁶ Additional programme specific requirements apply.

⁷ Additional programme specific requirements apply.



Minor: Quantum Materials & Radiation

The minor comprises a choice of 15 ECTS from the list below and is a coherent and deepening package of course units.

Course unit name	ECTS	Practical	Remarks
Atoms and Molecules	5		
Cosmology	5		
Nuclear Energy	5		
Nuclear Physics	5		
Solid Mechanics	5		
Ionizing Radiation in Medicine	5		
Physical and Chemical Kinetics	5		



Appendix V Entry requirements (Article 10.2.1)

A. HBO (university of applied science) propaedeutic certificate

1. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	Subjects at VWO (pre-university) level	Requirement: Dutch as a Second Language (programme II) for non-native speakers of Dutch
B Biology	wia or wib + na+sk+bio	Yes
B Pharmacy	wia or wib + na+sk	Yes
B Life Science and Technology	wib+na+sk	Yes
B Computing Science	wib	
B Artificial Intelligence	wia or wib	
B Physics	wib+na	
B Chemistry	wib+na+sk	
B Astronomy	wib+na	
B Mathematics	wib	
B Chemical Engineering	wib+na+sk	
B Industrial Engineering and Management Science	wib	
B Applied Physics	wib+na	
B Applied Mathematics	wib	

wia = Mathematics A; wib = Mathematics B; na = Physics; sk = Chemistry; bio = Biology

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).
3. The Admissions Board Bachelor's programmes FSE will determine whether deficiencies have been compensated satisfactorily.

B. Foreign qualifications (EEA)

1. Any certificate that grants access to a university in a European country will also grant access to Dutch universities.
2. The same requirements that also apply to candidates with an HBO (university of applied science) propaedeutic certificate will apply to these candidates in the entrance examination as defined in Article 7.28.3 of the Act (see A).
3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).
4. In addition, candidates are required to be competent in English: an IELTS score of 6.5, a TOEFL score of 580 (paper-based), of 237 (computer-based) or of 92 (internet-based) or equivalent.



- The Admissions Board Bachelor's programmes FSE will determine whether deficiencies have been compensated satisfactorily.

C. Foreign qualifications (German)

- German candidates must have a Zeugnis der Allgemeinen Hochschulreife ('Abitur').
- The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	
B Biology	wi (LK or GK) na (LK or GK) sk (LK or GK) bio (LK or GK) (at least one subject at Leistungskurs level)
B Pharmacy B Life Science and Technology B Chemistry B Chemical Engineering	wi (LK or GK) na (LK or GK) sk (LK or GK) (at least one subject at Leistungskurs level)
B Computing Science B Mathematics B Applied Mathematics B Artificial Intelligence	wi (LK)
B Physics B Astronomy B Applied Physics	wi (LK) na (LK or GK)
B Industrial Engineering and Management Science	wi (LK or GK) na (LK or GK) (at least one subject at Leistungskurs level)

wi= Mathematics; na = Physics; sk = Chemistry; bio = Biology

LK = Leistungskurs level; GK = Grundkurs level followed until end of Class 13 or Class 12 (if Gymnasium education lasts 12 years).

- Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).
- The Admissions Board Bachelor's programmes FSE will determine whether deficiencies have been compensated satisfactorily.



D. Foreign qualifications (International Baccalaureate)

1. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	from 2010/2011
B Biology	Biology (SL or HL) Maths (SL or HL) Physics (SL or HL) Chemistry (SL or HL) two of these subjects at HL
B Pharmacy B Life Science and Technology B Chemistry B Chemical Engineering	Maths (SL or HL) Physics (SL or HL) Chemistry (SL or HL) two of these subjects at HL
B Computing Science B Mathematics B Applied Mathematics	Maths HL
B Artificial Intelligence	Maths SL or Maths HL
B Physics B Astronomy B Applied Physics B Industrial Engineering and Management Science	Maths HL Physics HL

SL = Standard Level, HL = Higher Level

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).
3. The Admissions Board Bachelor's programmes FSE will determine whether deficiencies have been compensated satisfactorily.

E. Foreign qualifications (non-EEA)

1. A non-European certificate that according to NUFFIC and/or NARIC standards is equivalent to a Dutch VWO certificate will grant access to university in the Netherlands.
2. The same requirements that also apply to candidates with an HBO (university of applied science) propaedeutic certificate will apply to these candidates in the entrance examination as defined in Article 7.28.3 of the Act (see A).
3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).
4. In addition, candidates are required to be competent in English: an IELTS score of 6.5, a TOEFL score of 580 (paper-based), of 237 (computer-based) or of 92 (internet-based) or equivalent.



5. The Admissions Board Bachelor's programmes FSE will determine whether deficiencies have been compensated satisfactorily.

F. Entrance examination

1. The following requirements apply to the entrance examination as defined in Article 7.29 of the Act:

Degree programme	Nature and Health VWO level	or	Nature and Technology VWO level
B Biology	en, wia or b, sk, bio, na		en, wib, na, sk, bio
B Pharmacy	en, wia or b, sk, bio, na		en, wib, na, sk
B Life Science and Technology	en, wib, sk, bio, na		en, wib, na, sk
B Computing Science	en, wib, sk, bio		en, wib, na, sk
B Artificial Intelligence	en, wia or b, sk, bio		en, wib, na, sk
B Physics	en, wib, sk, bio, na		en, wib, na, sk
B Chemistry	en, wib, sk, bio, na		en, wib, na, sk
B Astronomy	en, wib, sk, bio, na		en, wib, na, sk
B Mathematics	en, wib, sk, bio		en, wib, na, sk
B Chemical Engineering	en, wib, sk, bio, na		en, wib, na, sk
B Industrial Engineering and Management Science	en, wib, sk, bio		en, wib, na, sk
B Applied Physics	en, wib, sk, bio, na		en, wib, na, sk
B Applied Mathematics	en, wib, sk, bio		en, wib, na, sk

en = English; wia = Mathematics A; wib = Mathematics B; na = Physics; sk = Chemistry; bio = Biology

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).
3. The Admissions Board Bachelor's programmes FSE will determine whether deficiencies have been compensated satisfactorily.



Appendix VI Clustering of Bachelor's degree programmes
Article 4.3.4, Article 4.6.1

Degree programme CROHO code	Name of degree programme	Clustered with CROHO code	Name of degree programme
56286	B Life Science and Technology	56860 56157	B Biology B Pharmacy
56860	B Biology	56286 56157	B Life Science and Technology B Pharmacy
56157	B Pharmacy	56860 56286	B Biology B Life Science and Technology
56980	B Mathematics	56965 50206 56962 50205	B Applied Mathematics B Physics B Applied Physics B Astronomy
56965	B Applied Mathematics	56980 50206 56962 50205	B Mathematics B Physics B Applied Physics B Astronomy
50206	B Physics	56962 50205 56965 56980	B Applied Physics B Astronomy B Applied Mathematics B Mathematics
56962	B Applied Physics	50206 50205 56965 56980	B Physics B Astronomy B Applied Mathematics B Mathematics
50205	B Astronomy	56962 56965 50206 56980	B Applied Physics B Applied Mathematics B Physics B Mathematics
56857	B Chemistry	56960	B Chemical Engineering
56960	B Chemical Engineering	56857	B Chemistry



Appendix VII Admission to the post-propaedeutic phase (Article 5.1.1)

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

- a. Students who have been issued a positive study advice from the degree programme in question;
- b. Students who have been issued a positive study advice from one of the degree programmes:
 - Applied Physics
 - Astronomy



**Appendix VIII Contact hours propaedeutic phase
 (Article 2.4)**

Bachelor's year 1	
Structure contact hours	Contact hours per year
Lectures	334
Tutorial	288
Practicals	71
Tutoring	8
Examinations	45
Other structured hours	18



Appendix IX University Minors of the faculty of Science and Engineering (Article 7.5.1)

1. Neurosciences Minor (taught in English):

- Neuroscience (15 ECTS)
- Behavioural Neuroscience (15 ECTS)

People, Planet, Profit Minor (taught in English):

- Overview and Coherence People Planet Profit (10 ECTS)
- Paper People Planet Profit (5 ECTS)
- Project People, Planet, Profit (15 ECTS)

Astronomy through Space and Time Minor (taught in English):

- The Evolving Universe (5 ECTS)
- Cosmic Origins (5 ECTS)
- Astrobiology (5 ECTS)

Einstein's physics: Space-time and Parallel Worlds (taught in English):

- Einstein's Universe (5 ECTS)
- Quantum World (5 ECTS)
- Building blocks of matter (5 ECTS)

2. The Programme Committee for the Bachelor's degree programmes in Biology and Life Science & Technology also has authority in the field of the Minor "Neurosciences" and/or its course units.

The Programme Committee for the Master's degree programme in Energy & Environmental Sciences also has authority in the field of the Minor "People, Planet, Profit" and/or its course units.

The Programme Committee for the Bachelor's degree programme in Astronomy also has authority in the field of the Minor "Astronomy through Space and Time" and/or its course units.

The Programme Committee for the Bachelor's degree programmes in Physics and Applied Physics also has authority in the field of the Minor "Einstein's physics: Space-time and parallel worlds" and/or its course units.

3. The Board of Examiners for the Bachelor's degree programmes in Biology and Life Science & Technology and the Master's degree programmes in Biology, Ecology & Evolution, Marine Biology and Molecular Biology & Biotechnology also has authority in the field of the Neurosciences Minor and/or its course units.

The Board of Examiners for the Master's degree programme in Energy & Environmental Sciences also has authority in the field of the People, Planet, Profit Minor and/or its course units.

The Board of Examiners for the Bachelor's degree programme in Astronomy also has authority in the field of the Astronomy through Space and Time Minor and/or its course units.

The Board of Examiners for the Bachelor's degree programmes in Physics and Applied Physics also has authority in the field of the Physics Minor "Einstein's physics: Space-time and parallel worlds" and/or its course units.



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4. These Teaching and Examination Regulations also apply in their entirety to the Minors in Neurosciences, People, Planet, Profit, Astronomy through Space and Time and Einstein's physics: Space-time and parallel worlds and/or their course units.



Appendix X Transitional arrangement (article 12.1)

Students who started the programme before 2018 and doing the track NExT, including a 30 ECTS minor, are also allowed to follow the programme as described in App. IV, including a smaller 15 ECTS minor and 3 mandatory courses.

Discontinued course units				Substitute course units				
<i>Course unit code</i>	<i>Course unit name</i>	<i>ECTS</i>	<i>Final exam</i>	<i>Course unit code</i>	<i>Course unit name</i>	<i>ECTS</i>	<i>Explanation</i>	<i>Equivalent Yes/No</i>
NAET-12	Experimental Techniques in Particle Physics	5	TBA	-	-	-	-	-
NAFDF-12	Fundamentals of Particle Physics	5	TBA	-	-	-	-	-