Assessment plan
Bachelor's degree programme Physics
2022-2023

June 2022

Introduction

This assessment plan is a systematic description of the type of assessment used in the various modules of the Bachelor's programme Physics. This assessment plan fits within the assessment policy of the Faculty of Science and Engineering [1], and the protocol used by the Board of Examiners of the degree programme [2].

The assessment plan is based on:

- the learning outcomes of the degree programme (appendix 1);
- the Teaching and Examination regulations of the degree programme;
- the description of the various modules of the degree programme in the digital course catalogue *Ocasys*, including:
    - Objective of the module;
    - Course content;
    - Lecturers and examiners;
    - Assessment method used;
    - Lecture format.

Assessment plan 2022-2023

The assessment plan contains two parts:

1. An overview of examiners and assessment methods used for all modules in the Physics Bachelor's programme. The following assessment methods are distinguished in this scheme:
    - Written examination (WE);
    - Oral examination (OR);
    - Assignment, including homework and written report (AST);
    - Assessment of Practical work, including laboratory and computer work (PR);
    - Presentation (P);
    - Midterm test (IT).

    In case of just one examiner, a deputy examiner [3] is given. The coordinator of the module is underlined, in case more examiners are involved in teaching.

2. A matrix describes the relation between the various modules of the programme and the specified learning outcomes of the degree programme. The specified learning outcomes are defined in the programme's Teaching and Examination Regulation and have been included in appendix 1.

[1] FSE Quality Assurance Manual 2016-2017; chapter 6: Assessment policy

[2] FSE Manual for Board of Examiners (version: 2019); Chapter 4: Duties of the Board of Examiners

[3] FSE Quality Assurance Manual 2016-2017; paragraph 6.3: Practical matters

Examiners and assessment methods of modules in the degree programme

First year (core programme)

Module	First examiner	Assessment method	Second examiner and other teachers
Calculus 1 (for Physics) (WBPH057-05)	P.M.J. Tibboel	AST, WE, IT	R.W.C.P. Verstappen
Calculus 2 (for Physics) (WBPH058-05)	T.F. Görbe	AST, WE, IT	H. Waalkens
Electricity and Magnetism (WBPH033-10)	M.S. Pchenitchnikov	PR, WE, IT	S. Hoekstra
Introduction to Astronomy (WBAS007-05)	J. Noel-Storr	AST, WE, IT	M.A.M. van de Weijgaert
Introduction to Energy and Environment (WBPH019-05)	H.A.J. Meijer	AST, WE	H. Chen
Introduction to Nanophysics (WBPH055-05)	P. Rudolf	WE, IT, P	B. Noheda Pinuaga
Linear Algebra (for Physics) (WBPH054-05)	M. Mendez	AST, WE, IT	D. Boer
Mathematical Physics (WBPH049-05)	G. Palasantzas	AST, WE, IT	H. Waalkens
Mechanics and Relativity (WBPH001-10)	P.D. Meerburg	AST, WE, IT	M.H. Lee
Medical Physics & Biophysics (WBPH022-05)	R. Vlijm	AST, WE	T. Schlathölter
Physics Laboratory 1 (WBPH013-05)	J.S. Blijleven	PR, WE	R.J.H. Klein-Douwel
Physics Laboratory 2 (WBPH050-05)	A.K. Biegun	AST, PR, P	J.S. Blijleven
Physics of Modern Technology (WBPH027-05)	C.H. van der Wal	WE, P	M.H. Diniz Guimaraes, A. Giuntoli
Physics of the Quantum Universe (WBPH028-05)	K.A.M. de Bruyn	AST, WE	D. Roest
Python for Physicists (WBPH044-05)	J.W. Brijan	AST, WE	C.J.G. Onderwater

Second year (core programme)

Module	First examiner	Assessment method	Second examiner and other teachers
Computational Methods in Science and Technology (WBHP005-05)	M. Kavatsyuk	AST, WE	*TBD*
Electronics and Signal Processing (WBPH038-05)	E. Chicca	PR, WE	J.S. Blijleven
Physics Laboratory 3 (WBPH051-05)	A.K. Biegun	AST, PR, P	J.S. Blijleven
Physics, Astronomy & Society: Ethical & Professional Aspects (WBPH053-05)	B. Piersma	AST, WE, P	J. Zevenberg, H.J. van der Windt, dr. H.A.J. Mulder
Quantum Physics 1 (WBPH014-05)	D. Roest	WE	A. Mazumdar
Structure of Matter (WBPH034-10)	R.A. Hoekstra	WE, IT	L.J.A.Koster
Thermal Physics (WBPH002-10)	T.A. Schlathölter	WE, IT	A. Borschevsky
Waves and Optics (WBPH032-05)	S. Hoekstra	WE, IT	A.K. Biegun

Second year (track programmes)

Module	First examiner	Assessment method	Second examiner and other teachers
Biophysics and Medical Physics			
Biomaterials 1 (WBBE007-05)	P. van Rijn	WE, P	P. Sharma
Molecular Biophysics (WBPH023-05)	W.H. Roos	WE	E. van der Giessen
Energy and Environmental Physics			
Climate System and Atmosphere (WBPH048-05)	H. Chen	WE	H.A.J. Meijer
Geo-energy (WBPH018-05)	J.M. Miocic	WE	H.A.J. Meijer
Nanophysics/ Partical Physics			
Complex Analysis (for Physics) (WBPH059-05)	T.F. Görbe	AST, WE, IT	K. Efstathiou
Quantum Physics 2 (WBPH052-05)	A. Mazumdar	AST, WE	D. Boer

Third year (track programmes)

Module	First examiner	Assessment method	Second examiner and other teachers
Biophysics and Medical Physics			
Cellular Chemistry (WBCH021-05)	B. Poolman	WE	P.J.M. van Haastert
Imaging Techniques in Radiology 1 (WBBE012-05)	H. Dijkstra	AST, WE, P	M.J.W. Greuter, P.M.A. van Ooijen
Introduction to Science Communication (WBEC001-05)	L.T.J. Kraan	R	H.A.J. Mulder, F.H.C.E. van der Graaf
Modelling Life (WBBY024-05)	G.S. van Doorn,	WE, PR, IT	B.M. Bakker, J. Bakker, A. Milias Argeitis, F.J. Weissing
Nanophysics and Nanotechnology (WBPH025-05)	M.A. Loi	WE	J. Slawinska
Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05)	J.E. van der Laan	OR, R	G. Roorda, S. Tuenter
Physics Laboratory 4 (WBPH026-05)	A.K. Biegun	AST, PR, P	J.S. Blijleven
Physics of Fluids (WBPH042-05)	P.R. Onck	WE	E. van der Giessen
Principles of Measurement Systems (WBPH029-05)	A.K. Biegun	WE	J.S. Blijleven
Bachelor Research Project (WBPH903-15)	*See list examiners research projects below*	AST, PR, P	

Module	First examiner	Assessment method	Second examiner and other teachers
Energy and Environmental Physics			
Air Pollution (WBPH035-05)	U. Dusek	PR, WE, IT	H.A.J. Meijer
Energy from Gas (WBPH039-05)	A. Purushothaman Vellayani	AST	W. de Jong
Introduction to Science Communication (WBEC001-05)	L.T.J. Kraan	R	H.A.J. Mulder, F.H.C.E. van der Graaf
Geo-energy (WBPH018-05)	J.M. Miocic	WE	H.A.J. Meijer
Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05)	J.E. van der Laan	OR, R	G. Roorda, S. Tuenter
Physics Laboratory 4 (WBPH026-05)	A.K. Biegun	AST, PR, P	J.S. Blijleven
Physics of Fluids (WBPH042-05)	P.R. Onck	WE	E. van der Giessen
Principles of Measurement Systems (WBPH029-05)	A.K. Biegun	WE	J.S. Blijleven
Solar Cells (WBCH018-05)	L.J.A. Koster	AST, WE, P	S.C. Veenstra
Bachelor Research Project (WBPH903-15)	*See list examiners research projects below*	AST, PR, P	

Module	First examiner	Assessment method	Second examiner and other teachers
Nanophysics			
Device Physics (WBPH037-05)	B.J. van Wees	AST, WE, P	T. Banerjee, M.A. Loi
Introduction to Science Communication (WBEC001-05)	L.T.J. Kraan	R	H.A.J. Mulder, F.H.C.E. van der Graaf
Materials Design: Theoretical Methods (WBCH024-05)	A. Borschevsky	AST, WE, PR	R.W.A. Havenith
Nanophysics and Nanotechnology (WBPH025-05)	M.A. Loi	WE	J. Slawinska
Nanoprobing and Nanofabrication (WBPH041-05)	T. Banerjee	WE	A. Grubisic-Cabo
Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05)	J.E. van der Laan	OR, R	G. Roorda, S. Tuenter
Physics Laboratory 4 (WBPH026-05)	A.K. Biegun	AST, PR, P	J.S. Blijleven
Principles of Measurement Systems (WBPH029-05)	A.K. Biegun	WE	J.S. Blijleven
Solid State Physics 1 (WBPH030-05)	J. Ye	AST, WE	M.A. Loi
Bachelor Research Project (WBPH903-15)	*See list examiners research projects below*	AST, PR, P	

Module	First examiner	Assessment method	Second examiner and other teachers
Particle Physics			
Advanced Mechanics (WBPH017-05)	E. Dimastrogiovanni	AST, WE	E. van der Giessen
Astroparticle Physics (WBPH036-05)	M. Vecchi	AST, WE	A.M. van den Berg
Experimental Particle Physics (WBPH040-05)	L. Willmann	AST, WE	M. Kavatsyuk
Introduction to Science Communication (WBEC001-05)	L.T.J. Kraan	R	H.A.J. Mulder, F.H.C.E. van der Graaf
Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05)	J.E. van der Laan	OR, R	G. Roorda, S. Tuenter
Physics Laboratory 4 (WBPH026-05)	A.K. Biegun	AST, PR, P	J.S. Blijleven
Principles of Measurement Systems (WBPH029-05)	A.K. Biegun	WE	J.S. Blijleven
Project Chaos Theory (WBMA025-05)	H. Waalkens	AST, P	K. Efstathiou
Relativistic Quantum Mechanics (WBPH045-05)	A. Mazumdar	AST, WE	D. Roest
Subatomic Physics (WBPH031-05)	K.H.K.J. Jungmann	WE	C.J.G. Onderwater
Symmetry in Physics (WBPH047-05)	D. Boer	WE	A. Borschevsky
Bachelor Research Project (WBPH903-15)	*See list of examiners research projects below*	AST, PR, P	

Third year (Minor: Quantum Materials & Radiation)

Module	First examiner	Assessment method	Second examiner and other teachers
Atoms and Molecules (WBPH003-05)	A. Borschevsky	WE	S. Hoekstra
Cosmology (WBAS001-05)	S. Zaroubi	AST, WE	M.A.M. van de Weijgaert
Ionizing Radiation in Medicine (WBPH007-05)	P.G. Dendooven	WE, P	E.R. van der Graaf
Nuclear Energy (WBPH010-05)	C. Rigollet	AST, WE	E.R. van der Graaf
Nuclear Physics (WBPH011-05)	J. Even	AST, WE	J.G. Messchendorp
Physical and Chemical Kinetics (WBPH012-05)	A.V. Mokhov	WE	H.B. Levinsky
Solid Mechanics (WBPH015-05)	E. van der Giessen	AS, WE	P.R. Onck

University Minor
Einstein's Physics: Space-time and Parallel Worlds

Module	First examiner	Assessment method	Second examiner and other teachers
Living in Einstein's Universe (WBPH060-05)	R.G.E. Timmermans	AST	*TBD*
Relativity Theory (WBPH061-05)	D. van Eijk	WE	D. Roest
The Quantum World (WBPH062-05)	C.J.G. Onderwater	WE	R.G.E. Timmermans

Examiners for Bachelor's Research projects

VSI
Bergshoeff, prof.dr. E.A.
Bethlem, dr. H.L.
Boer, prof.dr. D.
Borschevsky, prof.dr. A.
Bruyn, dr. K.A.M. de
Dimastrogiovanni, dr. E.
Eijk, D. van
Even, dr. J.
Hoekstra, prof.dr. S.
Jungmann, prof.dr. K.H.K.J.
Mazumdar, prof.dr. A.
Meerburg, dr. D.
Mulder, dr. M.
Onderwater, dr.ir. C.J.G.
Pallante, prof.dr. E.
Pellegrino, prof.dr. A.
Roest, prof.dr. D.
Timmermans, prof.dr. R.G.E.
Veghel, dr. M. van
Willmann, dr. L.

Zernike Institute
Banerjee, prof.dr. T.
Giessen, prof.dr.ir. E. van der
Grubisic-Cabo, dr. A.
Hildner, prof.dr. R.M.
Jansen, dr. T.L.C.
Mostovoy, prof.dr. M.V.
Onck, prof.dr.ir. P.R.
Pchenitchnikov, prof.dr. M.S.
Roos, prof.dr. W.H.
Rudolf, prof.dr. P.
Schlathölter, dr. T.A.
Slawinska, dr. J.
Vlijm, dr. R.
Wal, prof.dr.ir. C.H. van der
Wees, prof.dr.ir. B.J. van
Wel, prof.dr. P.C.A. van der
Zaag, dr. P.J. van der

ESRIG
Chen, prof.dr. H.
Dee, prof.dr. M.W.
Dusek, prof.dr. U.
Kalantar-Nayestanaki, prof.dr. N.
Kavatsyuk, dr. M.
Levinsky, prof. dr. H.B.
Meijer, prof.dr. H.A.J.
Miocic, dr. J.M.
Mokhov, dr. A.V.
Purushothaman Vellayani, prof.dr. A.

SSE *
Biegun, dr. A.K.
Blijleven, dr. J.S.
Brijan, dr. J.W.
Klein, dr. R.
Klein-Douwel, dr. R.H.J.
Rigollet, dr. C.E.

An examiner for the Bachelor Research projects in Applied Physics, Astronomy, or Mathematics may also act as second supervisor for a Bachelor Research Project in Physics.

* Examiners from the SSE may only act as second examiner for a Bachelor Research Project.

Relation between the learning outcomes and the curriculum

The following tables show for each of the specializations how the individual course units contribute to the final qualifications of the programme.

'+' indicates that a course unit has some contribution to the qualification under consideration.
'++' idem - significant contribution to the qualification under consideration.

The numbers in the table correspond to the qualifications that are listed in appendix I.

Year 1															
Learning outcomes	Mechanics and Relativity	Electricity and Magnetism	Physics Laboratory 1	Physics Laboratory 2	Python for Physicists	Physics of the Quantum Universe	Physics of Modern Technology	Introduction to Nanophysics	Energy and Environment	Medical Physics & Biophysics	Introduction to Astronomy	Calculus 1 (for Physics)	Linear Algebra (for Physics)	Calculus 2 (for Physics)	Mathematical Physics
A1	++	++				+	+	+	+	+	+	+	+	+	+
A2	++	++	+	+	+							+	+	+	+
A3						+	+	+	+	+	+				
A4	+	+	+	+	+							+	+	+	+
A5	++	++	+	+								++	++	++	++
A6			+	+		+	+	+	+	+	+				
B1		+		+	+										
B2				+	+										
B3				+	+	+	+	+	+	+	+				
B4		+	+	+		++	+	++	+	+	+				
B5		+		+	+	+	+	++	+	+	+				
B6						+		+							
B7					+										
1.1	++	++										++	++	++	++
1.2					+	+	+	+	+	+	+				
2.1	+		+	+	+	+	+	+	+	+	+				
2.2					++										
2.3			++	++	+										
2.4			++	++	+										

Year 2								
Learning outcomes	Computational Methods in Science and Technology	Quantum Physics 1	Thermal Physics	Waves and Optics	Electronics and Signal Processing	Physics, Astronomy, Ethics, and Society	Structure of Matter	Physics Laboratory 3
A1		++	++	++			+	
A2		++	++	++	+		+	
A3								
A4	++				+			+
A5	++	++	++	++	+		+	+
A6						++		
B1				++				+
B2	++			+				
B3				+		++		+
B4	+			++	+	+		+
B5						++		+
B6	+			+		+		+
B7				+				+
1.1		++	++	++	+		++	+
1.2								
1.3								
2.1					+			+
2.2	++							
2.3				+	+			+
2.4								+

Track: Biophysics and Medical Physics	**Year 2**		**Year 3**										
Biomaterials 1	Molecular Biophysics	Biomaterials 1	Minor	Physics Laboratory 4	Imaging Techniques in Radiology 1	Nanophysics and Nanotechnology	Principles of Measurement Systems	Cellular Chemistry	Physics of Fluids	Modelling Life	Oriënt. op Onderw. In de Bètawetenschappen	Introduction to Science Communication	Bachelor Research Project
A1	+								+				
A2	+	+			+	+	+	+	+	+			
A3	+	+			+	+		+		+	+	+	+
A4				+			+		+				+
A5				+			+		+				+
A6					+	+					++	++	+
B1				+							+	+	++
B2											+	+	+
B3				+							++	++	++
B4				+							+	+	++
B5				+							++	++	++
B6	+			+	+	+		+		+	+	+	+
B7				+							++	++	++
1.1				+									
1.2	++	++			++	+		++		++			++
1.3			++										
2.1				+			+		+				+
2.2													+
2.3				+									+
2.4				+			+						+

Track: Energy and Environmental Physics	**Year 2**		**Year 3**									
Learning outcomes	Geo-Energy	Climate System and Atmosphere	Minor	Physics Laboratory 4	Air Pollution	Principles of Measurement Systems	Solar Cells	Energy from Gas	Physics of Fluids	Oriënt. op Onderw. In de Bètawetenschappen	Introduction to Science Communication	Bachelor Research Project
A1					+				+			
A2	+	+				+	+	+	+			
A3	++	++					++	++		+	+	+
A4	+			+	+	+		+	+			+
A5	+	+		+	+	+	+	+	+			+
A6	+	+			+		+	+		++	++	+
B1				+						+	+	++
B2										+	+	+
B3				+						++	++	++
B4				+						+	+	++
B5				+						++	++	++
B6	+	+		+	+		+	+		+	+	+
B7				+						++	++	++
1.1				+								
1.2	++	++			++		++	++				++
1.3			++									
2.1	+	+		+	+	+	+	+	+			+
2.2												+
2.3				+	+							+
2.4				+	+	+						+

Track: Nanophysics	Year 2		Year 3											
Learning outcomes	Complex Analysis	Quantum Physics 2	Minor	Nanoprobing and Nanofabrication	Materials Design: Theoretical Methods	Device Physics	Physics of Fluids	Nanophysics and Nanotechnology	Oriënt. op Onderw. In de Bètawetenschappen	Introduction to Science Communication	Physics Laboratory 4	Principles of Measurement Systems	Solid State Physics 1	Bachelor Research Project
A1	++	++					+						+	
A2	+	+		+	+	+	+	+				+	+	
A3				+		+		+	+	+				+
A4					+		+				+	+		+
A5	++	++		++	+	++	+	++			+	+	+	+
A6									++	++				+
B1									+	+	+			++
B2					+				+	+				+
B3									++	++	+			++
B4									+	+	+			++
B5						+			++	++	+			++
B6									+	+	+			+
B7									++	++	+			++
1.1	+	++									+		++	
1.2				++		++		++						++
1.3			++											
2.1					+		+				+	+		+
2.2														+
2.3											+			+
2.4											+	+		+

Track: Particle Physics	**Year 2**		**Year 3**												
Learning outcomes	Complex Analysis (for Physics)	Quantum Physics 2	Minor	Astroparticle Physics	Symmetry in Physics	Subatomic Physics	Relativistic Quantum Mechanics	Advanced Mechanics	Chaos Theory	Experimental Particle Physics	Oriënt. op Onderw. In de Bètawetenschappen	Introduction to Science Communication	Physics Laboratory 4	Principles of Measurement Systems	Bachelor Research Project
A1	++	++			+	+				+					
A2	+	+		+	+	+	+	+	+	+				+	
A3				+		+					+	+			+
A4					++		+	+	++				+	+	+
A5	++	++		++	++	++	++	++	++	++			+	+	+
A6											++	++			+
B1											+	+	+		++
B2											+	+			+
B3											++	++	+		++
B4											+	+	+		++
B5											++	++	+		++
B6											+	+	+		+
B7											++	++	+		++
1.1	+	++											+		
1.2				++	++	++	++	++	++	++					++
1.3			++												
2.1													+	+	+
2.2															+
2.3													+		+
2.4													+	+	+

Appendix I Learning outcomes of the degree programme

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 draw up 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.