Assessment plan for the curriculum of the Bachelor's degree programme in Applied Physics 2024-2025

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1. Vision on assessment

Objectives

The vision behind the Applied Physics Bachelor's degree programme is to organize and facilitate the teaching and training of the next generation of innovative applied physicists. Its aim is to provide students with a solid understanding of the workings of nature and to offer them the tools and techniques to apply this knowledge towards new designs. This is done by providing them with profound knowledge of general physics subjects, training them in performing scientific research and product and process design, and providing them with general academic skills. Independent and critical thinking, an open mind, problem solving eagerness, skills in clear writing and exposition, and a dedication to Applied Physics both as an academic discipline and as a field that has strong connections to adjacent scientific disciplines and societal developments – these are important general objectives of the programme.

Assessment vision statement:

- The assessment guides and evaluates student learning in a diverse manner, with a focus on applied physics content knowledge and relevant skills including problem-solving, group work and applied physics practicals.
- The assessment stimulates students to adopt an active learning stance and to learn from their mistakes, by combining formative aspects at various stages and a summative assessment.
- The assessment equips students with an applied physics perspective that models relevant phenomena and studies and designs possible applications, and in this way prepares students for a future career or further study.

2. Assessment guidelines

Guidelines for assessment quality:

- The BSc programme consists of 165 ECTS worth of courses and a 15 ECTS research project. There are four 10-ECTS courses in the first two years of the programme, all other courses are 5 ECTS.
- The programme offers a variety of different assessment methods, assessing different learning outcomes and skills. The course assessment scheme can be found on Brightspace and Ocasys from the start of the course, and cannot be changed during the course (unless given explicit permission by the Board of Examiners).

- The majority of courses are assessed with an individual, written exam at the end of the course. A number of these courses have intermediate assessment moments as well, consisting of e.g. midterm exams or homework assignments, that contribute a fraction to the final grade.
- The 10-ECTS courses in the first year of the programme have a practical assignment as well, that needs to be completed with a pass grade before the full course can be passed.
- To facilitate preparation by the students for the final exam, a mock exam (for example an exam from a previous year) must be available, at least two weeks prior to the exam.
- A clear and explicit answer key for the exam is drawn up by the course coordinator to ensure the transparency and fairness of the grading process.

- Most resits of these courses consist of a single, individual, written exam. The examiner can opt for an oral exam in case there are very few students attending a resit. These are graded using the dedicated oral exam grading form and an independent observer (preferably the preassigned second examiner) must be present during the full exam. At the beginning of the exam, the student should be informed of the topics to be examined.

- Next to the courses with individual assessment, the programme also contains courses that are based on group work, e.g. practical or project-based courses. In these cases, the course grade is determined by presentations of the students as well as the final report that is handed in.
- Clear and explicit rubrics are available that facilitate the grading of the project as well as the

feedback to students.

- The 15-ECTS research project at the end of the programme takes place in one of the research groups and supervised by an examiner of the programme.
- Regular progress meetings (at least every week) with the (daily) supervisor will take place, in which the student will be given feedback and instructions on the day-to-day research. Progress meetings (at least every four weeks) with the supervisor should take place, in which the students will be given clear feedback on their progress.
- The examiner should provide feedback on at least one full draft version of the thesis, provided the student meets the agreed deadline for handing in the full draft.
- To ensure standardized and fair grading, the project is assessed by the examiner and a second examiner from another research unit than the first supervisor.
- All written assignments must be checked for plagiarism before grading.
- All assessment and feedback, final and day-to-day, is provided in English to prepare students for further study and a future career with an international job market.

3. Learning outcomes of the degree programme

Learning Outcome: *At the end of the programme, the graduate …*	
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 Applied Physics.
A2	Bachelor's graduates have mastered the basic concepts of their own discipline (see Appendix 1.1 for further specification) and are familiar with the interrelationships of these concepts within Applied Physics as well as with other disciplines.
A3	Bachelor's graduates have in-depth knowledge of several contemporary topics within Applied 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 Applied 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 Applied 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 Modelling) Bachelor's graduates are able to translate a physics problem, in particular a design problem, into a plan of approach and - taking into account the requirements of the client and/or 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 in English, both 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 Applied Physics has:	
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) Structure and Properties of Materials h) Calculus, Linear Algebra and Numerical Mathematics
1.2	Knowledge of a) Principles of design b) Continuum Mechanics
Appendix 2: Degree programme-specific learning outcomes - Skills The Bachelor's graduate in Applied 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 (symbolic) software package;
2.3	measure mechanical, electric, magnetic and optical properties of materials, while taking into account safety and environmental issues;
2.4	apply insights in the fundamental workings of nature for science-based design.

4. Overview of assessment methods, test moments for course units, and examiners

The abbreviations for the relevant teaching methods are explained in the legend of the table. Examples of assessment methods include:

- *Written Exam (WE)*
- *Multiple Choice (MC)*
- *Oral Exam (OR)*
- *Report (R)*
- *Presentation (P)*
- *Practical Work (PR)*
- *Assignment (AST)*

Year 1

Year	Period	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
1	1A	Calculus 1 (for Physics) (WBPH057-05)	5	AST, WE	Yes	continuous assessment, exam week	T.F. Görbe	H. Jardon Kojakhmetov
1	1B	Calculus 2 (for Physics) (WBPH058-05)	5	AST, WE	Yes	continuous assessment, exam week	T.F. Görbe	H. Waalkens
1	2A	Computational methods 1 (WBPH064-05)	5	AST, WE	Yes	continuous assessment	J. Slawinska	P.R. Onck
1	2	Electricity and Magnetism (WBPH033-10)	10	PR, WE	Yes		M.S. Pchenitchnikov	J. Aalbers
1	2A	Linear Algebra (for Physics) (WBPH054-05)	5	AST, WE, PR	Yes		M. Mendez	D. Boer
1	2B	Mathematical Physics (WBPH049-05)	5	AST, WE	Yes	continuous assessment, exam week	E. Dimastrogiovanni	TBD
1	1	Mechanics and Relativity (WBPH001-10)	10	MC, WE	Yes	continuous assessment, exam week	P.D. Meerburg	D. Roest
1	2B	Physics Lab: Design Project (WBPH075-05)	5	AST, P, R	Yes	continuous assessment, midterm, exam week	J.S. Blijleven	R.J.H. Klein-Douwel
1	1A	Physics Lab: Skills (WBPH077-05)	5	PR, WE, R	Yes	continuous assessment, exam week	J.S. Blijleven	R.J.H. Klein-Douwel

Year	Period	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	**Test moment(s)** (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
1	1B	Physics of Modern Technology (WBPH027-05)	5	WE, P	Yes		C.H. van der Wal	M.H. Diniz Guimaraes, A. Giuntoli

Year 2

Year	Period	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
2	1A	Computational methods 2 (WBPH065-05)	5	AST	Yes	continuous assessment	M. Kavatsyuk	J.W. Brijan
2	2A	Fundamentals of Electronics (WBPH070-05)	5	AST, PR, WE	Yes		E. Chicca	J.S. Blijleven
2	1B	Materials Science and Engineering (WBPH071-05)	5	WE, P, PR, AST	Yes	continuous assessment	B.J. Kooi	TBA
2	2B	Digital Signal Processing (WBPH067-05)	5	WE, PR	Yes		R. Lo Conte	E. Chicca
2	2B	Physics Lab: Advanced Applications 1 (WBPH072-05)	5	R	Yes		A.K. Biegun	J.S. Blijleven
2	2A	Applied Physics & Society: Ethical & Professional Aspects (WBPH082-05)	5	MC, AST, WE, P, R	Yes	continuous assessment	M. van Rijsel	J. Zevenberg
2	1A	Quantum Physics 1 (WBPH014-05)	5	AST, WE	Yes	continuous assessment, exam week	M.H. Diniz Guimaraes	D. Roest
2	2	From Atoms to Solids (WBPH085-10)	10	WE	Yes		A. Borschevsky	T.A. Schlathölter
2	1	Thermal Physics (WBPH002-10)	10	WE	Yes	mid-term, exam week	G. Palasantzas	L.J.A. Koster
2	1B	Waves and Optics (WBPH032-05)	5	AST, R	Yes	continuous assessment	S. Hoekstra	A.K. Biegun

Year 3

Year	Period	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
3	1B	Atoms and Molecules (WBPH003-05)	5	AST, WE	Yes		R. Hoekstra	A. Borschevsky
3	1A	Control Engineering for BME (WMBE024-05)	5	WE	Yes		C. De Persis	J. Sjollema
3	2A	Device Physics (WBPH037-05)	5	WE, P, R	Yes		B.J. van Wees	T. Banerjee, M.A. Loi
3	1B	Introduction to Science Communication (WBEC001-05)	5	R	Yes		L.T.J. Kraan	H.A.J. Mulder, F.H.C.E. van der Graaf
3	1A	Ionizing Radiation in Medicine (WBPH007-05)	5	WE, P	Yes		P.G. Dendooven	P. van Luijk
3	1B	Nanophysics and Nanotechnology (WBPH025-05)	5	AST, WE	Yes	continuous assessment, exam week	J. Slawinska	M.A. Loi
3	2A	Nanoprobing and Nanofabrication (WBPH041-05)	5	WE, R	Yes		T. Banerjee	A. Grubisic-Cabo
3	1A	Nuclear Energy (WBPH010-05)	5	AST, WE	Yes		C. Rigollet	J. Even
3	1A	Optical Spectroscopy (WBPH078-05)	5	AST, WE	Yes	exam week	P.J. van der Zaag	R. Vlijm
3	1B	Oriëntatie op Onderwijs in de Bètawetenschappen (WBEC002-05)	5	OR, R	Yes		J.E. van der Laan	G. Roorda, S. Tuenter
3	2A	Physics Instrumentation and Technology (WBPH069-05)	5	AST, WE	Yes	continuous assessment, exam week	A. Grubisic-Cabo	R. Hildner
3	1B	Physics Laboratory 4 (WBPH026-05)	5	PR, R	Yes		A.K. Biegun	J.S. Blijleven
3	2A	Physics of Fluids (WBPH042-05)	5	WE	Yes		P.R. Onck	E. van der Giessen
3	1B	Principles of Measurement Systems (WBPH029-05)	5	AST, WE	Yes		A.K. Biegun	J.S. Blijleven

Year	Period	Course	EC	Assessment methods	Does (part of the) assessment have a formative function?	Test moment(s) (e.g. mid-term, continuous assessment, exam week, etc)	First examiner	Second examiner
3	2A	Product Design by the Finite Element Method (for AP) (WBIE043-05)	5	AST	Yes		A.A. Geertsema	F.W. Wubs
3	1B	Solar Cells (WBCH018-05)	5	WE, P, R	Yes		L.J.A. Koster	S.C. Veenstra
3	1A	Solid Mechanics (WBPH015-05)	5	WE	Yes		E. van der Giessen	P.R. Onck
3	1B	Solid State Physics (WBPH068-05)	5	AST, WE	Yes		J. Ye	M.A. Loi
3	2B	Bachelor Research Project	15	AST, PR, P, R	Yes	continuous assessment	*See list examiners research projects below*	*See list examiners*

Examiners for Bachelor Research projects

Zernike Institute
Banerjee, prof. dr. T.
Bari, prof.dr. S.
Chicca, prof.dr. E.
Covi, dr. E.
Diniz Guimaraes, dr. M.H.
Ehrler, dr. B.
Giessen, prof.dr.ir. E. van der
Giuntoli, dr. A.
Hoekstra, prof.dr.ir. R.A.
Kooi, prof.dr.ir. B.J.
Koster, prof.dr. J.A.
Krushynska, dr. A.O.
Loi, prof.dr. M.A.
Maresca, dr. F.
Noheda Pinuaga, prof.dr. B.
Ocelik, ing.dr. V.
Onck, prof.dr.ir. P.R.
Palasantzas, prof.dr. G.
Protescu, dr. L.
Rudolf, prof.dr. P.
Vlijm, dr. R.
Wal, prof.dr.ir. C.H. van der
Wees, prof.dr.ir. B.J. van
Ye, prof.dr. J.
Zaag, dr. P.J. van der

ESRIG
Stamhuis, prof.dr. E.J.
Purushothaman Vellayani, prof.dr. A.

UMCG
Dendooven, dr. P.G.
Gerbershagen, prof, A.
Graaf, dr E.R. van der

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

5. Relationship between course units and details of the learning outcomes

	Learning outcomes	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 1	Mechanics and Relativity	X	X		X	X											X						
	Electricity and Magnetism	X	X		X	X											X						
	Physics Lab: Skills		X		X	X	X					X								X		X	X
	Physics Lab: Design project		X		X	X	X		X	X	X	X	X							X		X	X
	Computational methods 1		X		X				X	X	X		X		X			X		X	X	X	X
	Physics of Modern Technology	X		X			X				X	X	X					X		X			
	Calculus 1 (for Physics)	X	X		X	X											X						
	Linear Algebra (for Physics)	X	X		X	X											X						
	Calculus 2 (for Physics)	X	X		X	X											X						
	Mathematical Physics	X	X		X	X											X						X

	Learning outcomes	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	Computational methods 2				X	X															X		
	Quantum Physics 1	X	X			X											X						
	Thermal Physics	X	X			X											X						
	Waves and Optics	X	X	X		X											X					X	
	Materials Science and Engineering		X			X											X	X		X			X
	Fundamentals of Electronics		X		X	X						X					X			X		X	
	Aplied Physics & Society: Ethical & Professional Aspects						X				X	X	X	X									
	Structure of Matter	X	X			X											X						
	Digital Signal Processing		X	X	X	X			X	X					X		X	X			X	X	X
	Physics Lab: Advanced Applications 1				X	X			X		X	X	X	X	X		X			X		X	X

		Learning outcomes	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 3	*compulsory*	Control Engineering for BME		X		X	X			X							X	X	X		X
		Device Physics		X	X		X						X			X					
		Physics Laboratory 4				X	X		X		X	X	X	X	X	X		X		X	X
		Physics of Fluids		X		X	X										X				
		Solid State Physics	X	X			X									X					
		Bachelor Research Project			X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
	elective	Atoms and Molecules	X	X	X		X									X		X			X
		Introduction to Science Communication			X			X	X	X	X	X	X	X	X						
		Ionizing Radiation in Medicine		X	X			X		X			X			X	X		X		X
		Nanophysics and Nanotechnology		X	X		X	X									X				
		Nuclear Energy		X	X			X		X							X				X
		Nanophrobing and Nanofabrication		X	X		X	X									X				
		Oriënt. op Onderw. In de Bètawetenschappen			X			X	X	X	X	X	X	X	X						
		Optical Spectroscopy		X	X	X	X								X	X	X	X		X	X
		Product Design by the Finite Element Method		X		X	X			X			X				X		X		X
		Physics Instrumentation and Technology			X	X		X		X					X	X	X	X		X	X
		Principles of Measurement Systems		X		X	X			X								X			
		Solar Cells		X	X		X	X						X			X	X			X
		Solid Mechanics		X		X	X						X			X	X	X	X		X