

Assessment plan for the curriculum of the Master's degree programme in Physics, 2024-2025

Programme director: M.S. Pchenitchnikov

Date advice Board of Examiners: June 21, 2024

Date approval Faculty Board:

1. Vision on assessment

Objectives

The vision behind the Master of Physics programme is to train excellent researchers in the fields of materials science, subatomic and isotope physics, or theoretical physics. The programme offers three distinct tracks: Quantum Universe (QU), Advanced Materials (AM), and Science, and Business and Policy (SBP). The QU track emphasizes the relations between Theoretical Physics, Particle Physics and Astronomy in the study of nature on the different scales. The AM track places the main emphasis on the design and study of materials with a focus on achieving specific functionalities. The SBP track integrates cutting-edge physics knowledge with a comprehensive understanding of both business and policy aspects in science. The MSc Physics programme traditionally targets students aspiring to pursue research careers, with a substantial portion of graduates proceeding to enroll in PhD programs. At the same time, the programme also prepares graduates for a broader career in society. A significant number of students continue on diverse career paths, such as consultancy firms, process management, financial sectors, or pursuing teaching positions. This broad range of opportunities arises because the programme equips students not only with specialized knowledge but also with versatile competences and skills that enhance their adaptability and suitability for various professional roles.

Assessment vision statement:

- Assessment guides and evaluates student learning in a diverse manner, emphasizing content knowledge and essential skills, including problem-solving, group work, practical application, and relevance to real-world scenarios.
- Assessment motivates students by offering constructive feedback, promoting active learning from mistakes, and encouraging the integration of specific knowledge and skills.
- Assessment serves as a guiding principle for lifelong learning and as an instrument in shaping students' future careers by facilitating skill enhancement, adaptive growth, and decision-making.
- All assessments and feedback, final and day-to-day, are provided in English to prepare students for a career with an international job market.

2. Assessment guidelines

Guidelines for assessment quality:

- The course assessment scheme should be communicated to the students during the introduction to the course at the first lecture, and also included in the course webpage and Ocasys. The assessment scheme may not be changed during the course.
- The courses are assessed through written or oral exams as assigned in the assessment plan. For resits, the examiner can always choose for oral examination.
- If the course includes several parts taught by different instructors, the course coordinator determines how these components are integrated into the final assessment and their respective contributions to the overall grade.
- Written exams must contain the following information on the first page: the course title and code, when and where the exam takes place, the number of questions/pages, exam conditions (what is allowed and not allowed to use) and the grading scheme
- A clear and explicit rubric or a comprehensive grading scheme is drawn up by the course coordinator to promote fairness and transparency in the grading process.
- For courses with a written exam, a mock exam (for example, an exam from a previous year) must be available from the start of the course.
- Oral exams are graded using the dedicated oral exam grading form. At the beginning of the exam, the student should be informed of the topics to be examined (pre-indicated in the grading form). An independent observer (preferably the preassigned second examiner) must be present during the full exam. The examination material (photos of the blackboard or paper sheets with student's answers) should be collected and added to the examination form.
- For courses with hands-on practicals, the grade of the report might be a (weighted) part of the final grade. The grade might also be binary (pass/no pass); a pass grade is required to be

admitted to the exam.

- If the practical work is performed in teams, the team report might be handed in and graded for the whole team unless there are exceptional circumstances (e.g., a student did not participate in report writing). Individual reports might also be requested by the course coordinator. This should be clearly communicated to the students during the first lecture.
- All practicals are assessed through a written report with feedback to the students on development points. This is provided as explicit feedback written for each individual student on the grading form.
- To impart to students the practical significance of meeting deadlines and guarantee equitable grading, a Fail grade is assigned to reports not handed in on time.

Master research project:

- The first examiner may delegate daily supervision, but is ultimately responsible for the smooth flow and outcome of the research project.
- To ensure standardized and fair grading, the master research project should be assessed by the first examiner and an independent second examiner. They should not be from the same research unit, and not closely involved in the master project.
- For the research project, midterm assessment with specific feedback on development points and self-reflection of the student must be provided.
- In research projects, regular progress meetings (at least every week) with the daily supervisor should take place, in which the student is given feedback and instructions on the day-to-day research. Progress meetings (at least every four weeks) with the supervisor should also take place, in which the students will be given clear feedback on their progress.
- Examiners should provide feedback on at least one full draft version of the master thesis, provided the student meets the agreed deadline for handing in the full draft.
- The master thesis must be checked by the supervisor for plagiarism before grading.
- The students should be instructed on the possible use and misuse of AI and online information tools with the focus on ethics and critical thinking. The use of such tools may not be explicitly recognized in the acknowledgment section.
- If the research project is awarded a negative grade or there is a substantial delay, a remediation trajectory should be drawn by the supervisor and the student. The programme management should be informed promptly about this development.

3. Learning outcomes of the degree programme

Learning Outcome:	
A. Knowledge and understanding	
A1	understands the advanced concepts of physics, including the necessary mathematics and computer science, at a level which permits admission to a PhD programme;
A2	is familiar with the advanced quantitative character of physics and with the relevant research methods;
A3	[<i>Advanced Materials track</i>] has a thorough understanding of the current state of the art in materials science, more specifically of structure, functional properties and characterisation of advanced materials;
A4	[<i>Quantum Universe track</i>] has a thorough understanding of the main fields and presently active topics in theoretical physics, more specifically in the fields of general relativity, statistical mechanics, quantum mechanics, particle physics and radiation processes;
A5	[<i>Science, Business and Policy track</i>] has operational knowledge of, and insight into, the present functioning of companies and administrations, as well as the relevant legislation, in relation to physics oriented working areas.
B. Application of knowledge and understanding	
B1	is capable of carrying out research, aimed at the understanding of physical phenomena and their description in scientific terms;
B2	is capable of analysing a (new) complex physical problem, and to use modelling skills to develop a structured and well-planned research approach;
B3	is capable of applying his/her specific knowledge and mathematical, experimental, and computer skills to solve physical problems in his/her own and related subject areas and fields;
B4	is capable of collaborating in a (multi-disciplinary) team.
C. Judgement	
C1	is capable of obtaining relevant information using modern information channels, and to interpret this information critically;
C2	is capable of managing and judging his/her and others' actions within a highly scientific and professional context, taking societal and ethical aspects into account;
C3	is able to draw conclusions on the basis of limited or incomplete information, and is able to realise and formulate the limitations of such conclusions.
D. Communication skills	

D1	is capable of communicating clearly in English, both verbally and in writing, on his/her subject and relevant applications, at a level which is understandable to experts and non-experts, and using modern communication tools;
E. Learning skills	
E1	is capable of addressing issues inside as well as outside his/her main subject area, therefore and thereby gaining new knowledge and skills.

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)

Advanced Materials track (core programme)

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	2B	Advanced Quantum Mechanics (WMPH032-05)	5	AST, WE	Yes		M.V. Mostovoy	R.G.E. Timmermans
1	1A	Computational Physics (WMPH007-05)	5	R	Yes		P.R. Onck	E. van der Giessen
1	1A	Nanomaterials Synthesis and Engineering (WMPH049-05)	5	AST, P	Yes	continuous assessment, exam week	A. Grubisic-Cabo	M. Lerch
1	1B	Mathematical Methods of Physics (WMPH016-05)	5	AST	Yes		R. Klein	D. Boer
1	2A	Statistical Mechanics (WMPH029-05)	5	AST, WE	Yes		T. La Cour Jansen	M.V. Mostovoy
2	-	Physics Master Research Project (WMPH902-60)	60	AST, PR, P, R	Yes		<i>See list examiners research projects below</i>	
1	2A	Characterisation of Materials (WMPH021-05)	5	WE	Yes	exam week	G.R. Blake	B.J. Kooi
1	1B	Properties of Functional Materials (WMPH051-05)	5	WE	Yes	continuous assessment, exam week	C.H. van der Wal	R. Lo Conte
1	1B	Structure at Macro, Meso and Nano Scale (WMPH020-05)	5	AST, WE	Yes		L. Protesescu	B.J. Kooi, B. Noheda Pinuaga

Advanced Materials track (optional courses)

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	Atomic and (Bio-)Molecular Interactions (WMPH046-05)	5	OR, P	Yes	continuous assessment	S. Bari	R.A. Hoekstra
1	2A	Basics of Teaching (TEM0105)	5	WE	Yes		C.A.M. Griep-Hoebink	**
1	1B	Bioinspired Designer Materials (WMCH009-05)	5	WE, P	Yes		M.M.G. Kamperman	G. Portale
1	2B	Biophysical Imaging & Manipulation Techniques (WMPH047-05)	5	WE/OR, P, R	Yes		W.H. Roos	M.S. Pchenitchnikov
1	1B	Oriëntatie op Onderwijs in de Bètawetenschappen - voor Masterstudenten (WMEC013-05)	5	OR, R, P	Yes		J.E. van der Laan	G. Roorda
1	2B	Nanoscale Material Modeling (WMPH053-05)	5	OR, AST, P	Yes		A. Giuntoli	J.L. Slawinska
1	2B	Internship in secondary education 1 Teacher Education (TEM0205)	5	AST, OR	Yes		S. Tuenten	**
1	2A	Many-particle systems (WMPH036-05)	5	WE	Yes	continuous assessment, exam week	M.V. Mostovoy	J.G. Slawinska
1	2A	Mechanical Properties (WMPH023-05)	5	AST, PR, P, R	Yes		E. van der Giessen	P.R. Onck
1	2B	Mesosopic Physics (WMPH037-05)	5	AST, WE, P	Yes		B.J. van Wees	C.H. van der Wal
1	1A	Physics of Lasers (WMPH027-05)	5	WE/OR, PR	Yes		R. Hildner	M. S. Pchenitchnikov
1	2A	Supramolecular Chemistry (WMCH020-05)	5	WE, PR, P	Yes		S. Otto	R.C. Chiechi
1	2B	Physics with Industry (WMPH041-05)	5	AST, P, R	Yes		R.A. Hoekstra	P.R. Onck

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	2B	Surfaces and Interfaces (WMPHO14-05)	5	AST, WE	Yes		A. Grubisic-Cabo	P. Rudolf
1	1B	Theoretical Condensed Matter Physics (WMPHO31-05)	5	AST, WE	Yes	continuous assessment	M.V. Mostovoy	J.L. Slawinska
1	2B	Ultrafast Time-Resolved Spectroscopy (WMPHO40-05)	5	PR, WE	Yes		M.S. Pchenitchnikov	T. La Cour Jansen

** Course provided by the Lerarenopleiding which is part of the Faculty of Behavioural and Social Sciences. As such the course is bound to different quality assurance procedures. One of the differences being that there is only one examiner assigned to the course.

Quantum Universe track (core programme)

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	2B	Advanced Quantum Mechanics (WMPH032-05)	5	AST, WE	Yes	continuous assessment, exam week	M.V. Mostovoy	R.G.E. Timmermans
1	1A	Computational Physics (WMPH007-05)	5	R	Yes		P.R. Onck	E. van der Giessen
1	1B	Astroparticle Physics (WMAS027-05)	5	WE	Yes		M. Vecchi	S. Hoekstra
1	1A	General Relativity (WMPH009-05)	5	AST, WE	Yes	continuous assessment, exam week	E.A. Bergshoeff	D. Roest
1	1B	Mathematical Methods of Physics (WMPH016-05)	5	AST	Yes		R. Klein	D. Boer
1	2A	Particle Physics Phenomenology (WMPH026-05)	5	AST, WE	Yes		K.A.M. de Bruyn	D. Boer
1	2A	Statistical Mechanics (WMPH029-05)	5	AST, WE	Yes		T. La Cour Jansen	T.A. Schlatholter
1	2B	Student Seminar Quantum Universe (WMPH039-05)	5	P	Yes		L. Willmann	M. Vecchi, E. Dimastrogiovanni
2	-	Physics Master Research Project (WMPH902-60)	60	AST, PR, P, R	Yes		<i>See list examinors research projects below</i>	

Quantum Universe track (optional courses)

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	2A	Basics of Teaching (TEM0105)	5	WE	Yes		C.A.M. Griep-Hoebink	**

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	2B	Collider Experiments (WMPH033-05)	5	WE, P	No	exam week	M. Mulder	A. Pellegrino
1	2B	Cosmic Structure Formation (WMAS004-05)	5	PR, P, WE	Yes		M.A.M. van de Weijgaert	S. Zaroubi
1	2B	Elementary Particles (WMPH034-05)	5	WE	Yes		E. Pallante	R.G.E. Timmermans
1	1B	Exoplanets (WMAS026-05)	5	AST, PR, WE	Yes	continuous assessment	T. Lichtenberg	I.E.E. Kamp
1	1B	Oriëntatie op Onderwijs in de Bètawetenschappen - voor Masterstudenten (WMEC013-05)	5	OR, R, P	Yes		J.E. van der Laan	G. Roorda
1	2A	Basics of Teaching (TEM0105)	5	WE	Yes		C.A.M. Griep-Hoebink	**
1	1A	Formation and Evolution of Galaxies (WMAS005-05)	5	AST, WE	Yes		F. Fraternali	P. Dayal
1	1A	Fundamental Constants (WMPH008-05)	5	AST, R	Yes		L. Willmann	J. Even
1	2A	Geometry and Differential Equations (WMMA017-05)	5	AST, WE, P	Yes		A.V. Kiselev	J. Top
1	2A	Gravitational Waves (WMPH022-05)	5	AST, R	Yes		A. Mazumdar	D. Roest
1	1A	Hamiltonian Mechanics (WMMA019-05)	5	AST, P, R	Yes		M. Seri	H.W. Broer
1	2A	Star and Planet Formation (WMAS017-05)	5	AST, WE	Yes		F.F.S. van der Tak	I.E.E. Kamp
1	2B	Internship in secondary education 1 Teacher Education (TEM0205)	5	AST, OR	Yes		S. Tuenten	**
1	2A	Introduction to Plasma Physics (WMPH035-05)	5	AST, WE, P	No	exam week	C.E. Rigollet	J. Even
1	1A	Lie Groups in Physics (WMPH011-05)	5	WE	Yes		D. Boer	R.G.E. Timmermans
1	2B	Nuclear Astrophysics (WMPH038-05)	5	AST, WE, IT	No	Exam Week	C.E. Rigollet	J. Even

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	2B	Physics with Industry (WMPH041-05)	5	AST, P, R	Yes		R.A. Hoekstra	P.R. Onck
1	1B	Quantum Experiments (WMPH017-05)	5	AST, P	Yes	continuous assessment	S.A. Jones	L. Willmann
1	1B	Quantum Field Theory (WMPH018-05)	5	WE	Yes		E. Pallante	R.G.E. Timmermans
1	1B	High-energy Astrophysics (WMAS006-05)	5	AST, PR	Yes		P. Dayal	R.M. Mendez
1	2A	Deep Learning in Physics (WMPH054-05)	5	WE, AST	Yes		J. Aalbers	TBD

Science, Business and Policy track

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	Computational Physics (WMPH007-05)	5	R	Yes		P.R. Onck	E. van der Giessen
2	1	Introduction Science and Business (WMSE001-10)	10	AST, WE	Yes		S. Grooters	M.R. Berger, C. Carroll, G.J.W. Euverink, S. Grooters, H.J. van der Windt, J. Zevenberg
2	1	Introduction Science and Policy (WMSE002-10)	10	AST, R, WE	Yes		S. Grooters	M.R. Berger, B. Brink, J. de Ridder, G.J.W. Euverink, H.J. van der Windt, H.B. Winter, J. Zevenberg
1	1B	Mathematical Methods of Physics (WMPH016-05)	5	AST	Yes		R. Klein	D. Boer
1	1	Optional courses (courses from the Advanced Materials track or the Quantum	20	<i>See specific courses</i>	Yes		<i>See specific courses above</i>	

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
		Universe track)		<i>above</i>				
1	2	Physics Research (WMPH005-30)	30	PR, P, R	Yes		<i>See list examiners research projects below</i>	
2	-	Work Placement Business and Policy (WMSE902-40)	40	AST, PR, P, R	Yes		S. Grooters	M.R. Berger, M.K. de Boer, G.J.W. Euverink, C.M. Ree, M. van Rijssel, J. Zevenberg

Examiners for Master's Research Projects

VSI

Aalbers, dr. J.
Bergshoeff, prof.dr. E.A.
Bethlem, dr. H.L.
Boer, prof.dr. D.
Borshevsky, prof.dr. A.
Bruyn, dr. K.A.M. de
Dimastrogiovanni, dr. E.
Eijk, D. van
Even, dr. J.
Hoekstra, prof. dr. ir. R.A.
Hoekstra, prof.dr. S.
Jones, dr. S.
Jungmann, prof.dr. K.H.K.J.
Mazumdar, prof.dr. A.
Meerburg, dr. D.
Mulder, dr. M.
Pallante, prof.dr. E.
Pellegrino, prof.dr. A.
Roest, prof.dr. D.
Timmermans, prof.dr. R.G.E.
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.
Koster, prof. dr. L.J.A.
Lo Conte, dr. R.
Mostovoy, prof.dr. M.V.
Onck, prof.dr.ir. P.R.
Pchenitnikov, 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

Dee, prof.dr. M.W.
Dusek, prof.dr. U.
Kavatsyuk, dr. M.
Meer, dr. A.A. van der
Meijer, prof.dr. H.A.J.
Mokhov, dr. A.V.

Kapteyn Astronomical Institute

Vecchi, dr. M.

UMCG

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

An examiner for the Master Research projects of Applied Physics, Astronomy and of Mathematics may also act as second supervisor for a Master Research Project.

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

Advanced Materials track

Learning outcomes	A1	A2	A3	B1	B2	B3	B4	C1	C2	C3	D1	E1
Advanced Quantum Mechanics	X	X										
Characterization of Materials	X		X									X
Computational Physics	X	X		X							X	
Nanomaterials Synthesis and Engineering	X		X					X			X	X
Properties of Functional Materials	X		X									X
Mathematical Methods of Physics	X	X										
Statistical Mechanics	X	X										
Structure at Macro, Micro and Nano Scale	X		X									X
<i>Optional courses Advanced Materials</i>	X	*	*		*			*	*	*		*
Research ⁴	X	X	X	X	X	X	X	X	X	X	X	X

Quantum Universe track

Learning outcomes	A1	A2	A3	B1	B2	B3	B4	C1	C2	C3	D1	E1
Advanced Quantum Mechanics	X	X										
Computational Physics	X	X		X							X	
Electrodynamics of Radiation Processes	X		X									X
General Relativity	X		X									
Mathematical Methods of Physics	X	X										
Particle Physics Phenomenology	X		X									
Statistical Mechanics	X	X										
Student seminar Quantum Universe	X		X	X				X	X	X	X	X
<i>Optional courses Quantum Universe</i>	X	*	*					*	*	*		*
Research ⁴	X	X	X	X	X	X	X	X	X	X	X	X

⁴ The research project includes the compulsory modules Academic Skills, Scientific Integrity, General Physics Colloquium and Career Perspectives

Science, Business and Policy track

Learning outcomes	A1	A2	A3	B1	B2	B3	B4	C1	C2	C3	D1	E1
Computational Physics	X	X		X							X	
Internship Science, Business and Policy			X			X	X	X	X	X	X	X
Introduction Science, Business and Policy		X	X				X	X	X	X	X	X
Mathematical Methods of Physics	X	X										
<i>Optional courses in Science</i>	X	*	*	*	*			*	*	*	*	*
Research ⁴	X	X		X	X	X	X	X	X	X	X	X