university of groningen / faculty of science and engineering / physics

Appendices to the Teaching and Examination Regulations for the

Bachelor's degree programme in Physics

2024-2025

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

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 1.1 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 contemporary 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, and act accordingly.

B. Generic learning outcomes – Skills

B1. (Research) Bachelor's graduates are able to investigate a research question, design, plan and conduct research and report on it independently with an appropriate 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 physics problem into a plan of approach and – taking into account practical boundary conditions – 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 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 1.2.

1.1 Degree programme-specific learning outcomes – Basic Knowledge

The Bachelor's graduate in Physics has:

1.1.1 knowledge of the most important subjects in the field of:

a. Classical and Relativistic 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

1.1.2 knowledge of topics in at least one of the following research fields:

i. Biophysics and Medical Physics
j. Energy and Environmental Physics
k. Nanophysics
l. Particle Physics

1.1.3 achieved in the Minor, a deeper knowledge of subjects within their own discipline or a broad general knowledge of a different discipline.

1.2 Degree programme-specific learning outcomes – Skills

The Bachelor's graduate in Physics is able to:

1.2.1 estimate the orders of magnitude of various physical processes;
1.2.2 use specific software, such as a programming language or a (symbolical) software package;
1.2.3 setup and carry out an experiment, while taking into account the safety and environmental issues;
1.2.4 gain insight in the fundamental workings of nature through the analysis of experimental constructs and/or experimental data.

Appendix II. Majors and Minors (art. 3.7)

The degree programme consists of the Physics major (165 ECTS) and a free minor (15 ECTS).

Majors:
The Physics major consists of a core programme, mandatory for all Physics students, and a specific specialization programme which is available for four different lines of specialisation:

- Biophysics & Medical Physics (BMP)
- Energy & Environmental Physics (EEP)
- Nanophysics (NP)
- Particle Physics (PP)

Minors:

1. The Bachelor's degree programme of Physics offers the following deepening minor:
   - Quantum Materials & Radiation (15 ECTS)

2. The Bachelor's degree programme of Physics offers the following University Minor:
   - Einstein's physics: Space-time and Parallel Worlds (15 ECTS)

   This minor is offered university wide and as such not available for students from the bachelor degree programmes Physics, Applied Physics, and Astronomy.

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

- **List of course units; art. 4.1.1**
- **Compulsory order of examinations; art. 9.3**

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

Physics major programme

Course unit (course code)	ECTS	Remarks
Calculus 1 (for Physics) (WBPH057-05)	5	
Calculus 2 (for Physics) (WBPH058-05)	5	
Computational Methods 1 (WBPH064-05)	5	
Electricity and Magnetism (WBPH033-10)	10	
Linear Algebra (for Physics) (WBPH054-05)	5	
Mathematical Physics (WBPH049-05)	5	
Mechanics and Relativity (WBPH001-10)	10	
Physics Lab: Research Project (WBPH076-05)	5	
Physics Lab: Skills (WBPH077-05)	5	
Choice: - Introduction to Astronomy (WBAS007-05) - Introduction to Energy & Environment (WBPH019-05) - Physics of Modern Technology - (WBPH027-05) - Medical Physics & Biophysics (WBPH022-05) - Introduction to Nanophysics (WBPH055-05) - Physics of the Quantum Universe (WBPH028-05)	5	

3.2 First year of double bachelor's degree in Mathematics and Physics

If a student wants to obtain a Bachelor's degree in Mathematics as well as a Bachelor's degree in Physics at the same time, the student has the option to follow a slightly modified curriculum in which several courses are exempted.

A complete overview of all obligations and modifications within the propaedeutic phase of both programmes is provided in the Teaching and Examination Regulations of the Bachelor's degree programme in Mathematics.

Appendix IV. Course units second and third years of the degree programme

- **List of course units; art. 7.1.1**
- **Compulsory order of examinations; art. 9.3**

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

4.1 Physics major programme

Course unit (course code)	ECTS	Remarks
Physics Lab: Advanced Experiments 1 (WBPH074-05)	5	
Computational Methods 2 (WBPH065-05)	5	
Fundamentals of Electronics (WBPH070-05)	5	
Physics, Astronomy & Society: Ethical and Professional Aspects (WBPH053-05)	5	
Quantum Physics 1 (WBPH014-05)	5	
Quantum Physics 2 (WBPH052-05)	5	
Structure of Matter (WBPH034-10)	10	
Thermal Physics (WBPH002-10)	10	
Waves and optics (WBPH032-05)	5	
Specialisation specific courses in: - *Biophysics & Medical Physics* - *Energy & Environmental Physics* - *Nanophysics* - *Particle Physics*	40[1]	See specialisation specific tables below.
Minor	15[2]	
Bachelor Research Project (Physics) (WBPH903-15)	15[3]	Requires 150 ECTS of the Bachelor's degree programme completed.

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

[1] In case of Education minor this is 25 ECTS.
[2] In case of Education minor this is 30 ECTS.
[3] In case of a double degree Physics and Mathematics a combined research of 20 ECTS has to be done.

4.2 Specialization: Biophysics & Medical Physics (BMP)

Course unit (course code)	ECTS	Remarks
Year 2		
Molecular Biophysics (WBPH023-05)	5	
Year 3		
Cellular Chemistry (WBCH021-05)	5	
Imaging Techniques in Radiology (WBBE012-05)	5	
Modelling Life (WBBY024-05)	5	Not with Education minor
Physics Lab: Advanced Experiments 2 (WBPH073-05)	5	Not with Education minor
Physics of Fluids (WBPH042-05)	5	
Choice: - Nanophysics and Nanotechnology (WBPH025-05) - Principles of Measurement Systems (WBPH029-05)Statistics for Modern Physics (WBPH080-05) - Introduction to Science Communication (WBEC001-05) [4] - Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05) [5]	5	Not with Education minor

4.3 Specialization: Energy & Environmental Physics (EEP)

Course unit (course code)	ECTS	Remarks
Year 2		
Geo-Energy (WBPH018-05)	5	
Year 3		
Air Pollution (WBPH035-05)	5	Not with Education minor
Energy from Gas (WBPH039-05)	5	
Molecular Spectra and Structure	5	
Physics Lab: Advanced Experiments 2 (WBPH073-05)	5	Not with Education minor
Physics of Fluids (WBPH042-05)	5	
Choice: - Principles of Measurement Systems (WBPH029-05) - Statistics for Modern Physics (WBPH080-05) - Introduction to Science Communication (WBEC001-05) [6] - Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05) [7]	5	Not with Education minor

[4] Additional programme specific requirements apply.
[5] Additional programme specific requirements apply.
[6] Additional programme specific requirements apply.
[7] Additional programme specific requirements apply.

4.4 Specialization: Nanophysics (NP)

Course unit (course code)	ECTS	Remarks
Year 2		
Complex Analysis (for Physics) (WBPH059-05)	5	
Year 3		
Device Physics (WBPH037-05)	5	
Materials Design: Theoretical Methods (WBCH024-05)	5	
Nanophysics and Nanotechnology (WBPH025-05)	5	Not with Education minor
Nanoprobing and Nanofabrication (WBPH041-05)	5	
Solid State Physics (WBPH068-05)	5	Not with Education minor
Choice: - Physics Lab: Advanced Experiments 2 (WBPH073-05) - Principles of Measurement Systems (WBPH029-05) - Statistics for Modern Physics (WBPH080-05) - Introduction to Science Communication (WBEC001-05) [8] - Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05) [9]	5	Not with Education minor

4.5 Specialization: Particle Physics (PP)

Course unit (course code)	ECTS	Remarks
Year 2		
Complex Analysis (for Physics) (WBPH059-05)	5	
Year 3		
Advanced Electrodynamics (WBAS019-05)	5	
Symmetry in Physics (WBPH047-05)	5	
Subatomic Physics (WBPH031-05)	5	Not with Education minor
Choice - Experimental Particle Physics (WBPH040-05) - Relativistic Quantum Mechanics (WBPH045-05)	5	
Choice - Physics Lab: Advanced Experiments 2 (WBPH073-05) - Advanced Mechanics (WBPH017-05)	5	Not with Education minor
Choice - Principles of Measurement Systems (WBPH029-05) - Statistics for Modern Physics (WBPH080-05) - Introduction to Science Communication (WBEC001-05) [10] - Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05) [11]	5	Not with Education minor

[8] Additional programme specific requirements apply.
[9] Additional programme specific requirements apply.
[10] Additional programme specific requirements apply.
[11] Additional programme specific requirements apply.

4.6 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 (course code)	ECTS	Remarks
Atoms and Molecules (WBPH003-05)	5	
Cosmology (WBAS001-05)	5	
Ionizing Radiation in Medicine (WBPH007-05)	5	
Nuclear Energy (WBPH010-05)	5	
Nuclear Physics (WBPH011-05)	5	
Optical Spectroscopy (WBPH078-05)	5	
Physical and Chemical Kinetics (WBPH012-05)	5	
Solid Mechanics (WBPH015-05)	5	

4.7 Second and third year of double bachelor's degree in Mathematics and Physics

If a student wants to obtain a Bachelor's degree in Mathematics as well as a Bachelor's degree in Physics at the same time, the student has the option to follow a slightly modified curriculum in which several courses are exempted and one larger Bachelor's research project has to be done.

A complete overview of all obligations and modifications within the second and third year of both programmes is provided in the Teaching and Examination Regulations of the Bachelor's degree programme in Mathematics.

Appendix V. Contact hours (art. 3.6)

Bachelor's year 1	
Structure contact hours	**Contact hours per year**
Lectures	319
Tutorial/practicals	371
Projects	38
Tutoring	8
Examinations	45
Other structured hours	24

Bachelor's year 2	
Structure contact hours	**Contact hours per year**
Lectures	305
Tutorial/practicals	247
Projects	51
Tutoring	0
Examinations	40
Other structured hours	20

Bachelor's year 3	
Structure contact hours	**Contact hours per year**
Lectures	184
Tutorial/practicals	151
Projects	560
Tutoring	0
Examinations	40
Other structured hours	20

Appendix VI. Additional Requirements Open degree Programmes (art. 7.3)

Students wishing to pursue an open degree programme may file a request with the Board of Examiners of Physics and Applied Physics. The Board of Examiners will evaluate whether the proposed curriculum meets the learning outcomes of the degree programme.

Appendix VII. Transitional provisions (art. 12.1)

8.1 Transitional arrangement 2024-2025

Discontinued course units				Substitute course units				
Course code	*Course name*	*ECTS*	*Final exam*	*Course code*	*Course name*	*ECTS*	*Explanation*	*Equivalent Yes/No*
WBPH051-05	Physics Laboratory 4	5	23/24	WBPH073-05	Physics Lab: Advanced Experiments 2	5	Name change	Yes

8.2 Transitional arrangement 2023-2024

Discontinued course units				Substitute course units				
Course code	*Course name*	*ECTS*	*Final exam*	*Course code*	*Course name*	*ECTS*	*Explanation*	*Equivalent Yes/No*
WBPH013-05	Physics Laboratory 1	5	23/24	WBPH077-05	Physics Lab: Skills	5	Name change	Yes
WBPH050-05	Physics Laboratory 2	5	23/24	WBPH076-05	Physics Lab: Research Project	5	Name change	Yes
WBPH051-05	Physics Laboratory 3	5	23/24	WBPH074-05	Physics Lab: Advanced Experiments 1	5	Name change	Yes
WBPH030-05	Solid State Physics 1	5	23/24	WBPH068-05	Solid State Physics	5	Name change	Yes
WBPH005-05	Computational Methods in Science and Technology	5	23/24	WBPH064-05	Computational methods 2	5	Name change	Yes
WBPH038-05	Electronics and Signal Processing	5	23/24	WBPH070-05	Fundamentals of Electronics	5	Name change	Yes
WBPH036-05	Astroparticle Physics	5	24/25	WBAS019-05	Advanced Electrodynamics	5	Substituting course	Yes

8.3 Transitional arrangement 2022-2023

Discontinued course units				Substitute course units				
Course code	*Course name*	*ECTS*	*Final exam*	*Course code*	*Course name*	*ECTS*	*Explanation*	*Equivalent Yes/No*
WBMA003-05	Calculus 1	5	N/A	WBPH057-05	Calculus 1 (for Physics)	5	Substituting course	Yes
WBMA003-05	Calculus 2	5	N/A	WBPH058-05	Calculus 2 (for Physics)	5	Substituting course	Yes
WBMA018-05	Complex Analysis	5	N/A	WBPH059-05	Complex Analysis (for Physics)	5	Substituting course	Yes
WBPH044-05	Python for Physicists	5	23/24	WBPH063-05	Computational methods 1	5	Name change	Yes

8.4 Transitional arrangement 2021-2022

No transitional arrangements.

8.5 Transitional arrangement 2020-2021

Discontinued course units				**Substitute course units**				
Course code	*Course name*	*ECTS*	*Final exam*	*Course code*	*Course name*	*ECTS*	*Explanation*	*Equivalent Yes/No*
WILA1-06	Linear Algebra	5	N/A	WBPH054-05	Linear Algebra (for Physics)	5	Substituting course	Yes

Within the specialization 'Biophysics & Medical Physics', the course unit 'Structural Biology' has been replaced by the course 'Chemical Biology'. 'Structural Biology' is still provided for other degree programmes and it is therefore possible for physics students of previous cohorts to pass this course if they still need to.