Applied Physics

Faculty of Science & Technology,
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Report on the bachelor's programme Technische Natuurkunde and the master's programme Applied Physics of University of Twente

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Technische Natuurkunde

Name of the programme:	Technische Natuurkunde
CROHO number:	56962
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	none
Location(s):	Enschede
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2014

Master's programme Applied Physics

Name of the programme:	Applied Physics
CROHO number:	60436
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	Fluid Physics, Materials Physics, Optics & Biophysics
Location(s):	Enschede
Mode(s) of study:	full time
Expiration of accreditation:	31-12-2014

The visit of the assessment committee Physics and Astronomy to the Faculty of Science & Technology of University of Twente took place from 18^{th} until 19^{th} of March 2014.

Administrative data regarding the institution

Name of the institution:	University of Twente
Status of the institution:	publicly funded institute
Result institutional quality assurance assessment:	positive

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in Appendix 5.

Composition of the assessment committee

The committee that assessed the bachelor's programme Technische Natuurkunde and the master's programme Applied Physics consisted of:

- Prof. dr. Daan Lenstra, professor emeritus of Electrical Engineering at Delft University of Technology and fellow at Eindhoven University of Technology (chair);
- Prof. dr. Wim de Boer, professor of Physics at the University of Karlsruhe (DE);
- Prof. dr. Friso van der Veen, professor of Experimental Physics at ETH Zürich
- Christianne Vink MSc, didactic coach, educational advisor/trainer and partner of Academic Factory;
- Dr. ir. Harald Tepper, chief strategy officer at the Dutch Forensic Institute;
- Lisanne Coenen BSc, master student Applied Physics at Delft University of Technology;

Dr. J. Corporaal, who acted as secretary, supported the committee. She was supervised by Kees-Jan van Klaveren MA.

Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

The assessment of the bachelors' and master's programmes Applied Physics of the University of Twente is part of a cluster assessment. In the context of this cluster visitation, in the time period between November 2013 and April 2014, twenty-eight programmes at nine different institutions were assessed.

Appendix 2 contains the framework of reference.

The committee Physics and Astronomy is composed of sixteen members: in total

- Prof. dr. Daan Lenstra, professor emeritus of Electrical Engineering at Delft University of Technology and fellow at Eindhoven University of Technology (chair);
- Prof. dr. Wim de Boer, professor of Physics at the University of Karlsruhe (DE);
- Prof. dr. Elias Brinks, professor of Astrophysics at the University of Hertfordshire (UK);
- Prof. dr. Tom Theuns, reader in Astrophysics at Durham University (UK) and part time professor of Astrophysics at University of Antwerp (BE);
- Prof. dr. Gustaaf Borghs, professor emeritus of Physics at KU Leuven (BE) and senior fellow at the Interuniversity MicroElectronics Centre (IMEC);
- Dr. ir. Jaap Flokstra, retired associate professor Nanotechnology at University of Twente;
- Prof. dr. ir. Guido van Oost, full professor Plasma Physics at the Department of Applied Physics of Ghent University (BE);
- Dr. Henk Blok, retired associate professor at the Faculty of Sciences of VU University Amsterdam;
- Prof. dr. Martin Goedhart, professor Mathematics and Science Education at University of Groningen;
- Christianne Vink MSc, didactic coach, educational advisor/trainer and partner of Academic Factory;

- Dr. Jan Hoogenraad, owner of Spoorgloren BV for change management and quantitative service in public transport;
- Dr. ir. Harald Tepper, chief strategy officer at the Dutch Forensic Institute;
- Sander Breur MSc, PhD candidate at Nikhef, University of Amsterdam;
- Lisanne Coenen BSc, master student Applied Physics at Delft University of Technology;
- Carmen van Schoubroeck, bachelor student Mathematics and bachelor student Physics and Astronomy, Radboud University Nijmegen;
- Jelmer Wagenaar MSc, PhD candidate in Physics at Leiden University.

Preparation
The committee held a preliminary meeting on October 8, 2013. During this meeting the committee was instructed about the accreditation framework and the programme of the upcoming assessments. A vice chair for each visit was appointed and the Domain Specific Framework for Physics and Astronomy was set.

To prepare the contents of the site visits, the coordinator first checked the quality and completeness of the critical reflections prepared by the programmes. After establishing that the reports met the demands, they were forwarded to the participating committee members. The committee members read the reports and formulated questions on their contents.

Apart from the critical reflections, the committee members read a selection of fifteen theses. The theses were randomly chosen from a list of graduates of the last two completed academic years within a range of grades.

Site visit
A preliminary programme of the site visit was made by the coordinator and adapted after consultation of the chair of the committee and the contact persons at University of Twente. The timetable for the visit in Twente is included as Appendix 6.

Prior to the site visit, the committee asked the programmes to select representative interview partners. During the site visit, meetings were held with panels representing the faculty management, the programme management, alumni, the Programme Committee and the Board of Examiners. Meetings were also held with representatives of the students and teaching staff.

During the site visit, the committee examined material it had requested; an overview of this material is given in Appendix 7. The committee gave students and lecturers the opportunity – outside the set interviews – to speak informally to the committee during a consultation hour. No requests were received for this option.

The committee used the final part of the visit for an internal meeting to discuss the findings. The site visit was concluded with a public oral presentation of the preliminary impressions and general observations by the chair of the committee.

Report
Based on the committee's findings, the secretary prepared a draft report. This report was presented to the committee members involved in the site visit. After receiving approval, the draft report was sent to the Faculty with the request to check it for factual inaccuracies. The comments received from the Faculty were discussed with the committee chairman. Subsequently, the definitive report was approved and sent to the University of Twente.

Decision rules
In accordance with the NVAO's Assessment framework for limited programme assessments (as of 22 November 2011), the committee used the following definitions for the assessment of both the standards and the programme as a whole.

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor's or master's programme.

Unsatisfactory
The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically well surpasses the current generic quality standards across its entire spectrum and is regarded as an (inter)national example.

Summary judgement

Bachelor's degree programme Technische Natuurkunde

Standard 1 – Intended learning outcomes
The bachelor's degree programme Technische Natuurkunde is a Dutch taught, full-time programme and one of five bachelor's programmes in the Faculty of Science and Technology of the University of Twente. Its main goal is to provide students with a broad, basic knowledge of physics, mainly to prepare them to successfully enter a master's programme. There are no separate tracks, but students do choose from one of three areas of research for their bachelor's research project: optics, material physics or fluid phyics. These research areas form the three specialization tracks within the master's programme Applied Physics of the University of Twente.

The assessment committee concludes that the bachelor's programme has a clear profile with attention for design. Prospective students know what to expect after having read the programme's mission and main goals. The committee also observes that the learning outcomes of the programme are carefully formulated. The programme identifies which specific research, designing and communication skills BSc graduates should possess. The intended learning outcomes of the bachelor's programme are broadly defined and geared towards enrolling in a master's programme. The committee concludes that the intended learning outcomes match the domain specific requirements and that the academic orientation of the bachelor's programme is in line with what can be expected from a scientific bachelor's programme from an international perspective. However, it also urges the programme management to reflect on whether all learning outcomes are realistic and match the programme in its current form.

Standard 2 Teaching-learning environment
The bachelor's programme Technische Natuurkunde consists of 180 EC, evenly divided over three years. Each year is further divided into four parts ('kwartielen') of approximately ten weeks each. The curriculum of the bachelor's programme consists of three parts: mandatory theoretical and experimental courses (130 EC), optional and orientation courses within or outside the discipline (15 EC and a 20 EC minor) and a bachelor assignment at the end of the third year (15 EC).

The committee concludes that the contents and design of the bachelor's programme ensure that students are able to obtain the intended learning outcomes. The programme has a clear structure, with limited room for optional courses. The programme's learning outcomes are well translated in the curriculum. The first year focuses on providing students with the necessary theoretical knowledge and experimental skills. The other two years of the bachelor's programme emphasize the application of knowledge, the development of learning skills and the ability to judge and reflect upon research – necessary requirements for working independently as a researcher. Students finish the programme with the bachelor research project, in which all of the intended learning outcomes are tested.

Starting in 2013/2014, the curriculum of the bachelor's programme has been redesigned as a result of the university-wide implementation of the Twents Onderwijs Model (TOM). First of all, the committee notes that the implementation of TOM in the applied physics programme appears to be the result of thorough discussions and planning. TOM offers new possibilities to further structure the programme and to improve study rates. The thematic modules seem carefully planned in a manner that ensures a more transparent connection between individual courses and between the courses and the overall aim of the programme. Less attention seems to be paid to the didactic concept underpinning the programme: the use of problem and project-based learning as the most important teaching method. The didactic concept, the committee finds, is not very transparent and requires further elaboration.

The committee is of the opinion that the scientific orientation of the programme is more than sufficiently safeguarded. It also concludes that the programme depends heavily on the study association Arago for job orientation outside research. The committee strongly suggests that the programme management secures a more prominent place for job orientation activities within the bachelor's programme.

Completion rates of the bachelor's programme are low, mainly because of a delay during the third year. The committee urges the programme management to implement appropriate solutions to reduce this delay. The committee concludes that the programme has an adequate system of study guidance in place. Students are enthusiastic about their lecturers and generally feel well supported in getting acquainted with studying, study orientation and study planning.

The committee concludes that the academic staff is more than very well equipped for delivering the programme. All lecturers participate in research and thus are able to teach students about the latest developments in their field. The committee was also impressed by the dedication and enthusiasm of which the teaching staff testified. TOM seems to have created a sense of team spirit that is beneficial for the programme as a whole. However, the committee also concludes that the implementation of TOM has made great demands on the lecturers. The committee concludes that the university and faculty have not anticipated this and should have provided the necessary support to cope with this extra workload. The high workload has also resulted in the fact that a significant percentage of staff has not yet obtained a basic teaching qualification (BKO).

The new teaching and laboratory facilities, the committee concludes, are impressive. The committee understands the importance of the physics labs for the bachelor's programme, and shares the opinion of the programme management and the dean of the faculty that all must be done to maintain the high standard of these laboratory facilities. The committee also finds it very important that the implementation of TOM is supported with the necessary facilities: administrative support for the lecturers and adequate teaching facilities for problem- and project-based learning.

The committee concludes that students are generally well involved in the evaluation of the programme. The assessment committee also concludes that the Programme Committee, which can play an important role in the process of quality assurance, could have been better informed about the implementation of TOM. The committee stresses the importance of a well-informed, pro-active Programme Committee. This Committee can help identify problems before they occur (not only at a course level, but also at the level of the programme as a whole) and to solve these problems. To conclude, the committee stresses the importance of evaluating not just individual courses, but the bachelor's programme as a whole. For this and other purposes, it would be desirable if the programme kept closer ties with its graduates.

Standard 3 Assessment and achieved learning outcomes
The committee finds the assessment procedure adequate. Students are well informed about assessment procedures. Assessment forms match the intended learning outcomes of the individual courses and of the programme as a whole. The committee considered exams in the bachelor's programmes to be of a high standard. It was also happy to see that for each exam there are test matrices available containing, for instance, model answers.

The Board of Examiners is responsible for drawing up and enforcing the rules and regulations, and for checking the quality of assessment within the programme. The committee concludes that the Board of Examiners fulfils its statutory tasks, but could adopt a more pro-active role. The Board should for example formulate an opinion on the assessment of group work in the bachelor's programme. Also, the Board should decide on its line of approach in matters such as detecting fraud and plagiarism.

The introduction of a new assessment form for the bachelor's research project in September 2013 has led to more clarity on the criteria defining the final grade. Now the programme management and the Board of Examiners should stress the importance of properly filling in the forms.

To assess the level achieved by the students, the committee examined a range of bachelor theses. In general, it agrees with the marks that have been given and concludes that the level of the theses matches and surpasses the level that can be expected of a graduate of an academic bachelor's programme in applied physics.

The committee assesses the standards from the Assessment framework for limited programme assessments in the following way:

Bachelor's degree programme Technische Natuurkunde:

Standard 1: Intended learning outcomes	**satisfactory**
Standard 2: Teaching-learning environment	**satisfactory**
Standard 3: Assessment and achieved learning outcomes	**satisfactory**
General conclusion	**satisfactory**

Master's degree programme Applied Physics

Standard 1 Intended learning outcomes
The master's programme Applied Physics is one of five master's programmes in the University of Twente Faculty of Science and Technology. The programme is primarily research oriented; students are trained to start their professional career as applied physicists. From the start of the programme, they choose from one of three tracks (1) Fluid Physics, (2) Materials Physics, and (3) Optics and Biophysics. The track *Fluid Physics* focuses on 'phenomena that are encountered in liquids and gases', the track *Materials Physics* on the understanding and control of exceptional materials properties, and the track *Optics and Biophysics* on 'fundamental problems and cutting-edge applications in photonics and optical biophysics'.

The committee concludes that the master's programme has a clear profile. At the same time, it believes that the programme could position itself better internationally by highlighting its unique character in comparison to similar programmes elsewhere – in The Netherlands and abroad. The committee was impressed with the amount of detail given to the formulation of the intended learning outcomes. The programme identifies which specific research, designing and communication skills master graduates should possess. The intended learning outcomes of the master's programme are more specific than those of the bachelor's programme and they are geared towards starting a professional career as an applied physicist. The committee concludes that the intended learning outcomes are in line with the domain specific framework of reference and meet international standards.

Standard 2 Teaching-learning environment
The master's programme Applied Physics consists of 120 EC, divided over two years. The didactic concept underlying the programme is that of learning by means of a master-apprentice relation. Almost half (50 EC) of the master's programme is devoted to 5 EC courses. Furthermore, students take a compulsory, three-month internship (20 EC) and finish their studies by doing a research project (50 EC).

The committee concludes that the contents and design of the master's programme ensure that students are able to obtain the intended learning outcomes. The programme has a clear structure and offers a lot of flexibility. There is a clear connection between the aims of the courses and the learning aims of the programme. The courses provide students with the necessary theoretical knowledge basis. During the internship and the research project, the focus shifts to doing research. The didactic concept underpinning the master's programme, the committee finds, is not very transparent and asks for a better elaboration.

The committee is of the opinion that the scientific orientation of the programme is more than sufficiently safeguarded. It also concludes that, apart from the (mostly research oriented) internship, the programme depends heavily on study association Arago for job orientation outside research. The committee strongly suggests that the programme management secures a more prominent place for job orientation activities in the master's programme.

Students on average take 2.2 years to finish the programme. The committee concludes that the completion rates are good. The committee also observes that the programme has an adequate system of study guidance in place. The committee got the impression that students are generally very enthusiastic about their lecturers and seem to feel well supported in their study.

The committee concludes that the academic staff is very well equipped for delivering the programmes. All lecturers participate in research and thus are able to teach students about the latest developments in their field. The committee was also impressed by the dedication and enthusiasm of which the teaching staff testified. However, the committee also noted that the staff workload is tough. This in turn has resulted in the fact that a significant percentage of staff has not yet obtained a basic teaching qualification (BKO).

The teaching and laboratory facilities in the new Carré-building, the committee concludes, are impressive. Master students who have reached the research project phase get a workplace in or nearby the laboratory or chair of the research group in which they carry out their master's assignment. They are treated as members of the research group and participate in all group activities. The committee is enthusiastic about this procedure.

The committee concludes that students are generally well involved in the evaluation of the programme. The assessment committee also concludes that the Programme Committee, which can play an important role in the process of quality assurance, could have been better informed about the implementation of TOM in the bachelor's programme. The committee stresses the importance of a well-informed, pro-active Programme Committee. This Committee can help to identify problems before they occur (not only at a course level, but also at the level of the programme as a whole) and to solve these problems. To conclude, the committee stresses the importance of evaluating not just individual courses, but the master's programme as a whole. For this and other purposes, it would be desirable it the programme kept closer ties with its graduates.

Standard 3 Assessment and achieved learning outcomes
The committee finds the assessment procedure adequate. Students are well informed about assessment procedures. Assessment forms in the master's programme match the intended learning outcomes of individual courses and of the programme as a whole. The committee considered exams in the master's programme to be of a high standard. It was also happy with the fact that for each course there is an assessment plan available containing, for instance, model answersthe weighing of each assessment in the final grade.

The Board of Examiners is responsible for drawing up and enforcing the rules and regulations, and for checking the quality of assessment within the programme. The committee concludes that the Board of Examiners fulfils its statutory tasks, but could adopt a more pro-active role. The Board should for example formulate an opinion on the assessment of group work in the bachelor's programme. Also, the Board should decide on their line of approach in matters such as detecting fraud and plagiarism.

The introduction of a new assessment forms for the bachelor's research project in September 2013 has led to more clarity on the weighting of the elements the final grade is based on. It would be preferable, the committee concludes, if a similar form was adopted for the master research project. In addition, the programme management and the Board of Examiners should stress the importance of filling in the forms properly.

To assess the level achieved by the students, the committee examined a range of master's theses. In general, it agrees with the marks that have been given and concludes that the level of the theses matches and surpasses the level that may be expected of a graduate of an academic master's programme in physics.

The committee assesses the standards from the Assessment framework for limited programme assessments in the following way:

Master's degree programme Applied Physics:

Standard 1: Intended learning outcomes	**satisfactory**
Standard 2: Teaching-learning environment	**satisfactory**
Standard 3: Assessment and achieved learning outcomes	**satisfactory**
General conclusion	**satisfactory**

The chair and the secretary of the committee hereby declare that all members of the committee have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 11 June 2014

Prof. dr. Daan Lenstra

dr. Joke Corporaal

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes
The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

Findings

In this paragraph the findings of the committee with regard to the Domain Specific Framework of Reference and intended learning outcomes, the level and orientation of the two programmes are described. After considering the findings the committee comes to a conclusion on Standard 1.

1.1 Profile and orientation

Bachelor's degree programme Technische Natuurkunde
The bachelor's programme is one of twenty bachelor's programmes offered by the University of Twente. Together with four other bachelor's programmes and five master's programmes, it is situated in the Faculty of Science & Technology. The programme aims at 'a broad physics education at an elementary level'. In the critical reflection, the programmes outlines its mission as following: 'to educate students at an internationally renowned bachelor's level to become entrepreneurial researchers and engineers who are capable of developing, conveying and applying innovative knowledge according to academic standards in Applied Physics.'

The bachelor's programme has an introductory function and primarily aims at providing students with sufficient skills and knowledge in the fields of physics and applied physics to successfully follow a master's programme in applied physics or a related area. There are no official tracks within the bachelor's programme, and the committee notes that the amount of optional courses is limited. Key words used to describe the programme are 'a broad and exploratory curriculum' and 'sufficient knowledge and skills to make an informed choice for a further professional education'. However, the critical reflection also states that there appears to be hardly any labour market for academic Applied Physics bachelors in The Netherlands. The assessment committee is critical about this claim, and points out that this is a self-fulfilling prophecy that is the result of automatically expecting students to follow a two-tier programme. When confronted with these concerns, the management admitted that the fact that the industry is not interested in BSc-graduates might be a result of unfamiliarity with the knowledge and skills that bachelor graduates possess.

Master's degree programme Applied Physics
As stated in the critical reflection, the overall aim of the master's programme Applied Physics, one of 36 master's programmes at the University of Twente, is 'to educate students at an internationally renowned master's level to become entrepreneurial researchers, designers and engineers who are capable of developing, conveying and applying innovative knowledge according to academic standards in one of the three area's: Fluid Physics, Materials Physics

and Optics & Biophysics.' The master's programme surpasses the academic level of the bachelor's programme. The committee concludes that this can be seen in the fact that, in comparison with the bachelor's programme, there is a stronger focus on carrying out research and being part of a research group, which demands certain generic academic skills. According to the critical reflection, the programme does not educate students for a specific occupation. Instead, it trains students in handling and solving scientific problems and, in a broader sense, to 'make their knowledge relevant in a position for which an MSc APh degree is desired, or for which knowledge of applied physics is useful'.

The objectives of the master's programme are taken from the Course and Exam Regulations (OER) and are formulated as following. 'The graduates are able to:

- do research aiming for the development and application of measurement methods and techniques within or outside their own discipline
- design instrumentation for research and industrial applications
- do fundamental research while keeping the applications in mind.'

As already became clear from the overall aim of the programme, students choose from the start for one specific track or research area: Fluid Physics, Materials Physics or Optics and Biophysics. These tracks coincide with three of the faculty's five focus areas for research. Within each track, between three to five research groups work together by providing (part of) the courses.

1.2 Intended learning outcomes

The objectives of both programmes are translated into programme-specific aims and learning outcomes (see Appendix 3) using the five Dublin descriptors 'knowledge and understanding', 'applying knowledge and understanding', 'making judgements', 'communication' and 'learning skills'. Furthermore, both programmes have based their learning outcomes on the Domain Specific Framework of Reference (VSNU, 2002), the Tuning project standard (Tuning pilot group for physics, 2005) and ACQA-criteria (2005). The ACQA criteria (Academic Competences and Quality Assurance) have been formulated by the three Dutch technical universities in order to further specify the rather generic Dublin descriptors for applied academic programmes. The committee notes that all frameworks distinguish between two sets of skills: discipline specific knowledge and skills, and generic academic skills. In addition, the ACQA-criteria describe seven areas of competence (discipline, research, design, scientific approach, intellectual skills, co-operating skills & context), roughly overlapping with the Dublin descriptors.

The bachelor's programme Technische Natuurkunde has formulated seven general aims based on the seven ACQA-areas of competence. Those general learning outcomes are further divided into anywhere between five and eight specific aims. For instance, the general aim that graduates should be 'competent in cooperating and communicating' (aim 5) is further specified in six aims, for instance: 'is able to communicate in writing (lab journal, research and design report, poster), and verbally in Dutch (scientific presentation) about the results of learning, thinking and decision-making with colleagues, non-colleagues and managers' (5a) and 'has insight into, and is able to deal with, team roles and social dynamics' (5f).

The master's programme Applied Physics has formulated 46 specific learning outcomes, also divided over the 3TU 7 general 'areas of competence'. The learning outcomes surpass those of the bachelor's programme. This can be seen in the learning outcome for cooperating and communicating, which for the master's programme is described as: 'is able to cooperate and communicate with specialists in the chosen track and other stakeholders' (learning outcome 6) and further divided in 6a ('Is able to communicate in writing and verbally in English about research and solutions to problems with colleagues, non-colleagues and other involved parties') up to 6f ('Has insight into, and is able to deal with, team roles and social dynamics and is able to assume the role team leader.'). The research focus of the programmes is reflected in most learning outcomes, principally in learning outcomes 2 ('has the knowledge and the skills for doing research in a specific field of applied physics') and 4 ('has a scientific approach') and their respective sub-aims.

As for the bachelor's programme, the relation between the learning outcomes and the courses is made clear in a matrix in the critical reflection. Again, all skills are reflected in the curriculum, but the committee observed that there are small differences between the three tracks. For instance, context skills (awareness of the social, environmental, sustainability and safety context, learning outcome 7) are addressed in three of the four compulsory track courses within the track Materials physics, and in one of the four compulsory courses of the Fluid Physics track (namely 'Numerical techniques for PDE's'). In both tracks, however, those context skills feature prominently in the capita selecta course, the internship and master's research project.

During the site visit, a subject that came up frequently in the talks is the change of the bachelors' curriculum in 2013/2014. The start of this new curriculum is the result of the putting into effect of a new, university-wide didactic model called the Twents Onderwijsmodel (from now on: TOM). The main goal of TOM is to improve study rates (dropout and time-to-degree) by stimulating cohort-wise participation of the students. This is mainly achieved by organizing the curriculum differently (in thematic modules, for a description see 2.1.4) and by adopting new teaching methods such as project- and problem-based learning. The committee has some content-related concerns about TOM, which will be dealt with under 2.1.4. Here, the committee considers the implications this change has for the profile and learning outcomes of the bachelor's programmes. As far as the committee can see, TOM will not result in an altogether very different profile. The main goal of the bachelor's programme will remain unchanged, as will its intended learning outcomes. The committee is pleased to see that the basic structure of the bachelor's programme (an interdisciplinary approach after a monodisciplinary introduction in the first year) stays the same.

Considerations

The committee has discussed the profile, level and orientation of both programmes. It was impressed with the learning outcomes that both programmes have formulated in the context of the agreements made between the three Dutch technical universities (3TU). The committee observes that the learning outcomes are formulated with great breadth and a lot of attention for details, by specifying which specific research, designing and communication skills BSc and MSc graduates should possess. The intended learning outcomes of the bachelor's programme are more broadly defined and geared towards enrolling in a master's programme. Those of the master's programme are more specific and geared towards starting a professional career as an applied physicist. The committee concludes that the intended learning outcomes match the domain specific requirements. The academic orientation of the bachelor's and master's programme is in line with what can be expected from a scientific bachelor's and master's programme from an international perspective.

The assessment committee concludes that both programmes have a clear and distinctive profile with a lot of attention for design. This last aspect sets them aside from similar programmes in the Netherlands. The bachelor's programme focuses on a broad, introductory level, the master's programme on the further shaping and sharpening of research skills within one of the three specializations. The committee states that prospective BSc and MSc students know what to expect after having read the programmes' mission and objectives. As a programme taught in English, the master's programme also attracts English-speaking students from abroad. From such an international viewpoint, the committee feels that this programme could position itself more clearly by highlighting its unique character in comparison to similar programmes elsewhere – nationally and abroad.

The national and international frameworks to which the programmes refer, show that the scientific orientation of both programmes is more than sufficiently ensured. In contrast, a topic that the committee considers to be addressed insufficiently in the profiles of both programmes is job orientation. The committee advises both programmes to adopt a specific intended learning outcome on job orientation.

Conclusion

Bachelor's programme Technische Natuurkunde: the committee assesses Standard 1 as 'satisfactory'.
Master's programme Applied Physics: the committee assesses Standard 1 as 'satisfactory'.

Standard 2: Teaching-learning environment
The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Findings

The committee has studied the curricula of both programmes, has seen the course material, the digital learning environment and results of course evaluations. In this standard the findings of the committee concerning the content, orientation and structure of the programmes (2.1), intake and study load (2.2) teaching staff (2.3) and facilities and internal quality assurance (2.4) are discussed.

2.1 Programmes and coherence of the curricula

The bachelor's programme Technische Natuurkunde consists of 180 EC, evenly divided over three years. The master's programme Applied Physics consists of 120 EC, divided over two years. Each year of the bachelor's programme is further divided into four parts ('kwartielen') of approximately ten weeks each. An overview of both programmes can be found in appendix 4.

2.1.1 Bachelor's programme Technische Natuurkunde
The curriculum of the bachelor's programme consists of three parts: mandatory theoretical and experimental courses (130 EC), optional and orientation courses within or outside the discipline (15 EC and a 20 EC minor) and a bachelor assignment at the end of the third year (15 EC).

The first year of the bachelor's programme provides students with the basics of physics and mathematics (in courses such as 'Calculus I&II', 'Energy and Entropy' and 'Quantum phenomena') and applied physics (for instance in the courses 'Experimental laboratory I&II' and 'Instrumentation'). The first three blocks of the first year contain an elementary physics course, a mathematics course, and laboratory practice. The last block includes a design project ('Propedeutical project', 5 EC). All courses vary between 5 EC (theoretical courses) and 2.5 EC (mostly experimental and/or laboratory courses). The four-periods-a-year system and the size of the courses allow students to follow three or four courses per period and to obtain 15 EC per 'kwartiel'.

The second year focuses on the 'fundamentals of physics and applied physics' and has a similar set up as the first year. It is centered around the three topics 'advanced mathematical methods', 'fundamental physics' and 'knowledge and skills on instrumentation'. Both the second and the third year build on the knowledge and skills obtained in the first year of the programme. The course 'Linear structures II' (year 2), for instance, follows logically after 'Linear structures I' (year 1) and the course 'Optics lab' (second kwartiel) is scheduled following the theoretical course 'Introduction to optics' (first kwartiel second year).

The last year of the bachelor's programme is geared towards 'specialisation within the discipline and broadening outside the discipline'. In the minor (2 x 10 EC in the first two kwartielen of the third year), students are allowed to take courses at other faculties (for instance, the business-oriented minor 'Enterpreneurship' or the educational minor 'Learning to teach') or even outside the University of Twente. In the optional and orientation courses (15 EC, kwartiel 3 year 3) students can make a choice from courses in the field of natural sciences or engineering. They may also use this period for doing an external internship. The Board of Examiners sees to it that the minor and optional courses form a coherent set and fit in well with the rest of the programme. The programme management points out that, if desired, the minor and optional/orientation courses could be used as a bridging programme for a master's programme other than Applied Physics or for the labour market.

At the end of the third year, students perform a bachelor research project either in optics, materials physics or fluid physics (the three research specialization tracks in the master's programme Applied Physics) at one of the faculty's research chairs. Students conclude their bachelor research project with a written report of the research performed and an oral presentation for an academic audience.

Up until 2012/2013, the bachelor's degree programme Technische Natuurkunde offered three different honours programmes for talented students; one in advanced mathematics, one in science and academic practice, and one in engineering. About 10% of undergraduates made use of one of these options. From February 2014 onwards, the three honours programmes have been integrated in one university wide 'BSc-Honours Programme' (30 EC, designed for the best 5% of each bachelor's programme).

In study year 2013/2014, the bachelor's curriculum has been revised intensively as a consequence of the university-wide introduction of the Twents Onderwijs Model (TOM). The most important change is that courses are now offered in thematic modules of ten weeks each. Since TOM has started recently, the assessment committee based its assessment primarily on the contents and results of the old curriculum. The Twents Onderwijs Model and its implications for the bachelor's programme will be discussed under 'didactic concept'.

The committee has studied the bachelor's curriculum and the course material. It concludes that there is a clear connection between the intended learning outcomes of the individual courses and the outcomes of the programme as a whole. Design skills play a central role in the programme. The curriculum has a clear structure and the programme management clearly succeeds in offering a coherent, challenging and varied set of courses. The committee agrees with the approach that has been decided on to first provide students with basic disciplinary knowledge and laboratory skills to allow for a more interdisciplinary approach in the last two years of the programme. Although most of the curriculum is mandatory, there is also opportunity for students to pursue personal interests and talents. In this respect, the assessment committee is enthusiastic about the possibility to carry out an external internship in the third year and the broad choice of minor courses offered at the University of Twente, ranging from management courses to an educational minor.

2.1.2. Master's programme Applied Physics

The assessment committee has studied the programme of the master's programme Applied Physics. Almost half (50 EC) of the master's programme is devoted to 5 EC courses. Furthermore, students take a compulsory, three-month internship (20 EC) and finish their studies by doing a research project (50 EC).

The first, theoretical part of the curriculum consists of 20 EC compulsory track courses (different per track) and 30 EC optional courses. These optional or additional courses have to be filled in as following: two chair specific courses, two physics or technical elective courses and two free elective courses. These optional courses, the management states, may also be used to fill in gaps in knowledge or skills resulting from a different academic background.

To give an example, the curriculum of a master's student Applied Physics (in the Materials Physics track) may look like this:

- Four compulsory track courses: 'Theoretical Solid State Physics', 'Surfaces and Thin Layers', 'Nanophysics', and 'Advanced Materials'
- At least two and at the most six of eight different chair courses (for instance, 'Electronic Structure Theory' and 'Applications of superconductivity'), and four optional courses from other tracks;
- Internship (20 EC)
- Research Project (50 EC)

The programme encourages students to perform their internship abroad, for instance at CERN (Switzerland). By contrast, the MSc assignment is preferably carried out at one of the faculty's research groups, although the Board of Examiners may grant exemptions to this rule.

As for the master's curriculum, the committee concludes that it is well structured and successful in providing a coherent and varied set of courses for each track, enabling students to optimally prepare for a career in research while having the opportunity to follow personal interests and talents. The committee notes that the level of the courses is high and that there is a clear connection between the aims of the courses and the intended learning outcomes of each track. The committee also appreciates the compulsory internship, which is a rare feature in similar programmes in The Netherlands. Both the students and the alumni were very enthusiastic about this part of the programme. The committee shares their enthusiasm and thinks that an internship encourages students to think seriously about their future career.

2.1.3 Didactic concept

Until September 2013, the didactic concept of the bachelor's programme was based on the slogan 'Grasping the laws of the physical world', and focused on teaching students the basics of the three 'pillars': physics, mathematics and experimental skills. Basic courses focused on one of those three pillars, while in more advanced courses the pillars were combined. The didactic concept of the master's programme is that students should be able to study in a largely self-directed and autonomous manner. The second year of the master's programme is entirely devoted to research, based on the principle 'learning by means of a master-apprentice relation'.

The didactic vision underpinning both programmes since September 2013 is determined by the strategic plan of the University of Twente (RoUTe 14+). The Twents Onderwijsmodel (TOM), implemented in the bachelor's programme is part of this strategic plan. The basis of RoUTe 14+, the critical reflection explains, is to provide 'a balanced education in research, design and organisation […] to support the students in exploring their interests and strengths.' Research, design and organisational skills come together in research projects. Therefore, research practice forms a substantial part of both programmes. In the bachelor's programme, research skills are trained in the laboratory courses.

As a result of TOM, the bachelor's curriculum has been revised. The main goal of this new educational model is to improve study rates by stimulating cohort-wise participation of the students. The main difference between the old and the new BSc programme is that courses are now offered in thematic modules of ten weeks each that coincide with the former 'kwartielen'. Like the 'kwartielen', each module consists of an elementary mathematics course, a physic course and laboratory practice. During the site visit, the programme management explained that the thematic modules have been introduced to ensure a better connection between the different courses of the programme, and between the individual courses and the programme as a whole. Mathematics and physics courses, for instance, did not always connect well. Planning and discussing the learning aims and assessment methods of each module together should lead to a better coupling between the various courses and to a more even spread of the study load.

In the new curriculum, a research project is part of each block. Another key change is that courses now range from 2 EC to 5.5 EC. The total study load of each block, however, remains 15 EC. Modules offered in the first year are: 'Dynamica', 'Thermodynamica', 'Fundamentals of Materials' and 'Velden & Elektromagnetisme'.

The critical reflection describes that the first two modules 'have a selective and directive role'. In other words, these modules are designed in such a way that students with poor prospects or motivation are selected at an early stage. Furthermore, students should complete three out of four modules to meet the requirements formulated for the Bindend Studie Advies (BSA).

Within TOM, new different teaching methods are employed. The critical reflection names problem- and project based learning as important components. These new methods are complementary to the teaching methods already in use in the old programme: lectures, lab practice, projects executed in small groups (3-6 students) and supervised self-study (in the first year only).

The committee has discussed the new didactic concept extensively. First of all, the committee notes that the implementation of TOM in the bachelor's physics programme appears to be the result of thorough discussions and planning. Also, the committee thinks that the programme has made good use of the opportunities the new didactic model offers to improve the bachelor's programme. TOM offers new possibilities to structure the programme further and to improve study rates. The thematic modules seem carefully planned in a manner that ensures a better connection between individual courses. At the same time, the committee highly appreciated the thorough monodisciplinary knowledge basis provided in the old programme. It advises the programme to see to it that the introduction of a research project in each block will not be at the expense of providing students with the necessary elementary mathematics, physics and laboratory practice skills.

The committee concludes that the programme management has paid a lot of attention to the connection between courses, learning aims and modules. Less attention seems to be paid to implementing the new didactic concept with regard to the use of problem and project-based learning. Problem-based or self-directive learning calls for a very different way of supervising students, and for different assessment methods to check whether students have achieved the intended learning outcomes. The committee thinks problem- and project based learning can be part of a quality learning environment for students, but advises the programme to carefully consider the alignment of these concepts with all intended learning outcomes.

With regards to the various lines of development in the bachelor's programme, the committee concludes that the scientific developmental lines (mathematics, physics, laboraty practice) have been specified well. This is not the case for all lines of development. The programme management clarified that the academic line in the first two years mainly focuses on communication skills (for instance, writing a lab report, presenting and reflecting upon teamwork). Attention is not yet paid to ethical issues connected with carrying out research, plagiarism and/or fraud. The committee emphasizes that these are important subjects that should also be dealt with in the earlier phases of the academic learning line. Programme management also explained that the exact details of so-called 'reflectieonderwijs' (reflection education – a set of courses in which students learn to reflect upon their own role and position in a team, accounting for 15 EC in the third year) still need filling in. The programme wishes to organize this 'reflectieonderwijs' in close contact with industry. The bachelor's students with whom the committee spoke were concerned that the 'reflectieonderwijs' will be introduced at the expense of third year physics courses. The committee is pleased to hear that the programme management and teaching staff agree that this component of TOM should not affect the amount or depth of the physics courses. It urges management to find a form for the 'reflectieonderwijs' in which this type of education strengthens and contributes to the physics education. Therefore, the committee finds it important that the 'reflectieonderwijs' will be filled by the programme itself and in close contact with the industry. A subject the committee explicitly would like to see addressed in the 'reflectieonderwijs' is job orientation.

2.1.4 Scientific and professional orientation

To educate academically trained applied physicists, programmes are required that provides students with research skills, general knowledge and with basic academic skills for the working environment, for example the ability to discuss and present the methodology of their work or the ability to reflect and comment on ethical issues connected with research. The committee concludes that the orientation of both programmes is strongly geared towards a future career in research. By introducing students to the latest developments in the field of applied physics, and by allowing them to carry out their own research project, the committee finds the links of the programme with current developments in the field of scientific research demonstrable. The scientific orientation of both programmes is more than sufficiently safeguarded.

As previously stated, both programmes have paid a lot of attention to formulating learning outcomes. However, the assessment committee had difficulties finding out how general academic learning outcomes recur in the learning objectives of the courses. Therefore, it asked how the programmes secure the ambitions laid down in the learning outcomes, for instance the claim that master students 'have the potential to assume leadership roles' (in multidisciplinary teams), elsewhere formulated as '(he or she) is able to assume the role of team leader'. The management pointed out that this learning outcome comes to the foreground in the master's research project, which students carry out at one of the faculty's research chairs. The committee concludes that master's students are not explicitly trained to adopt the role of team leader. Therefore, it thinks that a more modest claim would be better. On the whole, the ambitions of the programme need to be compared with the learning aims of the programme to check whether they are realistic.

The committee finds it important that students are well informed about the possibilities on the job market, whether in- or outside academia. The bachelor's and master's students explained that study association Arago plays an important role in job orientation. It organizes outings to various companies in industry, as well as a study trip abroad. In addition, the master's students were very positive about the compulsory (research oriented) internship in the programme. The committee is enthusiastic about the active rol Arago plays in both programmes. It is also happy to hear that there are close ties between Arago and the programme management, and it agrees with management that students get a lot out of organizing job orientation activities. At the same time the committee concludes that the programme management should not depend solely on Arago for job orientation outside research. The committee believes that both programmes could keep better track of their alumni (a role that is now fulfilled by Arago) and ask for their expertise on, for instance, soft skills needed in a corporate and/or research environment or the further shaping of the bachelor and master curricula. Such an advisory council in which external experts could also be included - this was already suggested by the previous assessment committee, could also help to position the programmes better within the corporate world. In the bachelor's degree programme, job orientation could for instance be incorporated in the reflectieonderwijs.

2.2 Intake, study load and study guidance

Rates

The *bachelor's degree programme Technische natuurkunde* has laid down its admission requirements in the Course and Examination Regulations (OER). The programme grants direct access to students who hold a Dutch VWO diploma (profile Nature & Technology or Nature & Health) with mathematics B and phyics. The programme is also open to German students who have successfully finished their 'Abitur' (German equivalent of the VWO exam) with mathematics and physics. Students from Germany have to meet the requirement that they master Dutch at B1 level. To this end, the university offers Dutch language classes in the form of a summer school.

To ensure a better match between prospective students and the programme, the programme informs students that those with an average VWO-exam grade of 6.5 or lower in mathematics and physics will most likely not be able to successfully complete a physics study at academic bachelor's degree. This is exemplified by a graph linking study success with the average VWO grade. The committee reckons that it is a good initiative to stress the difficulty level of the programme to prospective students so that they can make an informed decision about whether the programme is feasible for them.

The number of students who started the bachelor's programme fluctuates between 57 (2006/2007), 43 (2010/2011) and 70 (2013/2014). The average intake is 54 over the last eight academic years. 13% of the students are female, which although low is in line with other academic physics programmes in the Netherlands. In the period 2006-2012, approximately 30% of the students discontinued their study after one year. The cumulative percentage rises to 32% after the second and 36% after the third year. The programme would like to bring these numbers down to a 30% total dropout, concentrated in the first year. The implementation of TOM should help to install a more serious attitude towards their study. Being part of a cohort should make students aware of the fact that it is important to keep on track with the rest. Finally, the Bindend Studie Advies, installed in 2009/2010 and raised to 45 EC in 2012/2013, should help to concentrate the dropout in the first year. The committee agrees that the dropout numbers currently are too high. It is content that the programme has taken appropriate measures to improve study rates, such as starting the first year with two demanding modules, raising the number of EC's required to obtain the BSA, and setting stricter deadlines for the bachelor's research project. It recommends that the programme will continue to keep a close eye on possible hurdles threatening study progress.

The *master's degree programme Applied Physics* has formulated different admission requirements for several groups of enrolling students. The specific admission conditions for each group are specified in the Education and Exam Regulations (OER). Direct access is granted to students who have successfully completed a bachelor's degree in applied physics or physics at a Dutch university. The programme is also open for students with a foreign university bachelor's degree in (applied) physics or materials science, or for students with a Dutch, non-academic (HBO) (applied) physics bachelor's degree. International students must have an average grade of at least 7.5 and submit proof of sufficient English language proficiency. An Admission Committee, consisting of the programme director, the coordinator internationalization and a member of the research group where the student will be hosted, decides upon admission. HBO-students have to follow a pre-master programme (maximum 30 EC) before they can enter the programme. Instead of an internship, they follow an additional competence programme (20 EC). The Board of Examiners decides upon the contents of the pre-master and the additional competence programme.

The number of enrolling students in the master's programme Applied Physics has steadily gone up from 26 students in 2006/2007 to 50 students in 2012/2013. The programme management expects that the inflow will go up even more because of the start of the bachelor Advanced Technology in 2004 and University College Atlas in 2013. The distribution of the tracks fluctuates. Over the last two years the track Materials Physics succeeded in attracting most students (almost 50% in 2011 and over 60% in 2012). The Fluid Physics track has decreased considerably from over 40% of the total intake in 2009 to under 20% in 2009. Optics & Biophysics has been steadily attracting between 20-30% of the total number of students since 2009.

Study load and study progress
As stated before, the curricula of the three-year *bachelor's degree programme Technische Natuurkunde* is divided in four 'kwartielen' (since 2013 'modulen') a year of approximately ten weeks each. Students follow no more than two theoretical courses next to each other. The research project takes up one block at the end of the bachelor's degree programme. The weekly amount of contact hours can be worked out by dividing the yearly contact hours provided in the critical reflection by 40 weeks a year. That amount is 17 for the first year of the bachelor's degree programme, going up to 18.5 in the second year and down to 11.75 in the last year of the programme (excluding minor and BSc assignment). These contact hours account for over 40% of the total study load. The study load of the bachelor degree programme is estimated at 40 hours a week.

In the first year of the *master's programme Applied Physics* students follow ten specialised courses (5 EC each) in the first year. The average number of contact hours is approximately 12 a week, which account for 28% of the first year's study load. The master's research project takes up 42% of the total study load.

The student representatives of the bachelor and master's programme with whom the committee spoke during the site visit were of the opinion that the programmes in their current form are feasible as long as students devote approximately 40 hours a week to their study. There are no major stumbling blocks, although the first year bachelor students did notice that the first module in the new curriculum was challenging. According to them, approximately four students left the programme after the first module to switch to a non-university physics programme.

The assessment committee concludes that both programmes in their current form are feasible. Also, the committee observes that on average bachelor's students take too long to graduate. The average study duration lies around 4.2 years for the bachelor's programme (versus 2.2 years for the master's programme). The delay in the bachelor's programme is caused by the fact that students take too long over their third year. The programme management is aware of the fact that the average study duration is too long. Since extracurricular activities appear to be the main reason for the delay, the committee suggests that appropriate measures to bring the study duration down are to better monitor students' extracurricular activities and to impose stricter deadlines for the research projects. It is satisfied to hear that the programme management already sets more stringent rules to the research project.

Guidance
Bachelor's students are guided by a member of staff, who functions as a mentor to a group of approximately ten students. Mentors see the students at least three times in the first year, and discuss matters such as study planning, BSA and study choice. The study advisor keeps a close eye on individual student's study progress and informs the mentor if students perform poorly. Additionally, students can also directly contact the study advisor for general study advice, or a study counselor for help with personal problems. The students mentioned that the system of study guidance is adequate. The bachelor students were enthusiastic about the study guidance provided in the first year by mentors and through supervised self-study classes. However, they would not recommend making these self-study classes compulsory.

For master students, the study advisor is the contact person to assist with study planning and studying in general. International master students and master students who have previously received a HBO-education are assigned to a tutor, namely the coordinator internationalisation and the HBO-coordinator. These students have a meeting with the tutor after each block, although for students from the HBO this stops once they have completed the pre-master. A faculty internship coordinator helps with finding a suitable place and supports the students during their internship. The supervision is in the hands of a daily supervisor in the company and a mentor from the university.

The committee is satisfied to hear that students generally feel that they are well supported in scheduling their programme.

2.3 Academic staff

The academic staff that delivers both the bachelor's and the master's degree programme consists of 43 lecturers. 24 students assistants and around 90 PhD-candidates also regularly assist in the teaching process. Of the core staff, all lecturers except two have a PhD-degree and participate in scientific research. 15 lecturers hold a position as full professor. The committee takes into consideration that the research of the department of Applied Physics was recently assessed as very good to excellent. According to the critical reflection, PhD students frequently contribute to the daily supervision of the final bachelor and master assignment, and student assistants (senior bachelor or master students) help as assistants in lab-training or in guided self-study classes. The student-staff ratio is estimated at 1:15.2 for both degree programmes.

40% of the academic staff have obtained the *Basis Kwalificatie Onderwijs* (BKO) or University Teaching Qualification. 23% has started the training, whereas 23% still has to start and another 14% (lecturers with an appointment of more than twenty years or professors with an appointment of less than eight hours a week) are granted exemption. The committee notes that the programme is (far) behind with the number of teaching qualifications, compared with similar programmes in The Netherlands. Therefore it asked why such a considerable number of staff has not started the teacher training yet. The programme management explained that the study load of the programme (about 250 hours) is considered high on top of educational and research responsibilities. Within a tenure track, however, the BKO is compulsory. The teachers that have followed the training did consider it useful and said that they make use of the insights they gained during the training. The committee insists that the programme management puts the teaching qualification higher on the agenda.

The committee was pleased to hear that both the bachelor's and the master's students were very enthusiastic about the quality of their lecturers. Both found their teachers very accessible. The bachelor's students were especially enthusiastic about the fact that lecturers showed them the link with their own research. The master's students praised the lecturers as very good supervisors, who pay attention to self-discipline when necessary. The graduates said that the informal atmosphere and the friendliness of the staff had stimulated them to reach their maximum potential.

The committee was impressed by the dedication and enthusiasm of the teaching staff, even though the average teaching load is at least 40% and a considerable amount of teaching preparation is done outside working hours. The implementation of TOM in the bachelor's programme, the committee concludes, seems to have made lecturers more aware of how individual courses relate to one another and to the learning outcomes of the programme as a whole. TOM has created a sense of team spirit that is beneficial for the consistency of the programme. However, the committee also concludes that the implementation of TOM has made great demands on for instance those lecturers involved in setting up the new modules. From various meetings during the site visit, the committee concludes that the university and faculty could have provided more support to cope with this extra workload, for instance by attracting administrative staff to help lecturers cope with extra administrative tasks. The committee was pleased to hear that the programme management is aware of the fact that due to TOM the workload is at a critical level. It is happy to hear that the programme management is already in the process of attracting more administrative staff.

The committee concludes that the academic staff is more than sufficiently equipped for delivering the programmes.

2.4 Facilities & Internal quality assurance

The bachelor's and master's degree programmes share facilities provided by the faculty of Science & Technology. The programme recently moved into a new building (Carré, Drienerlolaan 5). The assessment committee was able to get a good impression of the teaching facilities and physics labs during the visit. It was very impressed with these facilities. On its tour around the physics labs, the committee witnessed bachelor's students at work carrying out experiments. The set up of the laboratory experiments made a very good and balanced impression on the committee. One minor point of criticism would be that students have to sit quite closely together due to the size of the rooms. The committee appreciates how important the physics labs are for both educational programmes, and shares the opinion of the programme management and the dean of the faculty that all must be done to maintain the high standard of these laboratory facilities. As mentioned before, the committee also finds it very important that the implementation of TOM is supported with the necessary facilities: administrative support and adequate teaching facilities for problem- and project-based learning.

Master students who have reached the research project phase get a workplace in or nearby the laboratory or chair of the research group in which they carry out their master's assignment. They are treated as members of the research group and participate in all group activities. The committee is enthusiastic about this approach.

The committee has assessed to what extent students and graduates are involved in the evaluation and reforms of the programmes. Students are asked after each block to evaluate separate courses. If evaluations show that a course is rated below average, action will be taken. The programmes do not systematically evaluate the curriculum as a whole. Although study association Arago holds close ties with graduates, the programme itself does not keep in touch in a systematic way. The committee suggests that after graduating, students could be asked to evaluate the programme. The committee expects that such evaluations will lead to identifying potential stumbling block in the composition of the programme and to formulating improvement measurements. As mentioned previously, the graduates could also bring in their experiences in how the programmes prepared them for their current position in industry or academia.

Both programmes share one Programme (Educational) Committee, in which four members of staff and five students (one for each year of both programmes) are represented. Student members are approached via study association Arago, which makes a pre-selection of suitable candidates. The Programme Committee meets four or five times a year. The programme director is usually present at these meetings. The Programme Committee described its task as: advising the programme management and identifying recurring stumbling blocks in both programmes. The Committee gets its information from both formal and informal sources. The student members organize lunches for fellow students where they can bring issues forward that the Programme Committee should know about. According to the Programme Committee, if there are any problems with a particular course, those can often already be solved before the course evaluations at the end of the block. The Programme Committee sometimes directly advises the Dean of Faculty. This was last done when the Committee learned that the faculty is considering to change its bachelor's programmes to English. The Programme Committee informed the Dean that it has some serious concerns about this intended change.

The Programme Committee explained to the assessment committee that in the previous year a lot of time has been taken up by discussing the implementation of TOM in the bachelor's programme. The Committee currently follows the discussion about the content of the reflectieonderwijs with special attention. The assessment committee learned that the Board of the University wishes to organize this reflectieonderwijs centrally, possibly from within the Faculty of Philosophy. The Programme Committee advised negatively on this plan, together with the Programme Committees of the BSc programmes Avanced Technology and Chemistry. The Programme Committee strongly favours an approach in which the faculty decides on the contents and spread of the reflectieonderwijs over the third year.

From talking to the Programme Committee, the assessment committee concludes that this committee adopts a pro-active role when it comes to evaluating courses and advising on the contents of new courses. It worries the committee, however, that the Programme Committee was informed late about the implementation of TOM. The committee points out that the Programme Committee can only carry out its tasks prescribed in the Dutch Law on Higher Education if it is closely involved when important changes are being considered. The committee urges the management to keep the Programme Committee better informed in the future. Finally, the committee asks the Programme Committee to reconsider whether it really is desirable that the programme director is present at every meeting.

Based on the session with the Programme Committee, the assessment committee concludes that it takes a pro-active role in evaluating and improving courses. Yet the assessment committee found that the Programme Committee was informed rather late about the discussions on the reflectieonderwijs. It urges the programme management to keep the Programme Committee better informed in the future. It concludes that the Programme Committee should have been better involved in those discussions, and stresses that the Committee should also be pro-active in advising about (reforms of) the programmes as a whole. Finally, the assessment committee suggests that the Programme Committee might function more independently when the programme director is not present at every meeting.

Considerations

The committee concludes that the contents and design of both the bachelor's and the master's degree programme ensure that students are able to obtain the intended learning outcomes. Both programmes have a clear structure. The bachelor's programme has limited room for optional courses, whereas the master's programme offers a lot of flexibility. There is a clear connection between the learning outcomes of the individual courses and the intended learning outcomes of the programmes.

The committee notes that the implementation of TOM in the bachelor's physics programme appears to be the result of thorough discussions and planning. TOM offers new possibilities to structure the programme further and to improve study rates. The thematic modules seem carefully planned in a manner that ensures a better connection between individual courses and between the courses and the overall aim of the programme. Less attention seems to be paid to the use of problem and project-based learning as the most important teaching method. Finally, the committee believes it to be important that the reflectieonderwijs will be filled by the programme itself and in close contact with the working field. A subject the committee explicitly would like to see addressed in the reflectieonderwijs is job orientation.

The committee is of the opinion that the scientific orientation of both programmes is more than sufficiently safeguarded. It also concludes that both programmes depend heavily on study association Arago for job orientation outside research. The committee insists that both programmes secure a more prominent place for job orientation activities within their curricula.

Completion rates of the bachelor's programme are low, mainly because of a delay during the third year. The committee urges the programme management to implement appropriate solutions to reduce this delay. The completion rates of the master's programme are good. The committee concludes that both programmes have an adequate system of study guidance in place. Students are very enthusiastic about their lecturers and generally feel well supported in getting acquainted with studying, study orientation and study planning.

The committee concludes that the academic staff is more than sufficiently equipped for delivering the programmes. All lecturers participate in research and thus are able to teach students about the latest developments in their field. The committee was also impressed by the dedication and enthusiasm of which the teaching staff testified. TOM seems to have created a sense of team spirit that is beneficial for the programme as a whole. However, the committee also concludes that the implementation of TOM has made great demands on the lecturers. The committee concludes that the university and faculty have not anticipated and provided the necessary support to cope with this extra workload.

The new teaching and laboratory facilities, the committee concludes, are impressive. The committee understands the importance of the physics labs for the bachelor's programme, and shares the opinion of the programme management and the dean of the faculty that all must be done to maintain the high standard of these laboratory facilities. The committee also finds it very important that the implementation of TOM is supported with the necessary facilities: administrative support and adequate teaching facilities for problem- and project-based learning.

The committee concludes that students are generally well involved in the evaluation of the programmes. It concludes that the Programme Committee takes a pro-active role in evaluating and improving courses. It urges the programme management to keep the Programme Committee better informed about programme reforms in the future. It stresses that the Committee should also be pro-active in advising about (reforms of) the programmes as a whole. To conclude, the committee stresses the importance of evaluating both programmes as a whole. For this and other purposes, it would be desirable if the programmes kept closer ties with their graduates.

Conclusion

Bachelor's programme Technische Natuurkunde: the committee assesses Standard 2 as 'satisfactory'.
Master's programme Applied Physics: the committee assesses Standard 2 as 'satisfactory'.

Standard 3: Assessment and achieved learning outcomes
The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

Findings

This section deals with the assessment policy, the procedures regarding testing and examination and the assessment methods of both programmes. To this end various assessment materials have been evaluated, such as students' exams and essays, assessment keys and assessment forms. To assess whether graduates have obtained the intended learning outcomes, the committee studied a selection of bachelor's research project reports and master's theses and talked to alumni about the qualifications of the graduates and the relation to the requirements of the job market. Finally, the assessments and assessment system were discussed with students, the staff, the Board of Examiners and the programme management. 3.1 Deals with the assessment system and the Board of Examiners, 3.2 focuses on the academic level achieved.

3.1 Assessment system and Board of Examiners

Assessment procedure
In the critical reflection, the programme management describes its vision for the assessment procedure and the formal rules and quality assurance concerning assessment. Rules have been laid down in the Teaching and Examination Regulations (Opleidings- en Examen Regeling, OER), which is accessible for students and staff. The individual assessment procedure for each course is made clear at the beginning of each course and can be found in the study guide. The Board of Examiners sees to it that the rules are followed and checks the quality of assessment. There is one Board of Examiners for both programmes, which consists of two chairs, a secretary and three members of staff.

During the site visit, the assessment committee asked the members of the Board of Examiners whether they had received any form of training and whether they felt they had enough time to perform their duties. The Board of Examiners explained that they learned from one another. To check whether graduates have obtained the intended learning outcomes and whether exams reflect the learning aims of a course, the Board of Examiners works with a document linking the learning outcomes of the courses (including soft skills) to those of the programmes. Most time, they said, is taken up with making sure that the assessment rules, for instance those of the BSA, are followed in a concise matter. The implementation of TOM in the bachelor's programme, for instance, has led to new rules. Although the modules officially are classified as one course, students have to get at least a 5.5 for each sub-part. In other words, students cannot compensate a good physics mark with a low grade for mathematics or the other way around. If students fail one sub-part, they can repeat that particular component without having to repeat all parts. The BSA prescribes that three out of four modules have to be completed. The Board of Examiners decided that the BSA could also be positive if students have passed enough module components. The committee supports this decision.

Within TOM, the amount of group projects will most likely increase. The assessment committee asked the Board of Examiners how these group assignments will be assessed. The

Board of Examiners explained that their advice has not yet been asked, but that they are currently discussing their position. The committee finds it important that the Board of Examiners can guarantee that all students have achieved the learning objectives of each course. Therefore, the committee advises the Board to proactively pay special attention to the achieved learning outcomes of individual students who pass courses with a group project. The Board of Examiners does not actively check for fraud or plagiarism, but trusts the supervisors in charge to notice fraud when it occurs. The committee strongly recommends the Board of Examiners to actively and systematically check on fraud and plagiarism, for instance by using fraud detection software.

The assessment committee noticed that the percentage of graduates that obtain their diploma with the distinction 'cum laude' is high. In 2012, 18% of the bachelor's graduates acquired a 'cum laude' (on average 12% - the number has steadily gone up from 8% in 2007) versus 32% of the master's students (20% on average, gone up from 11% in 2007). Since a cum laude is usually reserved for the best 5-10% of students, the assessment committee regards these numbers as being (far) too high. The Board of Examiners was unaware of the exact numbers and told the committee that it agrees that the current numbers are too high.

The committee has looked at the working procedure of the Board of Examiners. The committee thinks it necessary for the Board of Examiners to adopt a more pro-active role. According to the committee, the Board should for example formulate an opinion on the assessment of group work and the maximum amount of students obtaining their diploma with distinction. Also, the Board should actively and systematically check on fraud and plagiarism.

Assessment forms
Both the bachelor and master's programme make use of various assessment forms. Most courses are concluded with a final written exam at the end of the course, but oral presentations and writing assignments are also used, as well as practical training with individual and group assignments, project reports and poster presentations. The committee has seen course exams of both programmes and concludes that they are of a high level. The committee was also impressed with the model answers provided in test matrices. It concludes that the various assessment forms tie in well with the intended learning outcomes.

Assessment procedure of bachelor and master´s research project
The bachelor and master's research project (especially the latter) form a considerable part of both programmes and determine whether or not students have acquired the intended learning outcomes. Consequently, the assessment committee has paid special attention to the assessment procedures of these conclusive assignments. The *bachelor research project* is often carried out in groups of two students. The students either choose an assignment put forward by one of the departments' research groups, or they formulate their own research project within one of those groups. The research project culminates in a written report and an oral presentation. The final assessment is done by a Bachelor Assignment Committee, consisting of the chair holder or associated professor of the research group where the project was carried out, a bachelor assignment coordinator and the daily supervisor. A bachelor assignment protocol shows which aspects are assessed and how much they weigh: literature study & positioning of the research (15%), research process (20%), research qualities (40%), report (15%), and presentation/discussion (10%). The three assessors fill in one assessment form together.

The *master research project* starts with students formulating a project proposal (signed by the supervisor in charge) for approval by the Board of Examiners. The master assignment is usually carried out at one of the faculty's research groups. If students wish to perform the assignment externally, they need permission from the Board of Examiners. The master research project is concluded with a written report and an oral presentation, both in English and addressed to an academic audience. The project is assessed by a Master Assignment Committee, consisting of the chair holder of the research group involved, the direct supervisor and an independent staff member from another chair. Sometimes (for instance, when the assignment was carried out externally), a fourth expert member is added to the committee. The examiners reach a consensus for two marks, one for the scientific contents and one for report, presentation and other academic skills.

The assessment committee asked the Board of Examiners how it can guarantee that the research projects are assessed independently, or, in other words, that students have indeed achieved the intended learning outcomes. The committee pointed out that the former committee has already raised objections against students performing their bachelor's projects together. The Board of Examiners is of the opinion that the assessors usually are able to make a distinction between two individual students. The committee finds this questionable. It believes that it is hard to make out from a written report if both students have contributed equally and thus have achieved the indended learning outcomes individually at a satisfactory level. The committee advises the programme to adopt the rule that the research reports be written individually.

The committee discussed the assessment procedure of the Bachelor and Master Assignment Committee with teaching staff, Board of Examiners and management. It learned that the assessment forms are filled in together, and that the presence of an independent staff member should assure an independent vote. One of the lecturers mentioned that he fills in his assessment form before and during the end presentation, so as to ensure that he is not influenced too much by the other judgements of the other assessors. The committee considers this to be a good practice, and suggests to systematically adopt this method for assessing the bachelor and master theses.

The assessment form for the bachelor research project is more elaborate than that of the master research project. The committee advises the master's programme to adopt a similar assessment form to that of the bachelor's project, so that students can have a better understanding of how the two final grades were arrived at. Further improvement in transparency could be achieved if examiners would write down a short motivation for their assessment on each assessment form. To conclude, the committee advises the programme management and the Board of Examiners to make sure that lecturers are aware of the importance of filling in the forms properly.

3.2 Achieved learning outcomes

The assessment committee has read a number of bachelor and master project reports in order to check whether students have achieved the intended learning outcomes. It concludes that the bachelors' theses show that graduates have achieved a respectably high level. The committee was especially impressed with a single bachelor's research project, performed at the NIKHEF and containing mathematics of an astonishingly high level. It judges that this thesis was deservedly marked with a 10. The committee marked most bachelor theses not far of the grades that these reports were given.

The committee considered the master research reports to be of a similar high level. Here also, the committee came across theses of an impressively high level that were righteously marked with a 9 or higher. Still, the committee also would have marked some master theses (considerably) lower. This tendency to grade the reports high, the committee expects, might be the result of the current cum laude policy which results in an unrealistic 32% of students obtaining this distinction. However, because assessment forms were often missing, the committee found it hard to see how the grades had been arrived at.

In general, the academic level of the theses matched or surpassed the level that may be expected of a bachelor or master's thesis at academic level.

From studying the information provided in the critical reflection and from talking to the graduates selected for an interview, the committee concludes that graduates have no trouble finding a job, most often in research. Almost all bachelor graduates (96%) enrolled in a master's programme offered by the University of Twente (of which 82% started in the master's programme Applied Physics). Of the master graduates 40% carried on in a PhD-track, 30% started working in an industrial company, 12% at a research institute, 6% in engineering or consultancy and 2% in government or education. The committee concludes that this convincingly shows that graduates have achieved the intended learning outcomes.

Considerations

The committee concludes that the system of testing and assessment is adequate. Students are well informed about assessment procedures. Assessment forms in both programmes match the learning outcomes of the courses and those of the programmes. The committee considered exams in both programmes to be of a high standard. It was also impressed with the fact that for each exam there are test matrices available containing, for instance, model answers.

The Board of Examiners in general adequately controls the system of testing and assessment and the achieved learning outcomes. Yet, the Board should adopt a more pro-active role. It should for example actively and systematically check for fraud and plagiarism and should have monitored the percentage of cum laude graduations. Also, the committee expects the Board to have a more articulate opinion on the assessment of group work in the bachelor's programme and to develop methods to check whether each individual student achieves the learning outcomes at a satisfactory level.

The introduction of a new assessment form for the bachelor's research project in September 2013 has led to more clarity on the weighting of the elements the final grade is based on. It would be preferable, the committee concludes, if a similar form was adopted for the master research project. Ideally, this form should still contain the necessary room for setting out the foundations for the assessment. In addition, the programme management and the Board of Examiners should stress the importance of filling in the forms properly.

To assess the level achieved by the students, the committee examined a range of bachelor and master theses. In general, it agrees with the marks that have been given and concludes that the level of the theses matches and surpasses the level that may be expected of a graduate of an academic bachelor's and master's degree programme in physics.

Conclusion

Bachelor's programme Technische Natuurkunde: the committee assesses Standard 3 as 'satisfactory'.
Master's programme Applied Physics: the committee assesses Standard 3 as 'satisfactory'.

General conclusion

In the committee's judgement, both the bachelor's degree programme Technische Natuurkunde and the master's degree programme Applied Physics at University of Twente fulfill the criteria for accreditation. It has noted many positive aspects and suggested several points for improvement. Weighing up those points and the individual assessment of each standard, the committee concludes that both programmes 'meet the current generic quality standards and show an acceptable level across its entire spectrum' and consequently can be assessed as 'satisfactory'.

Conclusion

The committee assesses the *bachelor's programme Technische Natuurkunde* as 'satisfactory'.
The committee assesses the *master's programme Applied Physics* as 'satisfactory'.

Appendices

Appendix 1: Curricula vitae of the members of the assessment committee

Prof. dr. D. (Daan) Lenstra studied Physics at the University of Groningen and got his PhD at the Delft University of Technology on the subject 'Polarization effects in gas lasers'. Since 1979 his research focuses on the broad area of quantum electronics. He was professor at the VU University Amsterdam from 1991-2006. Between 2000 and 2006 he was also professor at Eindhoven University of Technology. From 2004-2006 he was scientific director of the COBRA Research Institute. From November 2006 until his retirement in 2010 he was dean of the Faculty Electrical Engineering, Mathematics and Computer Sciences at Delft University of Technology. Since 2012 he is honorary advisor for the Faculty Electrical Engineering of Eindhoven University of Technology.

Prof. dr. W. (Wim) de Boer from the Karlsruhe Institute of Technology is a leading expert in the fields of particle - and astroparticle physics. His main interest focuses on the search for the elusive dark matter, which makes up more than 80% of the matter in the universe, but its nature is unknown. Prof. De Boer participates in the search for dark matter using the CMS detector at the Large Hadron Collider (LHC) at the European Particle Physics Laboratory CERN in Geneva and the AMS-02 detector on the International Space Station. He also contributed to the phenomenology of Supersymmetry by showing that Supersymmetry can lead to a Grand Unified Theory with a perfect candidate for a dark matter particle. Prof. De Boer received his PhD at Delft University of Technology in 1974. Since 2009, he is member of the Advisory Committee IMAPP, Radboud University Nijmegen.

Prof. dr. J.F. (Friso) van der Veen is Full Professor of Experimental Physics at the ETH-Zürich, where he was appointed in 2000. Since 2002, he is also Head of the Research Department of Synchrotron Radiation and Nanotechnology at the Paul Scherrer Institut in Villigen. Van der Veen studied Physics at Utrecht University where he also finished his PhD (cum laude) in 1978. He has worked as Technical Director at the FOM-Institute for Atomic and Molecular Physics, Amsterdam (1990-1996) and has been Professor of Surface Physics at University of Leiden (1987-1992) and Professor of Technical Physics (1992-1997) and Experimental Physics (1997-2000) at the University of Amsterdam. In 2005, Van der Veen was elected as Corresponding Member of the Royal Academy of Sciences of The Netherlands. He has supervised 31 PhD-dissertations and was (co)author of over 240 research papers.

Dr ir. H.L. (Harald) Tepper studied Chemical Technology at the University of Twente and in 2001 got his PhD in 'computational physics' at the same university. From 2002 until 2007, Tepper was postdoctoral researcher at the University of Utah (USA), and VENI-researcher at the AMOLF Institute in Amsterdam. Since 2007 he has worked in industry. He was management consult at the consultancy firm McKinsey & Company, where he worked, among other things, at large scale change processes, audits and benchmarking of organizations, and the strategy of an academic business school. Since September 2013 he works as Chief Strategy Officer at the Netherlands Forensic Institute. During his studies, he also obtained a diploma as teaching musician (clarinet) at the conservatoire. Tepper was co-founder and chairman of 'De Nationale DenkTank', a foundation which adds a multidisciplinary experience to the curricula for students and PhD students.

C. (Christianne) Vink MSc is didactic coach, educational advisor/trainer and partner at Academic Factory. She studied Psychology at VU University Amsterdam, where she graduated in 2009. From 1999 until 2006, she was a lecturer in refresher courses for (para)medic personnel. From 2010 until 2013, she was a lecturer at the at the University of

Amsterdam Faculty of Science. Vink is specialized in teaching and in developing academic programmes designed to ensure training in 'critical reflection'. Vink is involved as assessor in multiple 'BKO'-trajectories and is well experienced in curriculum assessments of academic programmes. Together with a colleague Vink works on a book on the design of interdisciplinary curricula, forthcoming summer 2014.

L. (Lisanne) Coenen BSc graduated from the bachelor's programme Applied Physics at Delft University of Technology in 2013. At the same time, she finished her pre master Philosophy of Natural Sciences at Leiden University. Since September 2013, she follows the master's programme Applied Physics (track 'Quantumnanoscience'), also at Delft University of Technology. Additionally, she follows the master's programme Philosophy of Natural Sciences at Leiden University. During her bachelor's programme, she was a board member of the student union for Applied Phyiscs in Delft and in 2012 she was a member of the Programme Committee for Applied Physics.

Appendix 2: Domain-specific framework of reference

The goal of a university programme is to prepare students for an independent practise of the profession of the relevant discipline, and to give them the ability to apply the knowledge and skills they have acquired. Dutch university programmes in the domain of (applied) physics and astronomy are required to reach a level which allows the graduate to be competitive in the international research or job market, in particular with respect to countries which have a high profile in these areas. The domain-specific reference frame is meant to be a gauge for reaching this goal.

The framework is based on the one used in the Teaching Programme Assessment (Onderwijsvisitatie) of 2007. The basis for that framework was derived from the qualifications as formulated in the document '*Reference points for the design and delivery of degree programmes in physics',* which was a product of the so-called *Tuning Project*. The frame of reference to be presented below has been updated by also making use of the more recent '*A European Specification for Physics Master Studies'* of the European Physical Society (2009). The descriptors for the programmes have been formulated in terms of competences acquired by the graduating student, which leads to specific requirements for the curriculum. Programmes with the same name at different (Dutch) universities will in general not be identical. Different specialisations in the research staff or focus on particular subjects leads to differences in the eligible part of the programmes, and there is a structural difference between (the goals of) general universities and universities of technology. As a consequence, there are different ways to comply with the requirements of the reference frame. It is essential, however, that the local choices for, and colouring of the programme fits the internationally accepted standards.

Programme descriptors
Very similar to the BSc programmes, the descriptors for the MSc programmes can be described with three types of competences, as is done below. The sequence within each category is, with few exceptions, taken from what is called the 'Rating of Importance Order' in the Tuning document. The basic difference with the descriptors for the BSc programmes is the different emphasis. While a BSc programme aims at including some aspects of the forefront of knowledge, an MSc programme aims at providing a basis (or opportunity) for originality.

<u>(a) Discipline-related cognitive competences.</u>

	Specific competence	**Description. On completion of the degree course, the student should**
1	Modelling skills	be able to identify the essentials of a process/situation and to set up a working model of the same; be able to perform the required approximations; i.e. critical thinking to construct physical models
2	Problem solving skills	be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems
3	Knowledge and understanding of Physics	have a good understanding of the important physical theories (logical and mathematical structure, experimental support, physical phenomena described);
4	Familiarity with basic and applied research	acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results

5	Frontier research	have a good knowledge of the state of the art in (at least) one of the presently active physics specialties
6	Human / professional skills	be able to develop a personal sense of responsibility, given the free choice of elective/optional courses; be able to gain professional flexibility through the wide spectrum of scientific techniques offered in the curriculum
7	Physics culture	be familiar with the most important areas of physics and with those approaches, which span many areas in physics.
8	Absolute standards	have become familiar with highly regarded research in the field with respect to physical discoveries and theories, thus developing an awareness of the highest standards

(b) Discipline-related practical skills.

	Specific competence	**Description. On completion of the degree course, the student should**
9	Mathematical skills	be able to understand and master the use of the most commonly used mathematical and numerical methods
10	Computer skills	be able to perform calculations independently, even when a small PC or a large computer is needed, including the development of software programmes
11	Experimental skills	have become familiar with most important experimental methods and be able to perform experiments independently, as well as to describe, analyse and critically evaluate experimental data; and to be able to scientifically report the findings

(c) Discipline-related generic competences.

	Specific competence	**Description. On completion of the degree course, the student should**
12	Literature search	be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development; have good knowledge of technical English.
13	Learning ability	be able to enter new fields through independent study
14	Ethical behaviour (relevant to physics)	be able to understand the socially related problems that confront the profession, and to comprehend the ethical characteristics of research and of the professional activity in physics and its responsibility to protect public health and the environment
15	Specific communication skills	be able to listen carefully and to present difficult ideas and complex information in a clear and concise manner to professional as well as to lay audiences; be able to work in an interdisciplinary team.
16	Managing skills	be able to work with a high degree of autonomy, even accepting responsibility in (project) planning, and in the managing of structures.
17	Updating skills	enjoy the ability to remain informed of new developments and methods, and be able to provide professional advice on their possible impact or range of applications.
18	Foreign language skills	be able to gain command of foreign languages through, usually elective, participation in courses taught in foreign language.

Note that in the generic competences in particular, learning ability and managing and updating skills receive more attention than in the description for the BSc programmes.

2. Programme

The variation in MSc programmes within the domains of Physics, Applied Physics, or Astronomy can be substantial. A general requirement is that the programme aims at teaching the student how to practice their profession in an independent manner. Central to the programme is therefore the individual research assignment, in which the student becomes acquainted with the daily research practice at a frontier of science. Similar requirements apply to Applied Physics programmes, with the understanding that the individual assignment can have a more applied character, and that a project can also have a focus on design. In all cases, the graduation assignment should preferentially be performed within a research group, and the student should be able to function as a fully-fledged member of the group. This requires a workplace which allows daily (social) contacts, and regular exchange of ideas, questions and thoughts with colleagues. This ensures the acquisition of a broad range of research skills.

These days, it is almost inevitable that physicists and astronomers operate in an international setting. The required level of the programme can therefore be indicated by referring to the exchange of information as occurs at scientific conferences and in scientific journals. The graduation work, delivered in the form of a thesis, should therefore link to that level. It should enable the student to enter the international market in a credible way, and research performed during the Master should regularly lead to, or be part of, a scientific publication. Apart from that, the research also has to be presented in oral manner.

In view of their future practicing of a profession, it is important that students learn to work with time constraints. The traditionally large freedom which Dutch students had and partly still have, can easily lead to the neglect of this aspect in study programmes. As this freedom is currently becoming less, it is the more important that the programmed safeguards and stimulates the progress of the student. Time management should be an explicit part of elements of the programme, in particular for a research project or an internship.

Apart from the research practice, the student should deepen his/her knowledge of physics by studying more specialised subjects, often through formal lecture series or study groups. Study programmes will probably want to offer a common core, but much of the direction for study will be furnished by the local research specialisations, and can therefore by quite different in focus.

An increasingly important facet of a disciplinary Master programme is that it can be combined with a different specialization in order to broaden the scope of professions which are open to the graduated student. Prime examples are specializations in the direction of education (leading to the profession of high school teacher, among others), science communication, or science-based business. In the latter case, study elements aiming more specifically at management or governance may be important. It can be expected from a programme that it allows students to orient themselves on the possibilities and ways to match their talents and interests with the job market. In the current Dutch system of a 2-year (120 EC) programme, the minimal requirement for a master's degree in Physics, Applied Physics or Astronomy is deemed to be one year of disciplinary studies. This leaves up to a year for such other specializations.

Appendix 3: Intended learning outcomes

Bachelor's programme Technische Natuurkunde:

To describe the academic level, the three technological universities in the Netherlands have developed criteria for academic bachelor's and master's degree curricula (3TU-Academic Criteria[1]), also called ACQA criteria, based on the Dublin descriptors. These criteria have been approved by the NVAO. The characterisation of a university graduate distinguishes seven areas of competence. He or she

1. is competent in one or more scientific disciplines
2. is competent in doing research
3. is competent in designing
4. has a scientific approach
5. possesses some basic intellectual skills
6. is competent in cooperating and communicating
7. takes the temporal and social context into account

The competence areas are elaborated on in the various competences. For each competence, it is indicated whether its emphasis is on knowledge (k), skills (s) or attitude (a).

The Applied Physics bachelor graduate:

1. **understands the basics of and has some skills in the field of applied physics.**
   A APh bachelor graduate is (1) familiar with the basics of existing scientific knowledge and has some skills to increase and develop this through study [a, b, e, f], and
   (2) has developed basic experimental skills [c, d].

   a. Understands the knowledge base and the structure of the relevant fields in applied physics:
      - physics: thermodynamics, electricity and magnetism, quantum mechanics....
      - applied physics: systems and signal processing, fluid mechanics, ...
      - the supporting disciplines: applied mathematics and applied computer science. The BSc-APh understands the relevant key-concepts, theories, methods, and techniques. [ks]

   b. Understands the structure of these relevant fields, and the connections between sub-fields. [ks]
   c. Has knowledge of and some skill in the way in which the following activities take place in applied physics: [ks]
      - truth-finding and the development of theories and models
      - interpretations of texts, problems, data, and results,
      - experiments, gathering of data and modelling,
      - decision-making based on data and modelling.

   d. Has some experimental skills in the relevant fields [ks]:
   e. physics: electricity and magnetism, solid state physics applied physics: systems and signal processing, fluid mechanics, optics …

[1] A.W.M. Meijers, C.W.A.M. van Overveld, J.C. Perrenet, Criteria for Academic Bachelor's and Master's Curricula, TU/e 2005 (also available via http://www.jointquality.org/ descriptors special descriptors).

f. Is aware of both the presuppositions of the standard methods and their importance. [ksa]
g. Is able (with supervision) to reflect on his/her own knowledge, and to revise and extend knowledge through study. [ksa]

2.	**has the basic knowledge and skills for doing research in the field of applied physics**. A bachelor graduate APh can, under supervision of a senior researcher, contribute to increasing scientific knowledge.

a. Is aware of the research methodology in the field of applied physics [ksa]
b. Is, under supervision, able to do research at bachelor's level:
   - analyse research problems in the field of applied physics with a limited complexity,
   - use the relevant knowledge base,
   - formulate the research objectives and, if relevant, the appropriate hypothesis,
   - formulate a research plan including the required theoretical and experimental steps, assumptions and approaches,
   - execute the different activities of the research plan,
   - analyse and evaluate the research results in respect to the defined problem,
   - assess research results on its usefulness,
   - defend this results against the parties involved. [ksa]
c. Is observant, and has the creativity and the capacity to discover certain connections and new viewpoints. [ksa]
d. Is able to work at different levels of abstraction and detail. [ks]
e. Is able to recognise, systematically collect, analyse, select and process relevant scientific information [ks]
f. Understands, where necessary, the importance of other disciplines (interdisciplinarity). [ka]
g. Is aware of the changeability of the research process through external circumstances or advancing insight. [ka]
h. Is, under supervision, able to contribute to the development of scientific knowledge in one or more areas of the disciplines involved in applied physics. [ks]

3	**has the basic skills for designing a product or process in the field of applied physics.** A bachelor graduate APh is familiar with the steps of the design process and able to carry them out in a not-complex situation.

a. Is aware of the design methodology in the field of applied physics and is aware of design being a cyclic process. [ksa]
b. Is, under supervision, able to design at bachelor's level:
   a. analyse design problems in the field of applied physics with a limited complexity,
   b. integrate the relevant knowledge base in a design,
   c. formulate the design requirements, objectives and boundaries, taking into account some safety, sustainability, environmental and economic aspects,
   d. formulate and execute the different activities of the design plan,
   e. defend the results against the parties involved. [ksa]
c. Is able to integrate existing knowledge in a design. [ks]

d. Is able to systematically collect, analyse, select and process relevant design information from literature, patents, databases and web-sites and is able to estimate lacking information [ks]
e. Has creativity and synthetic skills with respect to design problems. [ksa]
f. Is able to work at different levels of abstraction and detail including the system design level. [ks]
g. Is aware of the changeability of the design process through external circumstances or advancing insight. [ka]
h. Understands the importance of other disciplines (interdisciplinarity) and their contribution to the design process. [ks]

4	**has knowledge of a scientific approach.** A bachelor graduate APh has a systematic approach characterised by the use of theories, models and coherent interpretations.

a. Is inquisitive and has an attitude of lifelong learning. [ka]
b. Has a systematic approach characterised by the application of theories, models and coherent interpretations. [ksa]
c. Has the knowledge and the skill to justify and use models for research and design and assess their value (‘model’ is understood broadly: from mathematical model to scale-model). [ks] Is able to adapt models for his/her own use. [ks]
d. Has the ICT skills to process data and models.
e. Has insight into the nature of sciences and technology (purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity etc.) [k]
f. Has some insight into scientific practice (research system, relation with clients, publication system, importance of integrity etc.) [k]
g. Is able to document adequately the results of research and design. [ksa]

5	**possesses some basic intellectual skills such as reasoning, reflecting and forming a judgment.** A bachelor graduate APh has some skills in reasoning, reflecting, and forming a judgment.

a. Is able (with supervision) to reflect critically on his/her own thinking, decision making and acting, and able to adjust his/her behaviour on the basis of this reflection. [ks]
b. Is able to reflect on his/her more strong and weak capabilities with regard to his/her role as researcher, designer, organiser, and teacher/advisor and is able to adjust on the basis of this reflection. [ks]
c. Is able to reason logically and apply methods of reasoning. [ks]
d. Is able to ask adequate questions, and has a critical yet constructive attitude towards analyzing and solving simple problems in applied physics. [ks]
e. Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data or uncertainty. [ks]
f. Is able to take a standpoint with regard to a scientific argument in applied physics. [ksa]
g. Possesses basic numerical skills and has an understanding of orders of magnitude. [ks]

6	**is able to cooperate and communicate.** A bachelor graduate APh is able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and other stakeholders.

a. Is able to communicate in writing (lab journal, research and design report, poster), and verbally in Dutch (scientific presentation) about the results of learning, thinking and decision-making with colleagues, non-colleagues and managers. [ks]
b. Is able to interpret English written scientific literature and textbooks and to understand discussions and scientific debates in English. [s]
c. Is characterised by professional behaviour. This includes: reliability, commitment, accuracy, perseverance and independence as well as respect for others irrespective of their age, social economic status, education, culture, philosophy of live, gender, race or sexual nature. [ksa]
d. Is able to perform project-based work: is pragmatic and has a sense of responsibility; is able to deal with limited sources; is able to deal with risks, is able to make compromises. [ksa]
e. Is able to work and communicate within an interdisciplinary team. [ks]
f. Has insight into, and is able to deal with, team roles and social dynamics. [ks]

7	**is aware of the social, environmental, sustainability and safety context.** A bachelor graduate APh is aware that beliefs and methods have origins and that decisions have social consequences in time.

a. Is aware of the social, environmental, sustainability and safety aspects of the physics and related industries. [ksa]
b. Has an eye for the different roles of applied physics professionals in society: researcher, designer, organiser, teacher/advisor. [ks]
c. Is able to analyze the place of applied physics in society and to discuss the social, environmental, sustainability and safety consequences of new developments in relevant fields with colleagues and non-colleagues. [ks]
d. Is able to analyze and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with applied physics colleagues and non-colleagues (in research, designing and applications). [ks]
e. Optional: is familiar with and has experience with the technological organisational processes of a applied physics company. [ksa]

Master's programme Applied Physics:

To describe the academic level, the three technological universities in the Netherlands have developed criteria for academic bachelor's and master's degree curricula (3TU-Academic Criteria[2]), also called ACQA criteria, based on the Dublin descriptors. These criteria have been approved by the NVAO. The characterisation of a university graduate distinguishes seven areas of competence. He or she

1. is competent in one or more scientific disciplines
2. is competent in doing research
3. is competent in designing
4. has a scientific approach
5. possesses basic intellectual skills
6. is competent in cooperating and communicating
7. takes account of the temporal and the social context

The competence areas are elaborated in the various competences. For each competence, it is indicated whether its emphasis is on knowledge (k), skills (s) or attitude (a).

The master graduate Applied Physics:

1. Is specialised in a specific field of applied physics.
A master graduate APh is familiar with existing scientific knowledge, and is able to increase and develop this through study.

1a. Has a thorough mastery of parts of the relevant fields extending of the forefront of knowledge of:
- (applied) physics,
- the underlying disciplines of fluid physics, materials physics, optics and biomedical physics
- and understands the relevant key-concepts, theories, methods, and techniques. [ks]

1b. Looks actively for structure and connections in these relevant fields. [ksa]

1c. Has knowledge, skill and attitude to apply:
- truth-finding and the development of theories and models,
- interpretations of texts, problems, data, and results,
- experiments, gathering of data and modelling,
- decision-making based on data and modelling,
- independently in the context of more advanced ideas or applications in applied physics. [ksa]

1d. Has extended experimental skills of parts of the relevant fields. [ksa]

1e. Has the ICT skills to process text, data and models. [ksa]

1f. Is able to reflect on standard methods and their presuppositions; is able to question these; is able to propose adjustments, and to estimate their implications. [ksa]

1g. Is able to spot gaps in his/her own knowledge, and to revise and extend knowledge through study. [ksa]

2 A.W.M. Meijers, C.W.A.M. van Overveld, J.C. Perrenet, Criteria for Academic Bachelor's and Master's Curricula, TU/e 2005 (also available via http://www.jointquality.org/ descriptors special descriptors).

2. Has the knowledge and the skills for doing research in a specific field of applied physics.
A master graduate APh is able to acquire new scientific knowledge through research. For this purpose, research means: the development of new knowledge and new insights in a purposeful and methodical way.

2a. Is aware of the research methodology of complex nature in the field of applied physics [ksa]
2b. Is, independently, able to do research at a master's level:
- analyse research problems in the field of applied physics of more complex nature,
- use the relevant knowledge base,
- formulate the research objectives and, if relevant, the appropriate hypothesis,
- formulate a research plan including the required theoretical and experimental steps, assumptions and approaches,
- execute the different activities of the research plan,
- analyse and evaluate the research results in respect to the defined problem,
- assess research results on its scientific value,
- defend this results against the parties involved. [ksa]

2c. Is observant, and has the creativity and the capacity to discover certain connections and new viewpoints and is able to put these viewpoints into practice for new applications. [ksa]
2d. Is able to work at different levels of abstraction and detail. Given the process stage of the research
problem, chooses the appropriate level of abstraction. [ks]
2e. Is able to recognise, systematically collect, analyse and process relevant scientific information [ks]
2f. Is able, and has the attitude to, where necessary, draw upon other disciplines in his or her own research. [ksa]
2g. Is able to deal with the changeability of the research process through external circumstances or advancing insight. Is able to steer the process on the basis of this. [ksa]
2h. Is, independently, able to contribute to the development of scientific knowledge in one or more areas of the disciplines involved in applied physics. [ks]

3. Some have extended skills for designing in a specific field of applied physics.
As well as carrying out research, some master graduates APh will also carry out design work. Designing is a synthetic activity aimed at the realisation of new or modified artefacts or systems with the intention of creating value in accordance with predefined requirements and desires towards products and processes (safety, economics, environment etc.).

3a. Is aware of the design methodology of complex nature in the field of applied physics and is aware of design being a cyclic process [ksa]
3b. Is, independently, able to design at master's level:
- analyse product and process design problems in the field of applied physics of more complex nature,
- integrate the relevant knowledge base in a design,
- formulate the design requirements, objectives and boundaries and describe and translate these requirements in quantitative engineering parameters,
- formulate a design plan including the required global and detailed steps, assumptions and approaches,
- execute the different activities of the design plan,
- analyse and evaluate the design and design decisions in a systematic manner in respect to the defined requirements,

- make a technical analysis of the chosen design,
- defend this results against the parties involved. [ksa]

3c. Is able to systematically collect, analyse and process relevant design information from literature, patents, databases and web-sites and is able to estimate leaking information [ks]

3d. Has creativity and synthetic skills with respect to design problems. [ksa]

3e. Is able to deal with the changeability of the design process through external circumstances or advancing insight. Is able to steer the process on the basis of this. [ksa]

3f. Is able, and has the attitude, where necessary, to draw upon other disciplines in his or her own design. [ksa]

3g. Is able to formulate new research questions on the basis of a design problem. [ks]

4. Has a scientific approach.
A master graduate APh has a systematic approach characterised by the development and use of theories, models and coherent interpretations, has a critical attitude, and has insight into the nature of applied physics.

4a. Is able to identify and take part in relevant developments. [ksa]

4b. Is able to critically examine existing theories, models or interpretations in the area of his or her graduation subject. [ksa]

4c. Has great skill in, and affinity with the use, development and validation of models; is able consciously to choose between modelling techniques. [ksa]

4d. Has insight into the nature of sciences and technology (purpose, methods, differences and similarities between scientific fields, nature of laws, theories, explanations, role of the experiment, objectivity etc.) and has knowledge of current debates about this. [k]

4e. Has some insight into scientific practice (research system, relation with clients, publication system, importance of integrity etc.) and has knowledge of current debates about this. [k]

4f. Is able to document adequately the results of research and design and is able to publish these results. [ksa]

5. Possesses intellectual skills
A master graduate APh has skills in reasoning, reflecting, and forming a judgment. These are skills which are learned, or sharpened, in the context of the chosen area of the APh discipline, and which are generically applicable from then on.

5a. Is, independently, able to reflect critically on his/her own thinking, decision making and acting, and able to adjust his/her behaviour on the basis of this reflection. [ks]

5b. Is able to reflect on his/her more strong and weak capabilities with regard to his/her research, design, organisation, and teaching/advising and is able to adjust on the basis of this reflection.

5c. Is able to:
recognise fallacies,
reason logically and apply methods of reasoning such as induction, deduction, analogy. [ks]

5d. Is able to ask adequate questions, and has a critical yet constructive attitude towards analyzing and solving complex problems in applied physics. [ks]

5e. Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data or uncertainty, taking account of the way in which that data came into being. [ks]

5f. Is able to take a standpoint with regard to a scientific argument in applied physics and is able to assess this critically as to its value. [ksa]

5g. Possesses basic numerical skills and has an understanding of orders of magnitude. [ks]

6. **Is able to cooperate and communicate with specialists in the chosen track and other stakeholders.**
A master graduate APh is able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and other stakeholders. He is also able to participate in a scientific or public debate in English.

- 6a. Is able to communicate in writing and verbally in English about research and solutions to problems with colleagues, non-colleagues and other involved parties. [ksa]
- 6b. Is able to interpret English written scientific literature and textbooks and to understand discussions and scientific debates in English. [s]
- 6c. Is familiar with professional behaviour. This includes: reliability, commitment, accuracy, perseverance and independence as well as respect for others irrespective of their age, social economic status, education, culture, philosophy of live, gender, race or sexual nature. [ksa]
- 6d. Is able to perform project-based work for complex projects: is pragmatic and has a sense of responsibility; is able to deal with limited sources; is able to deal with risks, is able to make compromises. [ksa]
- 6e. Is able to work within an interdisciplinary team with great disciplinary diversity. [ks]
- 6f. Has insight into, and is able to deal with, team roles and social dynamics and Is able to assume the role of team leader. [ks]

7. **is aware of the social, environmental, sustainaibility and safety context**
Has the ability to integrate insights in the temporal social, environmental, sustainability and safety context into his or her scientific work. Beliefs and methods have their origins; decisions have social consequences in time. A master graduate APh is aware of this, and has the ability to integrate these insights into his or her scientific work.

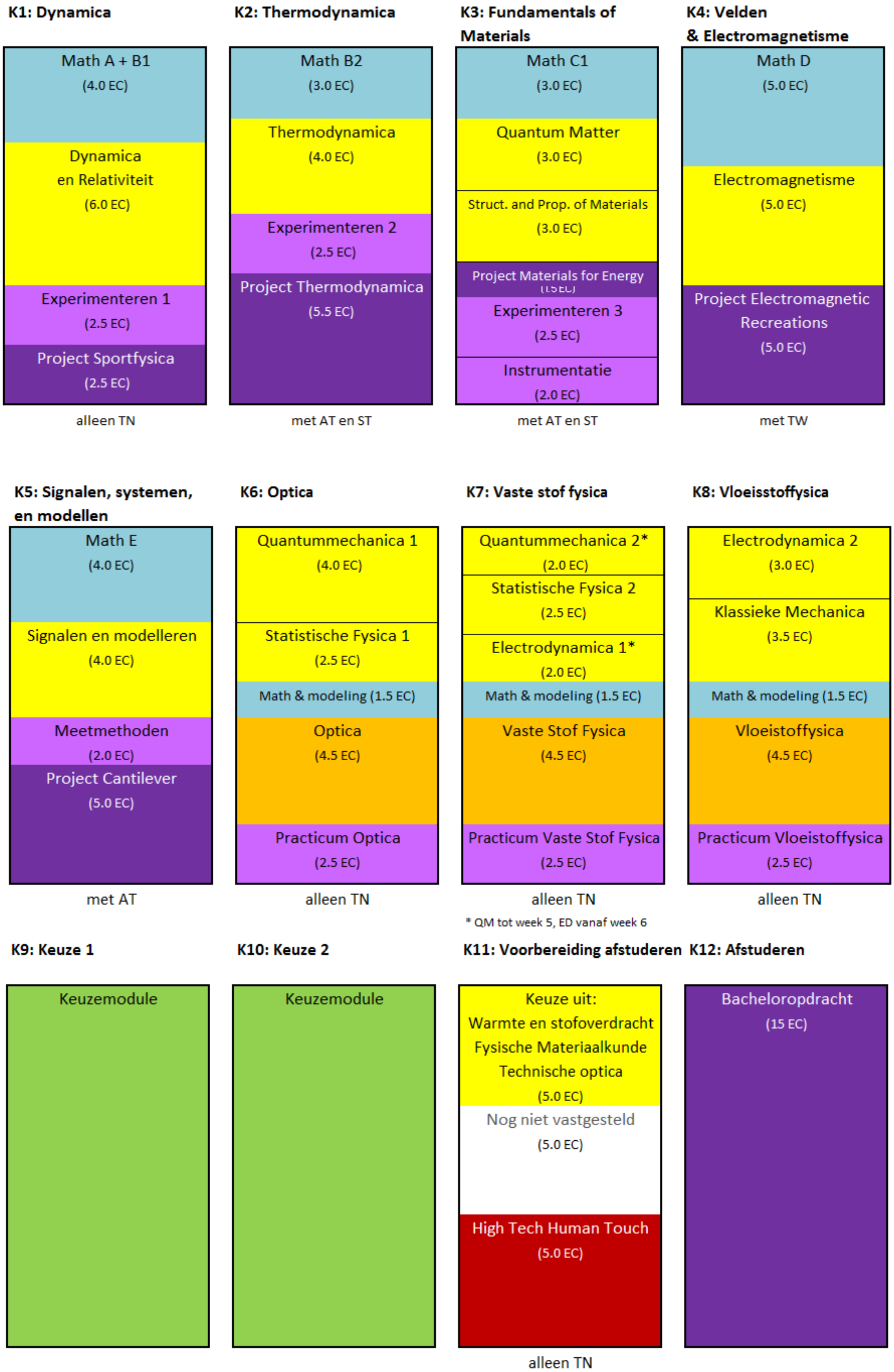
- 7a. Is aware of the social, environmental, sustainability and safety aspects of the physics and related industries. [ks]
- 7b. Has an eye for the different roles of applied physics professionals in society: researcher, designer, manager, advisor/teacher and chooses a professional position in society. [ksa]
- 7c. Is able to analyze the place of applied physics in society and to discuss the social, environmental, sustainability and safety consequences of new developments in relevant fields with colleagues and non-colleagues and integrates these consequences in scientific work. [ksa]
- 7d. Is able to analyze and to discuss the ethical and the normative aspects of the consequences and assumptions of scientific thinking and acting with applied physics colleagues and non-colleagues (in research, designing and applications) and integrates these ethical and normative aspects in scientific work. [ksa]
- 7e. Is familiar with and has experience with the technological organisational processes of a applied physics company. [ksa]

Appendix 4: Overview of the curricula

Bachelor's programme Technische Natuurkunde:

Year	Block	Subject	EC	Category
B1	1	Calculus I	5	mathematics and modelling
		Energy & entropy	5	basic physics
		Orientation science and technology	2.5	applications/project
		Experimental laboratory I	2.5	lab classes
	2	Calculus II	5	mathematics and modelling
		Dynamics	5	basic physics
		Orientation science and technology	2.5	applications/project
		Experimental laboratory I	2.5	lab classes
	3	Linear structures I	5	mathematics and modelling
		Electricity and magnetism	5	basic physics
		Experimental laboratory II	5	lab classes
	4	Quantum phenomena	5	basic physics
		Instrumentation	5	lab classes/project
		Prop.- project	5	applications/project
B2	1	Linear structures II	5	mathematics and modelling
		Introduction to optics	5	applied physics
		Dynamic modelling and simulation	5	mathematics and modelling
	2	Signals and transformations	5	mathematics and modelling
		Algorithms and programming	2.5	mathematics and modelling
		Statistical physics	5	basic physics
		Optics lab	2.5	lab classes/project
	3	Introduction quantum mechanics	5	basic physics
		Classical mechanics	5	basic physics
		Physics of fluids I	2.5	applied physics
		Physics of fluids lab	2.5	lab classes/project
	4	Electrodynamics	5	basic physics
		Physics of fluids II	2.5	applied physics
		Physical signal analysis	5	applied physics
		Computational physics	2.5	mathematics and modelling
B3	1	Introduction to solid state physics I	5	basic physics/lab classes/project
		Minor	10	minor
	2	Introduction to solid state physics II	2.5	basic physics/lab classes/project
		Instrumentation and computers lab	2.5	applied physics/project
		Minor	10	minor
	3	Optional and orientation courses	15	
	4	Bachelor assignment	15	bachelor assignment

New curriculum (after the introduction of the Twents Onderwijs Model):



Master's programme Applied Physics:

Fluid Physics **Chairs: Nanoionics (NI), Physics of Complex Fluids (PCF), Physics of Fluids (PoF)**				
Track courses				
Q1	193570010	Advanced Fluid Mechanics	5.0 EC	Track course NI, PCF, PoF
Q1	201300135	Soft and Biological Matter	5.0 EC	Track course NI, PCF
Q2	191551150	Numerical Techniques for PDE's	5.0 EC	Track course PoF
Q3	193565000	Capillarity Phenomena	5.0 EC	Track course NI, PCF, PoF
Q3	193580020	Experimental Techniques in Physics of Fluids	5.0 EC	Track course PoF
Q3	193400121	Nano-fluidics	5.0 EC	Track course NI, PCF
Chair courses				
Q1	193735060	Colloids and Interfaces	5.0 EC	Chair course PCF
Q2	193580010	Turbulence	5.0 EC	Chair course PoF
Q4	193580030	Granular Matter	5.0 EC	Chair course PoF
Q4	201300136	Physical Acoustics	5.0 EC	Chair course PoF
Q4	201300137	Ions and Devices	5.0 EC	Chair course NI
-	193565900	Capita Selecta PCF	5.0 EC	Chair course PCF
-	201100190	Capita Selecta NI	5.0 EC	Chair course NI

Materials Physics **Chairs: Computational Materials Science (CMS), Energy, Materials and Systems (EMS), Interfaces and Correlated Electron Systems (ICE), Physics of Interfaces and Nanomaterials (PIN), Quantum Transport in Matter(QTM)**				
Track courses				
Q1	193510040	Theoretical Solid State Physics	5.0 EC	Track course
Q1	193550020	Surfaces and Thin Layers	5.0 EC	Track course
Q3	193530010	Nanophysics	5.0 EC	Track course
Q3	193530020	Advanced Materials	5.0 EC	Track course
Chair courses				
Q2	193510020	Electronic Structure Theory 1	5.0 EC	Chair course CMS
Q2	193530000	Introduction to Superconductivity	5.0 EC	Chair course EMS/ICE/QTM
Q2	193550010	Surface Science	5.0 EC	Chair course PIN
Q3	201100146	Cryogenic Science and Technology	5.0 EC	Chair course EMS
Q4	193550000	Advanced Experimental Methods	5.0 EC	Chair course PIN
Q4	193510030	Electronic Structure Theory 2	5.0 EC	Chair course CMS
Q4	200900066	Introduction to Physics of Correlated Electrons	5.0 EC	Chair course ICE/QTM
Q4	193530030	Applications of superconductivity	5.0 EC	Chair course EMS

Optics and Biophysics **Chairs: Biological Electronic Structure (BES), Complex Photonic Systems(COPS), Laser Physics and Non-linear Optics (LPNO), Nanobiophysics (NBP), Optical Sciences(OS)**				
Track courses				
Q1	201300139	Laser Physics	5.0 EC	Track course
Q1	193515000	Quantum Optics	5.0 EC	Track course
Q3	201300141	Wave Optics	5.0 EC	Track course
Q3	201300142	Optics of Atoms, Molecules and Semiconductors	5.0 EC	Track course
Chair courses				
Q1	201300135	Soft and Biological Matter	5.0 EC	Chair course NBP
Q1	191411291	Applied Quantum Mechanics	5.0 EC	Chair course BES
Q2	193640020	Biophysical Techniques and Molecular Imaging	5.0 EC	Chair course NBP
Q2	193400131	Nano-optics	5.0 EC	Chair course OS
Q2	201100074	Nanophotonics	5.0 EC	Chair course COPS
Q2	193520030	Nonlinear Optics	5.0 EC	Chair course LPNO
Q4	201100075	Nanophotonic Experiments	5.0 EC	Chair course COPS
Q4	193520040	Experimental Laser Physics and Nonlinear Optics	5.0 EC	Chair course LPNO/OS
-	193570050	Advanced Quantum Mechanics	5.0 EC	Chair course BES

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

Bachelor's programme Technische Natuurkunde:

Intake:

	2006	2007	2008	2009	2010	2011	2012	2013	Mean
Total intake per October 1	57	54	40	51	43	58	57	70	54
Female	5	8	5	7	3	6	11	9	7
	9%	15%	13%	14%	7%	10%	19%	13%	13%
German	-	1	2	-	2	1	1	1	1
Double programme	2	2	-	3	-	2	2	2	2
From other WO	4	2	1	1	1	3	1	5	3
From HBO	-	-	-	3	1	-	1	-	1
Criterion group(1)	67%	67%	84%	80%	79%	75%	74%	85%	76%

(1) Criterion group is defined as students with an average VWO-grade for mathematics and physics of 7.0 or higher.

Cumulative dropout:

Cumulative dropout	2006	2007	2008	2009	2010	2011	2012	Cumulative dropout 2006-2012
after 1 year	40%	26%	13%	31%	30%	26%	39%	30%
after 2 years	46%	31%	20%	31%	30%	28%		32%
after 3 years	49%	37%	20%	33%	33%			36%
until now	53%	43%	28%	33%				39%
with P-diploma	2%	4%	0%	0%	0%			1%

Success rates:

Performances	all students	criterion group
P diploma ≤ 1 year	28%	37%
P diploma ≤ 2 years	48%	61%
P diploma final	60%	70%
BSc diploma ≤ 3 years of re-registrants	17%	19%
BSc diploma ≤ 4 years of re-registrants	47%	51%
BSc diploma ≤ 5 years of re-registrants	63%	69%
BSc diploma final of re-registrants	83%	88%

Percentages are averages over the period 2001-2010.

Master's programme Applied Physics:

Intake:

	2006	2007	2008	2009	2010	2011	2012	Average
Total intake	26	36	29	30	29	33	50	33
Female	4	5	6	4	3	4	7	5
	15%	14%	21%	13%	11%	12%	14%	14%
From BSc AP	26	32	22	24	16	29	39	81%
From other BSc	-	1	-	-	2	1	3	3%
From HBO	-	2	3	2	8	1	6	9%
International	-	1	4	4	2	2	2	6%

Succes rates:

Performances	mean over cohorts 2003-2010
MSc diploma ≤ 2 year	42%
MSc diploma ≤ 3 years	85%
MSc diploma final	97%

Teacher-student ratio achieved

Both programmes:

Year	Number of teaching FTEs	Number of registered BSc + MSc students	Number of students per teaching FTEs
December 2013	43 x 40% = 17,2 fte	262	15,2

Average amount of face-to-face instruction per stage of the study programme

Bachelor's programme Technische Natuurkunde:

Year	Scheduled hours							Minor	Bachelor Assignment	Contact hours (2)	Total number of hours
	Lectures	Tutorials	Combined Lect. & Tutor.	Lab courses	Projects	Supervised self-study	Exams (1)				
B1	175	200	25	150 (9%)	30 (2%)	50 (3%)	50 (3%)	-	-	680 (40%)	1680
	total: 400 (24%)										
B2	195	240	60	170 (10%)	35 (2%)	-	40 (2%)	-	-	740 (44%)	1680
	total: 495 (29%)										
B3	155	100	35	120 (7%)	30 (2%)	-	30 (2%)	420	560	470 (28%)	1680
	total: 290 (17%)										

(1) Excluding scheduled hours of re-exams
(2) Excluding minor and bachelor assignment in B3

The programme calculates the average amount of face-to-face instruction of the programme as a whole at 18 hours per week.

Master's programme Applied Physics:

		Scheduled hours					Total	Non-Scheduled Hours		Total
		Courses (50 EC)								
		Lectures	Tutorials	Lab projects	Projects	Exams (1)	Total course hours	Intership (120 EC)	MSc Assign. (50 EC)	Total hours
M1+M2	Hrs	200	100	35	15	45	1400	560	1400	3360
		395					1400	1960		3360
	%	14%	7%	3%	1%	3%	100%	17%	42%	100%
		28%						59%		100%

(1) Excluding scheduled hours of re-exams

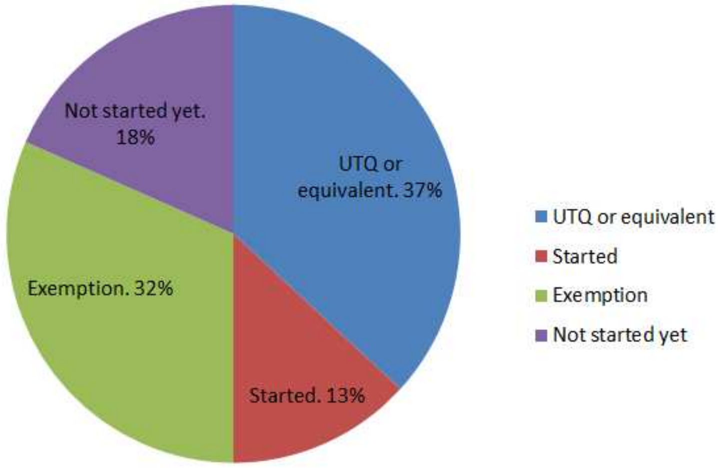
The programme calculates the average amount of face-to-face instruction of the programme as a whole at 12 hours per week.

Qualifications of the teaching staff:

<u>Percentage of PhD:</u>

Category	**Total**		**% PhD**	**Female**	
	No.	FTE		No.	FTE
Full professor	15	6,0	100%	2	0,8 (13%)
Professor (UHD+)	3	1,2	100%	1	0,4 (33%)
Associate professor (UHD)	12	4,8	100%	0	0 (0%)
Assistant professor (UD)	10	4.0	100%	3	1,2 (30%)
Other	3	1,2	33%	0	0 (0%)
Total	43	17,2		6	2,4 (14%)
Student assistants	24	1,3			

<u>Percentage of basic teaching qualification:</u>



UTQ or equivalent: Lecturers who have obtained their UTQ (University Teaching Qualifcation) or DUIT (Didactisch Universitair Inwerktraject Twente, precursor of UTQ)

Exemption: Lecturers with a appointment of more than 20 years at the University of Twente, or professors with an appointment of less than 8 hours a week ('deeltijdhoogleraren') are not obliged to enter the UTQ training

Started: Lectures who have started with their UTQ training

Not started yet: Lectures who have not started their UTQ training yet

Appendix 6: Programme of the site visit

Dag 1		
9.00	12.45	Voorbereidend overleg van de commissie + inzage documenten
12.45	13.45	Management Dr. ir. Ben Betlem (opleidingsdirecteur NT) Dr. ir. Martin Bennink (opleidingscoördinator NT) Dr. ir. Marloes Letteboer (opleidingsdirecteur TN/APh) Dr. Jeroen Verschuur (opleidingscoördinator TN/APh)
13.45	14.30	Studenten B Technische Natuurkunde Jorrit Bosma (B3) Max Busch (B2) Engbert Miedema (B1) Liesbeth Mulder (B2) Ton Nguyen (B3) Victoria Schermerhorn (B1)
14.30	15.00	Studenten M Applied Physics Carlijn van Emmerik Bram Hesselink* Jan Hofstés Julius de Hond Maurice Krielaart Viola Neumann
15.00	15.15	Pauze/intern overleg
15.15	16.15	Docenten Technische Natuurkunde/Applied Physics Prof. dr. ir. Marcel ter Brake Prof. dr. Klaus Böller Prof. dr. ir. Alexander Brinkman Dr. Michel Duits Prof. dr. Jennifer Herek Prof. dr. ir. Jacco Snoeijer
16.15	17.15	Spreekuur/intern overleg commissie
17.15	17.45	Studenten M Nanotechnologie Mathew Dilu Marleen Munsterman Francesca Rivello Mauricio Schmidt
17.45	18.15	Alumni Denise Leusink, MSc (Applied Physics) Daan Stam, MSc (Applied Physics) Verena Stimberg, MSc (NT, vooropleiding HBO-Chemie) Bart Kieviet, MSc (NT, vooropleiding BSc-TN)
19.00		Diner (alleen commissie)

Dag 2:		
9.00	9.30	Docenten M Nanotechnologie Drs. Patrick Bliek Dr. ir. Herman Offerhaus Prof. dr. ing. Guus Rijnders Prof. dr. ir. Wilfred van der Wiel Prof. dr. ir. Harold Zandvliet
9.30	10.15	Intern overleg commissie
10.15	11.00	Opleidingscommissies Dr. Stefan Kooij (TN/APh, voorzitter)

		Dr. ir. Herman Offerhaus (TN/APh) Robin Buijs (student TN/APh) Bob de Ronde (student TN/APh) Prof. dr. ir. Jurriaan Huskens (NT, voorzitter) Henk-Willem Veltkamp (student NT)
11.00	11.15	Intern overleg commissie
11.15	12.00	Examencie Technische Natuurkunde + studieadviseur Prof. dr. Willem Vos (voorzitter) Prof. dr. Paul Kelly Prof. dr. Devaraj van der Meer Prof. dr. Frieder Mugele Ir. Brigitte Tel (studieadviseur)
12.00	12.45	Examencie Nanotechnologie + studieadviseur Prof. dr. ir. Wilfred van der Wiel (voorzitter) Dr. Sonia Garcia Blanco Prof. dr. Frieder Mugele Dr. Peter Schön Ing. Rik Akse (studieadviseur)
12.45	14.15	Lunch, rondleiding, voorbereiding eindgesprek
14.15	15.00	Eindgesprek met management Prof. dr. ir. Hans Hilgenkamp (decaan a.i. TNW) Dr. ir. Ben Betlem (opleidingsdirecteur NT) Dr. ir. Martin Bennink (opleidingscoördinator NT) Dr. ir. Marloes Letteboer (opleidingsdirecteur TN/APh) Dr. ir Jeroen Verschuur (opleidingscoördinator TN/APh)
15.00	17.00	Opstellen bevindingen
17.00	17.30	Mondelinge rapportage

Appendix 7: Theses and documents studied by the committee

Prior to the site visit, the committee studied the theses of the students with the following student numbers:

Bachelor's programme Technische Natuurkunde:

0191957	0103004	1016938
1004581	1004549	1118064
1020943	1006266	1112279
1004433	1004441	0146099
1011480	0174777	1004492

Master's programme Applied Physics:

0067482	0170666	0072931
0096318	0113077	0191795
0217573	1086510	1240447
1075144	1259636	0165670
0151041	0149225	0174696

During the site visit, the committee studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment):

- Study material: books and syllabi, readers, study manuals;
- Minutes and reports of relevant committees (Programme Committee, Board of Examiners);
- Tests and assignments with the assessment criteria and standard answers;
- Summary and analysis of evaluation results;
- Regulations and manuals for internships and thesis;
- Information and documentation for students;
- Documents on the BKO programme;
- Alumni-surveys.

Furthermore, the committee has requested al available course materials for a selection of courses of the past academic year. The following courses have been selected:

Bachelor's programme Technische Natuurkunde:

Dynamica & Relativiteit	Module bachelor 1
Orientation Science and Technology	Bachelor 1
Introduction Quantum Mechanics	Bachelor 2
Instrumentation and Computers Lab	Bachelor 3

Master's programme Applied Physics:

Exp. Techniques in Physics of Fluids	track course Fluid Physics (Physics of Fluids)
Laser Physics	track course Optics and Biophysics
Theoretical Solid State Physics	track course Material Physics

Appendix 8: Declarations of independence

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: D. LENSTRA

PRIVÉ ADRES: HUIZERWEG 58
1261 AZ BLARICUM

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

DESKUNDIGE

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: UTRECHT DATUM: 8 oktober 2013

HANDTEKENING:

2

[redacted]

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Willem de Boer

PRIVÉ ADRES: Dekan-Hofheinz-Str. 26
D-76229 Karlsruhe

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

[redacted]

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Karlsruhe DATUM: 21. 11. 2013

HANDTEKENING:

2

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: J.F. VAN DER VEEN

PRIVÉ ADRES: SONNENBERGSTRASSE 47
5408 ENNETBADEN
ZWITSERLAND

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

TECHN NAT TU TWENTE

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: ENNETBADEN

DATUM: 19 dec 2013

HANDTEKENING:

2

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: H. L. Tepper

PRIVÉ ADRES: P/a Nederlands Forensisch Instituut
Laan van Ypenburg 6
2497 GB Den Haag

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Natuurkunde / Sterrenkunde

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Utrecht

DATUM: 8 oktober 2013

HANDTEKENING:

2

nvao
nederlands-vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Christianne R Vlik

PRIVÉ ADRES: Tumenstraat 33C
1076 VC
Amsterdam

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

nvao
nederlands - vlaamse accreditatieorganisatie

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Utrecht DATUM: 8-10-2013

HANDTEKENING:

2

Q436

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: Lisanne Coenen

PRIVÉ ADRES:

Stil Gezicht 9, 2612 RV Delft

IS ALS DESKUNDIGE / ~~SECRETARIS~~ GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Natuurkunde bij verschillende universiteiten

AANGEVRAAGD DOOR DE INSTELLING:

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Delft DATUM: 30/10/13

HANDTEKENING:

2

Qu36

nvao
nederlands - vlaamse accreditatieorganisatie

ONAFHANKELIJKHEIDS- EN GEHEIMHOUDINGSVERKLARING

INDIENEN VOORAFGAAND AAN DE OPLEIDINGSBEOORDELING

ONDERGETEKENDE

NAAM: John Corpraal

PRIVÉ ADRES: Weerenhof 8207
6536 CA, Nijmegen

IS ALS DESKUNDIGE / SECRETARIS GEVRAAGD VOOR HET BEOORDELEN VAN DE OPLEIDING:

Natuur- en Sterrenkunde (BA en MA)

AANGEVRAAGD DOOR DE INSTELLING:

Universiteit van Utrecht, Universiteit Twente,
Universiteit van Amsterdam, Vrije Universiteit Amsterdam

VERKLAART HIERBIJ GEEN (FAMILIE)RELATIES OF BANDEN MET BOVENGENOEMDE INSTELLING TE ONDERHOUDEN, ALS PRIVÉPERSOON, ONDERZOEKER / DOCENT, BEROEPSBEOEFENAAR OF ALS ADVISEUR, DIE EEN VOLSTREKT ONAFHANKELIJKE OORDEELSVORMING OVER DE KWALITEIT VAN DE OPLEIDING TEN POSITIEVE OF TEN NEGATIEVE ZOUDEN KUNNEN BEÏNVLOEDEN;

1

VERKLAART HIERBIJ ZODANIGE RELATIES OF BANDEN MET DE INSTELLING DE AFGELOPEN VIJF JAAR NIET GEHAD TE HEBBEN;

VERKLAART STRIKTE GEHEIMHOUDING TE BETRACHTEN VAN AL HETGEEN IN VERBAND MET DE BEOORDELING AAN HEM/HAAR BEKEND IS GEWORDEN EN WORDT, VOOR ZOVER DE OPLEIDING, DE INSTELLING OF DE NVAO HIER REDELIJKERWIJS AANSPRAAK OP KUNNEN MAKEN.

VERKLAART HIERBIJ OP DE HOOGTE TE ZIJN VAN DE NVAO GEDRAGSCODE.

PLAATS: Nijmegen DATUM: 28/1/'14

HANDTEKENING:

2