TEACHING AND EXAMINATION REGULATIONS

2019-2020

Appendix - Programme Specifics

MASTER OF SCIENCE
APPLIED PHYSICS

DELFT UNIVERSITY OF TECHNOLOGY

Administrative data

Nomenclature in CROHO	**MSc Applied Physics**
CROHO registration number	**60436**
Orientation and level of the programme	**Higher education, Academic Master level**
Number of credits	**120 ec, 2 years**
Mode(s) of study	**Fulltime**
Period of NVAO accreditation	**1 January 2015 till 1 July 2022**

THIS DOCUMENT

The implementation regulations in this document apply to the teaching and the examinations related to the Master's degree programme in Applied Physics. This document is part of the Teaching and Examination Regulations.

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Article 1 – Admission to the programme **(TER art. 3)**

Individuals holding one of the following degrees have access to the education of the Master's degree programme on the condition that all of the stated requirements have been met.

1. Students in possession of a Bachelor of Science degree in Applied Physics from 4TU or the Rijksuniversiteit Groningen will be admitted to the Master's programme.

2. Students who do not possess a degree mentioned in paragraph 1 are required to obtain proof of admission to the programme from the dean, who will seek the advice of the admissions officer on this matter.
   In order to obtain proof of admission, the student must meet or, as the case may be, possess:
   a. The general relevant criteria set by the executive board in the "Policy on fees and enrolment", laid down in Appendix 1 of the Student Charter, and clarified in Part 1.2 "Entrance and admission" of the mentioned Student Charter.
   b. A certificate, together with the accompanying list of marks, proving that he/she possesses knowledge of a sufficiently high level and broad scope to successfully complete the Master's programme within the allotted period of two years.

3. Students in possession of a Bachelor of Science degree in Physics (or equivalent in level and content) from a Dutch university will be admitted to the Master's programme, provided that they fulfil the following requirements:
   - BSc has been completed within at most five years;
   - Cumulative Grade Point Average ≥ 7.0.

4. Students in possession of a Bachelor of Science degree in Aerospace Engineering, Applied Earth Sciences, Applied Mathematics, Civil Engineering, Electrical Engineering, Marine Technology, Mechanical Engineering, Molecular Science and Technology, or Nanobiology from Delft University of Technology, admitted to and having passed the TU Delft Applied Physics bridging (minor) programme within the allotted period will be admitted to the Master's programme.
   Students will be admitted to the bridging programme, provided that they fulfil the following requirements:
   - Study delay at the time of admission to the bridging programme is limited to a maximum of 1 year;
   - Cumulative Grade Point Average ≥ 7.0.

5. Students in possession of a Bachelor degree in Applied Physics from a Dutch university of Applied Sciences (HBO), admitted to and having passed the TU Delft Applied Physics bridging (minor) programme within the allotted period will be admitted to the Master's programme.
   Students will be admitted to the bridging programme, provided that they fulfil the following requirements:
   - No delay of studies (without good reason);
   - Cumulative Grade Point Average ≥ 7.5;
   - The demands on the level of English language mentioned in the Student Charter.

   Notwithstanding the general relevant criteria set by the executive board, laid down in Part 1.2 "Entrance and admission" and appendix 1 "Policy on fees and enrolment" of the Student Charter, students holding a HBO Bachelor degree in Applied Physics are <u>not</u> obliged to do a preliminary exam 'VWO wiskunde B'.

6. Students in possession of a Bachelor of Science degree in (Applied) Physics or equivalent from a foreign university can be admitted to the Master's programme provided that they fulfil the following requirements:
   - No delay of studies (without good reason);
   - Cumulative Grade Point Average ≥ 7.5 (guideline, specific requirements concerning the CGPA apply to certain countries. These countries and their requirements are posted on the TU Delft website);
   - Average grade for core courses ≥ 7.5 (guideline, as above);
   - The demands on the level of English language mentioned in the Student Charter.

Article 2 – Goal of the programme **(TER art. 5.1)**

The programme is intended to educate students to earn a Master of Science degree in Applied Physics, providing them with a level of knowledge, insight and skills that enable them to perform independent professional and scientific activities in the area of Applied Physics at the level of a Master of Science.

Article 3 – The programme's final attainment levels (TER art. 5.2)

In addition to the general attainment levels described in article 5.2, MSc Applied Physics graduates should possess the following competences:

1. Mastery of Applied Physics at an advanced academic level. This means mastery of a choice of advanced general physics subjects (such as Quantum Mechanics, Statistical Physics, Electrodynamics, Continuum Physics) and the necessary mathematics, in addition to a choice of applied physics subjects (such as Quantum Electronics, Optics and Lasers, Fluid Dynamics, Reactor Physics) and optionally other advanced technical subjects (such as Computer Science, Materials Science, Chemistry, Life Sciences), as well as skills in the field of experimental techniques, data analysis, simulation and modelling. This knowledge and these skills should be mastered at a level comparable to that of Applied Physics programmes at international, top-quality, educational institutions.
2. In-depth knowledge of at least one area within Applied Physics, so that international research literature can be understood.
3. Thorough experience of research in (Applied) Physics and complete awareness of the applicability of research in technological developments.
4. Capable of understanding a wide variety of different problems and being able to formulate these at an abstract level, whilst being able to see the relation between diverse problems at this abstract level and to contribute creatively to their solution, focusing on practical applications.
5. Capable of creating innovative technical designs, taking feasibility issues into account.
6. Capable of working in a (possibly interdisciplinary) team of experts, performing the aforementioned activities and communicating easily in both written and spoken English.
7. Capable of carrying out a (research) project, including planning and time management. Working independently and taking initiatives where necessary.
8. Capable of making English language presentations of personal research activities to varied audiences. Capable of adapting to the background and interest of the audience.
9. Knowledge of technology-related developments in society, such as sustainability issues. Capable of developing and defending opinions in this area.

Article 4 – Structure of the programme (TER art. 6)

1. The Applied Physics programme is a two-year MSc programme and comprises 120 EC. The programme has a core-orientation structure. Within this structure, there is a choice of research tracks. The core programme comprises 90 EC and has the same structure for all students. Combining the core programme with a 30 EC orientation completes the programme.

2. **Tracks.** The tracks within the Applied Physics core programme are:
   - Physics for Energy,
   - Physics for Fluids Engineering,
   - Physics for Health and Life,
   - Physics for Instrumentation,
   - Physics for Quantum Devices and Quantum Computing.

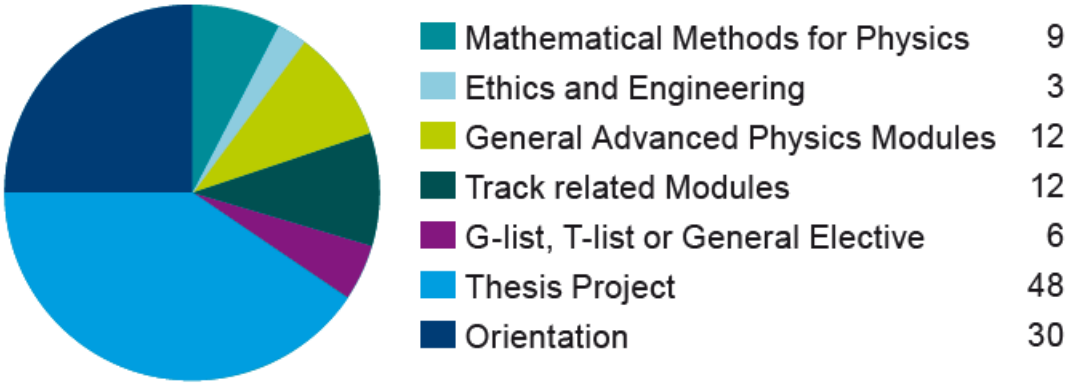
3. **Orientations.** Four orientations of 30 EC each can be chosen:
   - Research and Development (R&D),
   - Education (Ed1/Ed2),
   - Management of Technology (MoT),
   - Study Abroad (SA).

4. **Special programmes.** A special programme within the MSc Applied Physics is:
   - Casimir pre-PhD programme. This programme focuses on preparing and educating students for a PhD position within the Leiden Institute of Physics, the Kavli Institute of Nanoscience in Delft, or elsewhere.

5. **Programme additions.**
   - Honours programme. This is an additional individual challenging programme for students with a better than average performance in their MSc programme (>7.5 weighted average and no study delay).
   - Double degree programmes. These are three year programmes: Applied Physics – Management of Technology, Applied Physics – Applied Mathematics, or an individually approved combination of Applied Physics with another MSc programme.

Article 5 – Composition of the programme. **(TER art. 7.5)**

5.1 The core programme comprises 90 ec and has the same structure for all tracks and students:



5.1.1 Master Thesis Project, 48 EC

The Applied Physics core programme includes the Master Thesis Project

AP3902, Master Thesis, 48EC

The topic of the Thesis Project (6ec thesis preparation, 42ec thesis work) is related to the graduation track and is done in a research section of one of the departments of the faculty of Applied Sciences or in an affiliated group.

Affiliated groups are:
For Physics for Fluids Engineering: Clouds & Climate group (CiTG), Fluid Mechanics section (3mE), Multiphase Systems section (3mE);
For Physics for Instrumentation: Centre for Systems and Control - Numerics for Control & Identification / Optics group (3mE).

The prior approval of the Board of Examiners should be obtained if the thesis work is performed outside the mentioned departments or affiliated groups.

For the Casimir pre-PhD programme, the master thesis project has a different structure; see 5.3.1.

5.1.2 Obligatory Modules, 12 EC

The Applied Physics core programme includes compulsory math and ethics modules.

AP3001, Mathematical Methods for Physics, 9EC
WM0320TU, Ethics and Engineering, 3EC

Students that have passed the Partial Differential Equation module TW2070, WI2607 or WI3150TU+WI3151TU/ WI4150TU in their bachelor's programme, e.g. as part of their minor, have two options with respect to AP3001:
1: Complete the three parts of AP3001, including the PDE part.
2: Voluntary skip the PDE part of AP3001 and choose a different MSc-level course of at least 3EC (either an Applied Physics course, a math course, or another course).

Students that have passed the Complex Analysis module TW2040, WI2602 or EE2M11 in their bachelor's programme, have two options with respect to AP3001:
1: Complete the three parts of AP3001, including the Complex Analysis part.
2: Voluntary skip the Complex Analysis part of AP3001 and choose a different MSc-level course of at least 3EC (either an Applied Physics course, a math course, or another course).

It isn't possible to get an exemption in the master programme based on courses passed in a bachelor programme without doing an alternative master course module (Teaching and Examination Regulations, article 7.3).

5.1.3 General Advanced Physics Modules (G-list): 12 EC

The advanced physics modules aim at breadth as well as depth in general physics knowledge, following on from the Bachelor's programme. At least two modules must be chosen from this list:

AP3021, Advanced Statistical Mechanics, 6EC
AP3032, Continuum Physics, 6EC
AP3051, Advanced Quantum Mechanics, 6EC
AP3071, Advanced Electrodynamics, 6EC

5.1.4 Track related Modules (T-list): 12 EC

T-list modules are more specialised than G-list modules. They are technical and science subjects relating to and recommended for at least one of the tracks. The student should take at least 12 EC from the T-list of the track of his or her choice.

a. Physics for Energy:

AP3082, Computational Physics, 6EC
AP3141, Environmental Physics, 6EC
AP3211, Advanced Solid State Physics, 6EC
AP3271, Molecular Electronics, 6EC
AP3311, Neutrons, X-Rays and Positrons for Studying Microscopic Structures and Dynamics, 6EC
AP3332, Physics of Energy Materials, 3EC
AP3341, Nuclear Reactor Physics, 6EC
AP3352, Introduction to Nuclear Science and Engineering, 6EC
AE4W02TU, Introduction to Wind Turbines: Physics and Technology, 4EC
CH3322, Energy Storage in Batteries, 4EC
CH3632, Chemistry and Physics of Solar Cells, 6EC
CH3672, Computational Materials Science, 3EC
CH3783, Materials Chemistry for the Nuclear Fuel Cycle, 3EC

b. Physics for Fluids Engineering:

AP3082, Computational Physics, 6EC
AP3141, Environmental Physics, 6EC
AP3171, Advanced Physical Transport Phenomena, 6EC
AP3181, Applied Multiphase Flow, 6EC
AP3551, Computational Multiphase Flow, 6EC
AE4180, Flow Measurement Techniques, 3EC
AE4W02TU, Introduction to Wind Turbines: Physics and Technology, 4EC
CH3053, Applied Physical Transport Phenomena, 6EC
CH3061, Multiphase Reactor Engineering, 4EC
CH3152, Molecular Transport Phenomena, 5EC
CH3421, Computational Transport Phenomena, 6EC
CIE4601, Physics of the Earth and Atmosphere, 5EC
CIE4708, Water in the Atmosphere, 5EC
ME45000, Advanced Heat Transfer, 3EC
ME45031, Turbulence for AP, 6EC (or ME45030, 5EC)
ME45043, Advanced Fluid Dynamics for AP, 6EC (or ME45042, 5EC)
ME45160, Advanced Applied Thermodynamics, 5EC
WI4011, Computational Fluid Dynamics, 6EC

c. Physics for Health and Life:

AP3061, Acoustic, Elastic and Electromagnetic Waves, 6EC
AP3082, Computational Physics, 6EC
AP3122, Advanced Optical Imaging, 6EC
AP3132, Advanced Digital Image Processing, 6EC
AP3162, Physics of Biological Systems: Mathematical modelling in Systems Biology, 6EC
AP3232, Medical Imaging Signals and Systems, 6EC

AP3352, Introduction to Nuclear Science and Engineering, 6EC
AP3371, Radiological Health Physics, 6EC
AP3461, The Origins of Life, 6EC
AP3511, Biophysics, 6EC (combined with NB4070)
AP3531, Acoustical Imaging, 6EC
AP3582, Medical Physics of Photon and Proton Therapy, 6EC
AP3691, Evolution and Engineering of Living Systems, 6EC
CH3763, Nuclear Medicine, 3EC
CH3771, Nuclear Chemistry, 6EC
LM3512NB, Systems Biology, 6EC
NB4020, High Resolution Imaging, 4EC
NB4070, Soft Matter, 6EC
4403ADBPL, Advanced Biophysics, 6EC
4403THBPH, Theoretical Biophysics, 6EC

d. Physics for Instrumentation:

AP3061, Acoustic, Elastic and Electromagnetic Waves, 6EC
AP3082, Computational Physics, 6EC
AP3091, Elementary Particles, 6EC
AP3112, Quantum Optics and Lasers, 6EC
AP3122, Advanced Optical Imaging, 6EC
AP3152, Optics for Lithography, 6EC
AP3222, Nanotechnology, 6EC
AP3252, Electron Microscopy Characterization of the Nanoscale, 3EC
AP3311, Neutrons, X-Rays and Positrons for Studying Microscopic Structures and Dynamics, 6EC
AP3382, Advanced Photonics, 6EC
AP3392, Geometrical Optics, 3EC
AP3401, Introduction to Charged Particle Optics, 6EC
AP3531, Acoustical Imaging, 6EC
AP3652, Electronics for Physicists, 3EC
AP3701, Submm and Terahertz Physics and Applications, 3EC
AE4880, Space Instrumentation, 4EC
EE4635, Terahertz Superconducting Astronomical Instrumentation, 4EC
ME46310, Opto-Mechatronics, 4EC
SC42030, Control for High Resolution Imaging, 3EC
SC42065, Adaptive Optics Design Project, 3EC

e. Physics for Quantum Devices and Quantum Computing:

AP3082, Computational Physics, 6EC
AP3101, The Interpretation of Quantum Mechanics, 3EC
AP3112, Quantum Optics and Lasers, 6EC
AP3202, Topology in condensed matter, 6EC (not scheduled in 2019-2020)
AP3211, Advanced Solid State Physics, 6EC
AP3222, Nanotechnology, 6EC
AP3252, Electron Microscopy Characterization of the Nanoscale, 3EC
AP3261, Mesoscopic Physics, 6EC
AP3271, Molecular Electronics, 6EC
AP3281, Quantum Transport, 6EC
AP3292, Quantum Hardware, 6EC
AP3303, Applications of Quantum Mechanics, 3EC
AP3421, Fundamentals of Quantum Information, 4EC
AP3421-P, Quantum Information Project, 2EC
AP3652, Electronics for Physicists, 3EC
AP3662, Special Topics in Quantum Technology, 3EC
AP3681, Fairy Tales of Theoretical Physics, 6EC
CH3672, Computational Materials Science, 3EC
CS4090, Quantum Communication and Cryptography, 5EC
EE4575, Electronics for Quantum Computation, 5EC

5.1.5 G-,T-, or GE-list elective: 6 EC

The remaining module(s) can be chosen from subjects from the G-list or the T-list, or a more general elective from the GE-list can be taken:

4403TGR64, Theory of General Relativity, 6EC
CS4195, Modelling and Data Analysis in Complex Networks, 5EC
CS4220, Machine Learning 1, 5EC
EE4C02, System Engineering, 3EC
IN4049TU, Introduction to High Performance Computing, 6EC
LM3691, iGEM, 18EC - a maximum of 12 EC of this module can be included in the MSc programme; 6EC must be done extra-curricular.
NB4130TU, Biologic, 3EC
WI4006, Special Functions, 6EC
WI4201, Scientific Computing, 6EC
WI4211, Advanced Topics in Analysis, 6EC
WI4260TU, Scientific Programming for Engineers, 3EC
WI4265TU, Parallel Programming, 3EC
WI4415, Approximation Theory, 6EC
WI4430, Martingales, Brownian Motion, and Stochastic Processes, 6EC
WI4771TU, Object Oriented Scientific Programming with C++, 3EC

If a student wishes to take a module, within or outside of the faculty, that's not on the lists approval from the Board of Examiners must be obtained.

5.2 Orientations

Combining the core programme with a 30 EC orientation completes the master programme.

5.2.1 Research and Development (R&D)

The R&D orientation is the only orientation that allows for incorporating bridging/homologation courses in the programme (see article 6). It consists of two of the following three blocks of modules:

a. a non-academic internship, often done abroad (18 EC).

AP3911, Internship in Industry, 18EC

b. a group design project and a preparatory design course (15 EC).

EE4C02, System Engineering, 3EC
AP3843, Design Project, 12EC

c. additional electives (12-15 EC).

6-9 EC	G-, T-, or GE-list modules.
6 EC	G-, T-, GE-, or S-list modules; or assigned homologation modules.

G-, T-, and GE-list modules are listed in art. 5.1. For homologation modules see art. 6.
S-list (Societal) example modules are:

AS3111, ATHENS, 2EC
AS3121, Scientific Writing and Argumentation, 3EC
AS3131, Art, Empathy & Ethics, 4EC
AS3141, Multidisciplinary Project, 6EC
MOT9515, CleanTech Business Study, 5EC
UD5000, Interdisciplinary CDIO Bootcamp, 2EC
WM0203TU-Eng, Oral Presentations, 2EC
WM0516TU, Turning Technology into Business, 6EC
WM0939TU, Technology in Sustainable Development, 5EC
WM0943TU, Sustainable Business Game, 5EC
WM1101TU, English for Academic Purposes 3, 3EC
WM1102TU, Written English for Technologists 2, 3EC
WM1112TU, Spoken English for Technologists 2, 3EC
WM1115TU, Dutch Elementary 1, 3EC

WM1116TU, Dutch Elementary 2, 3EC
WM1117TU, Dutch Intermediate 1, 3EC
WM1135TU, English for Academic Purposes-4, 3EC
WM1136TU, Written English for Technologists-1, 3EC
WM1137TU, Spoken English for Technologists-1, 3EC
WM4019TU, The Journey, 6EC
WM4028TU, Experience Entrepreneurship, 5EC

For the complete list see: http://studiegids.tudelft.nl/a101_displayProgram.do?program_tree_id=22487.
Only subjects marked as 'Category MSc level' are accepted.
In addition electives for the annotation 'Technology in Sustainable Development' (www.tudelft.nl/tisd) and for the annotation 'Entrepreneurship' (www.tudelft.nl/en/tpm/about-the-faculty/departments/staff-departments/delft-centre-for-entrepreneurship/education/master-programs/annotation-entrepreneurship) are allowed for the S-list.

Within the R&D orientation, students can fulfil the requirements for the Technology in Sustainable Development, Entrepreneurship, Nuclear Science and Engineering, and Quantum Technologies annotations. Certificates will be granted during the graduation ceremony upon request of the student.

5.2.1.a1 Annotation Technology in Sustainable Development (TiSD)

This is a university initiative. Approval of the Master's thesis work and the internship by the coordinator (W.G. Bouwman) is required. The thesis project must be focussed on sustainable development or the development of knowledge and technology aimed at a more sustainable future.

The **thesis project** (AP3902) must be focussed on sustainable development or the development of knowledge and technology aimed at a more sustainable future.
The **internship** (AP3911) should have a clear relation to sustainability.
5 EC colloquium 'Technology in Sustainable Development' (WM0939TU).
6 EC Environmental Physics (AP3141).
4 EC of modules from the TiSD cluster-A and cluster-B list. At least 3EC must be chosen from the cluster B list. The lists can be found at www.tudelft.nl/tisd

5.2.1.a2 Annotation Entrepreneurship (AE)

The student makes a proposal for the courses to be followed and for the final thesis and will discuss the proposal with the coordinator of the Delft Centre for Entrepreneurship (DCE) and a coordinator from the faculty. The programme should be approved by the programme coordinator and must always be approved by the board of examiners in advance.
Minimum requirements for the Annotation Entrepreneurship certificate (15EC compulsory, plus 5EC electives):

MOT9610, Entrepreneurship Basic course, 5EC
MOT9611, Project Entrepreneurship Thesis related, 5EC
MOT9612, Business Development Lab (short), 5EC
Elective(s) on entrepreneurship, 5EC

If the requirements for the Annotation Entrepreneurship certificate are fulfilled, sufficient experience with (start-up) companies is present in the courses done, and the total number of credits done is at least 120EC, the industrial internship may be dropped from the programme if the Board of Examiners gives permission.

5.2.1.a3 Annotation Nuclear Science and Engineering (NSE)

Nuclear Science and Engineering has to be a core issue in the graduation project and the internship. Approval of the Master's thesis work and optionally the internship by the coordinator (M. Rohde) is required. Nuclear Science and Engineering may have a focus on either "health" or on "energy".

The **thesis project** (AP3902) must be focussed on nuclear science and engineering.
At least 15EC of electives, design project, and/or internship must be NSE related, including at least 9EC from the NSE electives list: AP3091, Elementary Particles, 6EC AP3232, Medical Imaging Signals and Systems, 6EC AP3311, Neutrons, X-Rays and Positrons for Studying Microscopic Structures and Dynamics, 6EC AP3341, Nuclear Reactor Physics, 6EC AP3352, Introduction to Nuclear Science and Engineering, 6EC AP3371, Radiological Health Physics, 6EC AP3582, Medical Physics of Photon and Proton Therapy, 6EC CH3763, Nuclear Medicine, 3EC CH3771, Nuclear Chemistry, 6EC CH3783, Materials Chemistry for the Nuclear Fuel Cycle, 3EC

5.2.1.a4 Annotation Quantum Technology (QT)

The Quantum Technology annotation consists of a set of 20ec of compulsory courses, a graduation project focussed on quantum technology and additional work approved by the coordinator of the annotation, M. Veldhorst. The requirements for the Quantum Technology annotation are:

The **thesis project** (AP3902) must be focussed on the topic of quantum technology (Software & Theory, Hardware & Experiment, Quantum Computer Engineering, Quantum Materials).
AP3292, Quantum Hardware, 6EC
AP3421, Fundamentals of Quantum Information, 4EC
CS4090, Quantum Communication and Cryptography, 5EC
EE4575, Electronics for Quantum Computation, 5EC
Annotation Extras - three options: A. Quantum Information Project (AP3421-P, 2EC). B. Focus course: Special Topics in Quantum Technology (AP3662, 3EC). C. Quantum Technology Annotation Assignment (AP3942, 0EC) - Participation in company visits with challenging group and personal assignments and/or additional effort for QuTech Academy.

5.2.2 Education (Ed1/Ed2)

The educational programmes are aimed at Dutch-speaking students only, because they are oriented towards the Dutch school system and because it includes internships (Schoolpracticum) at Dutch schools. Consequently the educational orientation modules are taught in Dutch. The programme consists of Basisdeel/Ed1 (30 EC) and Verdiepingsdeel/Ed2 (30 EC).
The minor Education (Basisdeel/Ed1) can be done during the bachelor programme and leads to qualification as a tweedegraads secondary school teacher with limited qualification (beperkte bevoegdheid). If a student has done the minor Education, only the Verdiepingsdeel/Ed2 of 30 EC remains for the master programme orientation. The combination of the minor Education and Ed2 orientation leads to qualification as a fully-qualified eerstegraads (grade-one) secondary school teacher.
Students that did not take the minor Education can follow the Basisdeel/Ed1 orientation as part of their master programme and then optionally do the Verdiepingsdeel/Ed2 as a post-master course in order to become fully qualified.
The programme should be approved by the coordinator of the MSc Science Education and Communication.

30 EC Education - Basisdeel (Ed1)
SL3041, Introductory Teaching Placement, 3EC
SL3116, Research Methodology in Social Sciences for Education, 3EC
SL3164, Physics Teaching Placement A, 9EC
SL3332, Subject Pedagogy Physics 2, 4EC
SL3462, Educational Sciences, 6EC
SL3781, Didactics 1 Professional Learning Community, 5EC
30 EC Education - Verdiepingsdeel (Ed2)
SL3012, Personal Professional Development, 3EC
SL3021, The Designing of Communication and Education Products, 6EC
SL3311, Educational Research for Teachers, 6EC
SL3371, Subject Pedagogy Physics 3, 3EC
SL3414, Physics Teaching Placement B, 12EC
If, due to changes in the programmes, SL3116 (Research Methodology in Social Sciences, 3EC) has not been done as part of the minor or basisdeel, it has to be done additionally for the qualification as a fully-qualified eerstegraads (grade-one) secondary school teacher.

5.2.3 Management of Technology (MoT)

This orientation is offered by the faculty of Technology, Policy and Management. The programme consists of either the first semester or the second semester of the MSc Management of Technology. A mixture of courses from both semesters is only permitted if it's a coherent set of modules that is approved by the MoT programme director, R.M. Verburg, in advance.

1st SEMESTER MoT Modules (30 EC)
MOT1412, Technology Dynamics, 5EC
MOT1421, Economic Foundations, 5EC
MOT1442, Social and Scientific Values, 5EC
MOT1461, Corporate Finance, 5EC
MOT1524, Leading and Managing People, 5EC
MOT1532, High-tech Marketing, 5EC

2nd SEMESTER MoT Modules (30 EC)
MOT1003, Integration Moment, 5EC
MOT1435, Technology Strategy and Entrepreneurship, 5EC
MOT1451, Inter- and Intra-organisational Decision Making, 5EC
MOT1531, Business Process Management & Technology, 5EC
MOT2312, Research Methods, 5EC
MOT2421, Emerging and breakthrough Technologies, 5EC

5.2.4 Study abroad

This programme consists of a semester at a foreign university. A package of 30 EC of courses (optionally including a research project of a maximum of 20 EC) must be done. Note that an industrial internship (AP3911) is not required if this orientation is chosen.
Another option for an exchange semester at a foreign university is to do 30 EC of course modules that fit in the (core) programme and select one of the other orientations.
A Study Abroad programme must always be approved by the board of examiners in advance.

5.3 Special programmes

5.3.1 Casimir pre-PhD special programme

This programme, linked to the BN and QN departments, focuses on preparing and educating students for a PhD position within the Leiden Institute of Physics, the Kavli Institute of Nanoscience in Delft, or elsewhere. It's also designed to respond to the increased mobility of students after their BSc and entering an MSc programme.
Leiden University and Delft University of Technology have established in 2004 the Casimir graduate school (http://casimir.researchschool.nl) which accommodates PhD students within the Kavli Institute of Nanoscience in Delft and the Leiden Institute of Physics. The research within the school is grouped into six themes, each covering theoretical, experimental and applied research areas both at Leiden and Delft.
For Applied Physics students in Delft, admission into this programme proceeds as follows. Students within the Applied Physics degree courses inform the coordinator that they are interested in following the Casimir special programme in the course of their first semester. After the first examination period in January, a special committee consisting of staff members from both Leiden and Delft decides on the admission into the programme. Students who are declined can continue with the regular AP programme without incurring delays.
For a limited number of students completing this special programme successfully, a PhD position is guaranteed. In order to qualify for one the PhD positions, students should complete this programme within two years. In cases where students incur substantial delays without good reason, the admission into the special programme can be withdrawn.
Participation in the Les Houches summer school (France) which is organized jointly with French Universities in Grenoble and Lyon. This course is not compulsory although it is strongly encouraged to participate. Participation is free for students admitted into the Casimir special programme.

The Casimir special programme comprises:

- **Obligatory Modules, 12 EC:**

AP3001, Mathematical Methods for Physics, 9EC
WM0320TU, Ethics and Engineering, 3EC

- **General Advanced Physics Modules (G-list), 12 EC:**

AP3021, Advanced Statistical Mechanics, 6EC
AP3051, Advanced Quantum Mechanics, 6EC

- **One course from the 'Foundational' list, 6 EC:**

AP3032, Continuum Physics, 6EC
AP3071, Advanced Electrodynamics, 6EC
AP3211, Advanced Solid State Physics, 6EC
AP3511, Biophysics / NB4070, Soft Matter Physics, 6EC
AP3681, Fairy Tales of Theoretical Physics, 6EC
4403ADBPL, Advanced Biophysics, 6EC
4403CONDE, Theory of Condensed Matter, 6EC
4403EFTH3, Effective Field Theory, 3EC
4403QFTH6, Quantum Field Theory, 6EC
4403TGR64, Theory of General Relativity, 6EC

- **Two courses from the 'Topical' list, 12 EC:**

AP3101, The Interpretation of Quantum Mechanics, 3EC
AP3112, Quantum Optics and Lasers, 6EC
AP3162, Physics of Biological Systems: Mathematical modelling in Systems Biology, 6EC
AP3202, Topology in Condensed Matter, 6EC
AP3252, Electron Microscopy Characterization of the Nanoscale, 3EC
AP3261, Mesoscopic Physics, 6EC
AP3271, Molecular Electronics, 6EC
AP3281, Quantum Transport, 6EC
AP3292, Quantum Hardware, 6EC
AP3303, Applications of Quantum Mechanics, 3EC
AP3421, Fundamentals of Quantum Information, 4EC
AP3421-PR, Quantum Information Project, 2EC
AP3461, The Origin of Life, 6EC
AP3662, Special Topics in Quantum Technology, 3EC
AP3691, Evolution and Engineering of Living Systems, 6EC
CS4090, Quantum Communication and Cryptography, 5EC
4403ADVOP, Advanced Optics, 6EC
4403SIMOP, Single Molecule Optics, 6EC
4403THBPH, Theoretical Biophysics, 6EC

- **One course from the 'Methods' list, 5 EC:**

AP3082, Computational Physics, 6EC
AP3222, Nanotechnology, 6EC
AP3652, Electronics for Physicists, 3EC
EE4575, Electronics for Quantum Computation, 5EC
WI4201, Scientific Computing, 6EC

- **A research project of 36 EC** (AP3902CAS) in a department in of the Kavli Institute in Delft or the LION in Leiden.
- **Two smaller projects of 8 EC** each (AP3961, AP3971), to be carried out in different groups, and in a different group than where the 36 EC Research project takes place.
- **Writing a PhD research proposal** (AP3952, 8EC), possibly based on the large or on the smaller research projects.
- The remaining EC's (12) are filled with **elective modules** from the topical, foundational or methods lists.

5.3.2 Skipped (was Excellence track on Fluid and Solid Mechanics)

5.3.3 Honours Programme

The Honours Programme consists of at least 20 EC on top of the regular master programme of 120 EC. The full Applied Physics programme including the additional honours track should be finished according to schedule. It is an individual programme that contains a 5 EC specially developed course for all TU Delft honours track students plus a coherent package of at least 15 ec of challenging course modules or projects composed by the student.

Programme			**Credits**
Collective Part – obligatory UD2010, Critical Reflection on Technology			5
Individual Part **Examples:** Company Oriented HPM AS1011HPM AS1021HPM Research Oriented HPM AS1031HPM x Coherent package of courses example: AP3932HPM	 Applied Sciences Company Project Applied Sciences Honours Classes Applied Sciences Research Project Project related course Summer School Casimir pre-PhD programme	 12 3 9-15 0-6 5	15

5.3.4 Double degree programme[1] Applied Physics – Management of Technology

This is a three year programme Applied Physics – Management of Technology of the Faculties of Applied Sciences (AS) and Technology, Policy and Management (TPM).
Students finishing a Master AP degree with orientation MoT may decide to do an additional year of Master MoT courses and thesis in order to obtain a double degree in both AP and MoT. Admission to this double degree programme is decided upon by the programme directors of the MSc Applied Physics and the MSc Management of Technology. The programme consists of:

Programme	**EC**
The AP core programme	90
The AP orientation MoT / 1st semester MoT modules (list of modules in art. 4.2.3)	30
2nd semester MoT modules (list of modules in art. 4.2.3)	30
MOT2004, Preparation for the Master Thesis	5
MoT MSc Thesis Project (MOT2910)	30

The 120EC Applied Physics part of the programme consists of the 90EC AP Core Programme and the 30EC second semester MoT modules.

5.3.5 Double degree programme Applied Physics – Applied Mathematics

This is a three year programme Applied Physics – Applied Mathematics.
Admission to this double degree programme is decided upon by the programme directors of the MSc Applied Physics and the MSc Applied Mathematics. A double bachelor programme or a bridging programme is required to enter this programme.

The programme consists of:

Option 1 - two different thesis projects:

Programme	**EC**
AP courses: AP3001-FE (Finite Elements)* – 3 EC WM0320TU (Ethics and Engineering) – 3 EC G-list courses – 12 EC T-list courses – 12 EC G-,T-, or GE-list, or math courses instead of AP3001 parts already covered* – 6 EC G-,T-, or GE-list course – 6 EC	42
AP Thesis Project	48
AM courses: Common courses (from WI4201, WI4203, WI4227, WI4430, WI4455) – 18 EC Specialisation courses (from list) – 30 EC WM1028AM (Ethics for Applied Mathematics) is not needed if WM0320TU is done	48
AM Thesis Project	42

*If applicable Applied Physics bridging/homologation courses can also be done in the programme here.
AP3001 parts are covered by (list is not complete):
Complex Analysis : TW2040, WI2602, EE2M11
Finite Elements : WI4014TU, WI4205
Partial Differential Equations : TW2070, WI2607 or WI3150TU+WI3151TU/WI4150TU

The 120EC Applied Physics programme consists of the 90EC AP courses and thesis project and 30EC of AM common and specialisation courses.

[1] More generally, double degree programmes combining applied physics with other master courses taught at TU Delft are possible, but always subject to the restrictions imposed by the university. The main restrictions are that the double degree programme comprises at least 180 EC and that there are two identifiable final project reports for both degrees. Formal admission by the programme directors is required in advance.

Option 2 - combined thesis project and industrial internship:

Programme	**EC**
AP courses - as above	42
AM courses - as above	48
Double Degree Combined Thesis Project	60
Industrial Internship (AP3911 or WI5118)	18
Additional AP G-,T-, or GE-list course	6
Additional AM elective course	6

The 120EC Applied Physics programme consists of 42+6 EC of AP courses, 18 EC Industrial Internship, 48 EC for the Thesis Project and 6 EC WI4201.

5.3.6 Free study programme

Students may compile a free curriculum concluded by a final exam. Such a curriculum must consist entirely or mainly of modules given in conjunction with the programme. It has to comply with the final attainment levels of the programme. The curriculum must be accompanied by a justified request and submitted to the Board of Examiners for approval.

Article 6 Bridging and homologation programmes

Article 1.4 mentions that students holding a Bachelor degree in Physics from a Dutch university can be admitted to the programme with a homologation programme of at most 6 credits. Examples of modules that can be assigned in a homologation programme are:

TN2545, Systemen en Signalen, 6EC
TN2785, Fysische Transportverschijnselen, 6EC

If a homologation module is assigned, a maximum of 6EC can be incorporated in the Master programme in the R&D orientation.
Students holding a Bachelor of Science degree in Aerospace Engineering, Applied Earth Sciences, Applied Mathematics, Civil Engineering, Electrical Engineering, Marine Technology, Mechanical Engineering, Molecular Science and Engineering, or Nanobiology from Delft University of Technology may apply, but, if admitted, will be required to follow a bridging and/or homologation programme to provide them with the required background to allow them to complete the Master programme.
Bridging modules must be completed before a student can be admitted in the Master programme; homologation modules can be done as part of the Master. The bridging and/or homologation programmes are listed below. The final decision about a bridging or homologation programme, also in other cases, is made on an individual basis.

Students can be admitted to the Master programme if the extent of their deficiencies is limited to a maximum of 18 credits. If deficiencies extend this size, students can only be admitted to the bridging programme. Completion of the bridging programme by students formally admitted to it guarantees admission to the Master programme.
A maximum of 18 credits of homologation modules can be incorporated in the Master programme, if an exemption is obtained for the Industrial Internship (AP3911); otherwise 6 credits of homologation modules can be done in the R&D orientation and if exemptions have been obtained for compulsory courses (Mathematics for Physics and/or Ethics and Engineering) homologation courses can be done as alternatives.

Required bridging/homologation courses for TU Delft BSc Aerospace Engineering:

TN2054, Electromagnetisme, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Applied Earth Sciences:

TN2054, Electromagnetisme, 6EC
TN2211, Electronische Instrumentatie, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Applied Mathematics:

TN2054, Electromagnetisme, 6EC
TN2211, Electronische Instrumentatie, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC

TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC (not required if TN1531TW is done)
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2785, Fysische Transportverschijnselen, 6EC (or 4052FYSTRY, 6EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Civil Engineering:

TN1201, Thermodynamica, 3EC
TN2054, Electromagnetisme, 6EC
TN2211, Electronische Instrumentatie, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2345, Inleiding Golven, 3EC
TN2421, Optica, 3EC
TN2545, Systemen en Signalen, 6EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Electrical Engineering:

TN1201, Thermodynamica, 3EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC
TN2785, Fysische Transportverschijnselen, 6EC (or 4052FYSTRY, 6EC)

Required bridging/homologation courses for TU Delft BSc Marine Technology:

TN2054, Electromagnetisme, 6EC
TN2211, Electronische Instrumentatie, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Mechanical Engineering:

TN2054, Electromagnetisme, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2345, Inleiding Golven, 3EC

TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Molecular Science and Technology:

TN2054, Electromagnetisme, 6EC
TN2211, Electronische Instrumentatie, 6EC
TN2304, Kwantummechanica 1, 3EC (or TN2305, 4EC)
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2345, Inleiding Golven, 3EC
TN2421, Optica, 3EC
TN2545, Systemen en Signalen, 6EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6EC (or TN2625, 4EC)
TN2785, Fysische Transportverschijnselen, 6EC (not if 4052FYSTRY) is done
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

Required bridging/homologation courses for TU Delft BSc Nanobiology:

TN2054, Electromagnetisme, 6EC
TN2304, Kwantummechanica 1, 3EC (or NB3017, 2.5EC)
TN2314, Kwantummechanica 2, 3EC (or NB3018, 2.5EC)
TN2321, Klassieke Mechanica, 3EC
TN2345, Inleiding Golven, 3EC
TN2421, Optica, 3EC
TN2612, Relativiteitstheorie, 3EC
TN2624, Statistische Fysica, 6-3EC
TN2785, Fysische Transportverschijnselen, 6EC (or 4052FYSTRY, 6EC)
TN2844, Vaste Stof Fysica, 6EC
TN2953SO, Research Practicum, 3EC

For students holding a Bachelor of Engineering (HBO) degree in applied physics, the bridging/ homologation programme is:

TN2054, Electromagnetisme 1, 6EC
TN2244WI, Lineaire Algebra en Differentiaalvergelijkingen, 6EC
TN2304, Kwantummechanica 1, 3EC
TN2314, Kwantummechanica 2, 3EC
TN2321, Klassieke Mechanica, 3EC
TN2345, Inleiding Golven, 3EC
TN2421, Optica, 3EC
TN2545, Systemen en Signalen, 6EC
TN2624NB, Statistische Fysica, 3EC
TN2953SO, Research Practicum, 3EC
TN2986, Mathematical methods for Modern Physics, 2EC (*)
WI1142TN, Lineaire algebra deel 1, 3EC

(*) TN2986 is not compulsory if WI1142TN is passed before enrolling in the bridging programme.

The quantum mechanics subjects TN2304 and TN2314 form a module. The minimum pass grade for these subjects is 5.0, provided that the weighted average of the two subjects is at least 5.8.

Article 7 Examinations

7.1 The form of the examinations and the methods of assessment

The form of the examinations and the methods of assessment are described in the (digital) study guide, http://ap.msc.studyguide.tudelft.nl.

7.2 Order of the exams

7.2.a Graduation Project, Master's thesis

You may start your Master Thesis Project if you:

- have been admitted to the master programme Applied Physics,
- have passed bridging/homologation modules or other obligations from the bachelor programme,
- have passed all obligatory (12EC), G-list (12 EC) and T-list (12EC) modules,
- have made a project plan with your thesis supervisor; this project plan should be handed in at enrollment.

At the start of the final project, the appropriate registration form must be filled in and handed in at the thesis project office.
The date and time of the master project presentation is determined by the thesis supervisor, after hearing the student. In exceptional cases, the board of examiners may be involved in setting this date and time.
Further rules governing the MSc graduation projects can be found in article 26 to 29 of the Rules and Guidelines of the Board of Examiners.

Article 8 Transition ruling

The core programme described in article 5 is compulsory for students who enrolled after 30-06-2011 for the first time in the master Applied Physics.
Students who enrolled before 01-07-2011 can choose between the previous programme (instead of AP3001 a choice of at least 6 credits from WI3150TU, WI4014TU, WI4143TN, and WI4150TU, and 3 credits from the S-list) and the new programme.
Students who enrolled before 01-07-2011 can put the modules AP3011, AP3061, AP3081 and AP3091 on their G-list even if they apply for the new programme, provided they have passed those modules before 01-09-2012.

If WI4243AP/AP3001 is part of a student's programme WI3150TU, WI4014TU, WI4143TN, and WI4150TU can't be chosen as optional modules.

Students enrolled before 01-09-2016 starting the thesis work after 01-07-2017 will do AP3902 instead of AP3901.

Before 2010-2011 AP3241TU (Particle Therapy Holland) was a D-list module; from 2010-2011 it's on the R-list.
Before 2011-2012 CH3771 (Nuclear Chemistry) was a D-list module; from 2011-2012 it's on the R-list.
AP3132D (Advanced Digital Image Processing) is a D-list module; before 2017-2018 ET4283 was on the R-list.
Either AP3421D (from 2017-2018) or AP3292D (before 2017-2018) counts as a D-list module; not both.

Equivalences:
AP3001 = WI4243AP-11
AP3001-CA = WI4243AP-CA = WI4244AP = WI4143TN = WI2602 = TW2040 = EE2M11
AP3001-FE = WI4243AP-FE = WI4014TU = WI4205
AP3001-PDE = WI4243AP-PDE = WI3150TU + WI3151TU / WI4150TU = WI2607 = TW2070
AP3021 = AP3021G
AP3032 = AP3032G
AP3051 = AP3051G
AP3061 = AP3061D
AP3071 = AP3071G
AP3082 = AP3082D = AP3081D
AP3091 = AP3091D
AP3112 = AP3112D = AP3111D
AP3122 = AP3221 = AP3121D
AP3132 = AP3132D = ET4283
AP3141 = AP3141D
AP3162 = AP3162D = AP3161D
AP3171 = AP3171D
AP3181 = AP3181D
AP3192 = AP3191D

AP3211 = AP3211D
AP3222 = AP3232D = AP3221D = NS3501
AP3232 = AP3232D = AP3231D
AP3242 = AP3241
AP3261 = AP3261D = NS3521
AP3271 = NS3531 = 4403MOLE6
AP3281 = AP3281D = NS3571
AP3292 = AP3292D
AP3311 = AP3311D
AP3341 = AP3341D
AP3352 = CH3792
AP3371 = AP3371TUD
AP3382 = AP3381
AP3392 = AP3391
AP3421 = AP3421D
AP3511 = AP3511D = NB4070 = NS3511
AP3582 = AP3581 + AP3242
AP3652 = AP3651
AP3691 = AP3691D
AP3902 = AP3901
CH3152 = CH3151
CH3783 = CH3782
CS4222 = IN4085
ME45031 = WB1424ATU
ME45043 = ME45041 = WB1427-13
SL3116 = SL3111
SL3781 = SL3031 + SL3122
UD2010 = WM0355HT
WM0922TU = WM0939TU; Difference in EC to be compensated by TiSD electives.

Bridging programmes:
TN1612SK, 2 EC = TN2612, 3 EC
TN2053 = TN2054
WI2140TN, 4 EC = WI2240TN, 3EC + TN2953DV, 1 EC
TN2244WI, 6 EC = WI2240TN, 3EC + WI2242TN, 3 EC
TN2301 = TN2302 = TN2303 = TN2304 = TN2305
TN2311 = TN2312 = TN2314
TN2622, 4 EC = TN2624, 6 EC
TN2843, 5 EC = TN2844, 6 EC
TN4780TA, 4 EC = TN2785, 6 EC = SET3021, 4 EC = 4052FYSTRY, 6EC

TN2953SK, 2 EC + TN2953DV, 1 EC = TN2953SO, 3 EC (voor HBO schakelaars)
TN2953SK, 2 EC = TN2953SO, 3 EC (voor overige schakelaars)