

FACULTY OF SCIENCES
University of Amsterdam
VU University Amsterdam

TEACHING AND EXAMINATION REGULATIONS
PART B

Academic year 2017-2018

MASTER'S PROGRAMMES
Joint Degree Physics and Astronomy
Single Degree Physics
Single Degree Astronomy & Astrophysics

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Chapter 1. General Provisions

Article 1.1 – Definitions

In addition to part A, the following definitions are used in part B

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|----------------------------|--|
| a. Research project | Compulsory internship including master's thesis and colloquium |
| b. Personal Education Plan | An individual study plan for the student's master programme |
| c. Course | Education imparted in a series of lessons or meetings |
| d. Admissions Board | Track-specific committee (track coordinator + VU/UvA staff member) that decides on admission |

Article 1.2 – General information master's programme

1. The Master's programmes Physics and Astronomy (CROHO 65016), Physics (CROHO 60202) and Astronomy & Astrophysics (CROHO 60230) are offered on a full-time basis and the language of instruction is English.
2. In this document the reader should consider articles referring to the new track names (and to Astronomy & Astrophysics as track instead of a programme) to be applicable to the old tracks and programmes as well.
3. The programme has a workload of 120 EC.
4. A component of the programme consists of 3 EC or multiples of this number.
5. Within the programme Physics and Astronomy the following tracks are offered:
 - Astronomy and Astrophysics
 - Advanced Matter and Energy Physics
 - Gravitation, Astro- and Particle Physics (GRAPPA)
 - Physics of Life and Health
 - Science for Energy and Sustainability
 - Theoretical Physics
 - Science, Business & Innovation (SBI). No incoming students starting academic year 2017-2018. Starting September 2017 the SBI track is an independent master programme and has its own TER.
6. Within the programme Physics the following tracks are offered:
 - Advanced Matter and Energy Physics
 - Gravitation, Astro- and Particle Physics GRAPPA/Particle and Astroparticle
 - Physics of Life and Health
 - Science for Energy and Sustainability
 - Theoretical Physics
 - Science, Business & Innovation.
7. The Master's programme Physics does not accept new incoming students. Starting September 2017 the SBI track is an independent master programme and has its own TER. Within the programme Astronomy & Astrophysics the following tracks are offered:
 - Astronomy and Astrophysics
 - Gravitation, Astro- and Particle Physics GRAPPA/AstrophysicsThe Master's programme Astronomy & Astrophysics does not accept new incoming students
8. In each Master track the student may choose a major or a minor from the list below (see Article 4.1).
 - Major Science Communication;
 - Major Science in Society;
 - Major Teaching;
 - Minor Teaching;
 - Minor Tesla.

9. The student determines the content of the Master's programme in consultation with the track coordinator of the Master's programme and according to the rules of Chapter 3. The study programme must be approved by the Examinations Board. For this purpose, a completed Personal Education Plan (PEP) form has to be submitted to the Examination Board. The student submits this PEP, signed as correctly by the track coordinator, to the Examinations Board. If the student wants to change the contents of the study programme, the student promptly consults with the track coordinator of the study programme. If this results in a new PEP the student submits this to the Examinations Board.

Article 1.3 – Enrolment

The programme starts at the beginning of the first semester (September). This enrolment date ensures a programme that can be expected to be completed within the official period.

Chapter 2. Aim of the programme and exit qualifications

Article 2.1 – Aim of the programme

The general objective of the Master's programme is to provide students with such a knowledge, skills, abilities and insight in the field of Physics and/or Astronomy, including the necessary mathematical, experimental, computational and communicative skills, to enable them to work as a professional Physicist or Astronomer, or to become qualified to pursue advanced training as scientific researcher.

The programme also aims at furthering the understanding of the position and role of physics and astronomy in the sciences and in society, and to further a social sense of responsibility.

The aim of the Master's programmes in Physics and Astronomy, Physics, and Astronomy & Astrophysics is to:

- a) educate students to become independent academic professionals, through conducting fundamental scientific research as well as working with current scientific knowledge, and applying this knowledge in new and continuously changing practical situations;
- b) actively stimulate interdisciplinary collaboration in the development of science, based on knowledge in the field of physics/astronomy;
- c) offer students the possibility to develop skills, knowledge and insight in a specialisation in the field of physics/astronomy, with emphasis on formulating relevant scientific questions and the approach to formulate answers to these questions;
- d) provide student-oriented education that is of a high, internationally recognised quality;
- e) offer students the opportunity to gain knowledge and insight in an international setting;
- f) provide an inspiring academic learning environment, and to offer feasible study specialization programmes to a demanding and heterogeneously composed student population;
- g) develop the ability in students to convey acquired knowledge to others.

Article 2.2 – Exit qualifications

1. The graduate of the Master's programmes Physics and Astronomy, Physics, Astronomy & Astrophysics:
 - a) has a thorough theoretical and practical knowledge of modern physics/astronomy, including the knowledge of other disciplines required for that purpose;
 - b) has a thorough knowledge of theoretical and/or experimental methods and research experience in at least one sub-area within the physics/astronomy discipline;
 - c) is able to become acquainted with other sub-areas of the physics/astronomy discipline within a reasonable period of time;
 - d) is able to formulate a research plan based on a realistic problem definition within the physics/astronomy discipline;

- e) is able to analyse and formulate research results and to draw conclusions;
- f) is able to write a scientific report or an internationally accessible scientific publication and to participate in discussions on (specialised) topics in the field of study;
- g) is able to consult international professional literature in the relevant sub-areas and to apply the knowledge gained from that;
- h) is able to apply one's knowledge of physics/astronomy in a broader (multidisciplinary) context;
- i) is employable in those positions for which knowledge and research skills in the field of physics/astronomy are a prerequisite;
- j) has sufficient knowledge of, and insight in the social role of physics/astronomy to make a sound choice regarding one's own profession, as well as in the exertion of this profession;
- k) is able to cooperate with other people, to convey knowledge to other people, and to give a presentation both to discipline specialists and to a broader audience.

2. Each graduate in the programme curriculum:

- students selecting an experimental or observational Master's programme must be able to independently conduct experiments, or devise observations and the corresponding controls, conducting and evaluating these within a given period of time;
- is able to compare and incorporate obtained research results and conclusions within the framework of the results of other scientists;
- is able to form a vision on the development of scientific research in the field of physics/astronomy;
- is able to quantitatively and qualitatively analyse physics/astronomy processes, to incorporate data in existing or new models and to present the results at various levels of abstraction.

3. In addition to paragraph 1 and 2, the student who has completed the track Advanced Matter and Energy Physics has obtained the following track-specific qualifications:

- a. a well-founded knowledge of the theoretical background behind experimental physics in the sub-disciplines: (hard and soft) condensed matter physics; atomic and laser physics;
- b. a well-founded knowledge of experimental approaches of relevance in modern research into at least one of the following research fields:
 - emergent materials, strongly correlated electron systems and unconventional superconductivity;
 - energy materials and processes for (solar) energy conversion;
 - complex liquids, granular and soft bio-matter;
 - high-precision laser spectroscopy, ultracold quantum gases, quantum information and simulation with ultracold atoms.
- c. proficiency in applying the theoretical knowledge learned to enable the interpretation of the results from experimental work - executed by the graduate at least in part as an independent investigator able to do guided research - in a research project in a field within or close to those given in paragraph 2 above.

4. In addition to paragraph 1 and 2, the student who has completed the track Gravitation, Astro- and Particle Physics (GRAPPA) has obtained the following track-specific qualifications:

- a. a well-founded theoretical knowledge in particle physics and/or astroparticle physics and/or cosmology;
- b. a well-founded knowledge of experimental or theoretical approaches in at least one of the following research fields:
 - Standard Model and Beyond the Standard Model Physics;
 - Dark Matter;
 - Gravitational Waves and tests of Gravity;
 - Cosmic Messengers;

- (Astro-)Particle Physics Detector R&D.
5. In addition to paragraph 1 and 2, the student who has completed the track Physics of Life & Health has obtained the following track-specific qualifications:
 - a. a well-founded knowledge of the physics background behind processes on a cellular or organ level
 - b. a well-founded knowledge of experimental or simulation approaches into at least one of the following research fields:
 - Novel imaging modalities;
 - Novel therapeutic applications;
 - Cellular biophysics;
 - Organ biophysics;
 - c. proficiency in applying the theoretical knowledge learned to enable the interpretation of the results from experimental work - executed by the graduate at least in part as an independent, principal investigator - in a research project in a field within or close to those given in 2.1.2.12 above.
 6. In addition to paragraph 1 and 2, the student who has completed the track Science for Energy and Sustainability has obtained the following track-specific qualifications:
 - a. a thorough knowledge of the scientific, technological and societal challenges for our future associated with energy and sustainability problems;
 - b. proficiency in analysing and evaluating the current energy and sustainability problems;
 - c. proficiency in applying the acquired theoretical and practical insights in day-to-day practice at an institution, company or organization, strongly focused on providing scientific solutions to current and future energy and sustainability problems;
 7. In addition to paragraph 1 and 2, the student who has completed the track Theoretical Physics has obtained the following track-specific qualifications:
 - a. a well-founded and working knowledge of Quantum Field Theory for particle physics as well as many body physics;
 - b. a thorough knowledge of the fundamental aspects in modern statistical physics and condensed matter theory;
 - c. is informed about basic theoretical concepts as second quantization, path integrals;
 - d. is capable of finding the appropriate theoretical framework for a wide range of physics problems.
 8. In addition to paragraph 1 and 2, the student who has completed the track Astronomy and Astrophysics has obtained the following track-specific qualifications:

a well-founded knowledge of experimental or theoretical approaches in at least one of the following research fields:

 - X-ray binaries and compact objects
 - Gamma ray bursts and radio transients
 - Advanced instrumentation
 - Planet and star formation.
 9. In addition to paragraph 1, the student who has completed the track Science, Business & Innovation has obtained the following track-specific qualifications:
 - a. a thorough knowledge of the specific natural scientific and social scientific aspects of business innovation trajectories in the area of human life and health care (track Life & Health) or in sustainable energy technology (track Energy & Sustainability);
 - b. a proficiency in analyzing and solving problems with respect to business innovation trajectories in drug development and health diagnostic instruments (track Life & Health) or in sustainable energy technology (track Energy & Sustainability);
 - c. a proficiency in applying the acquired theoretical and practical insights in day-to-day practice at an institution, company or organization, strongly focused on providing natural science- and social science-based solutions that enable business innovation trajectories in

drug development and health diagnostic instruments (track Life & Health) or in sustainable energy technology (track Energy & Sustainability).

Chapter 3. Admission to the programme

Article 3.1 – Entry requirements (TER)

1. Students who have successfully completed the following degrees may be admitted:
 - a Bachelor's degree in Physics and Astronomy, in Physics, in Technical Physics, or in Astronomy, awarded by a Dutch University;
 - a Bachelor's Degree in *Beta-gamma met een Natuurkunde Major* (Liberal Arts and Sciences with a Physics Major), awarded by the University of Amsterdam;
2. Without prejudice to the provisions of paragraph 1, the Admissions Board may grant admission to the study programme when concluding that the previous education of the candidate is equivalent to the Bachelor's degree referred to in paragraph 1.
3. Without prejudice to the provisions of paragraphs 1 and 2 the Admissions Board may grant admission to a student whose previous education does not meet aforementioned requirements for admission to the study programme of a chosen track, when concluding that the candidate is able to meet the admission requirements within a reasonable period of time. At the request of a candidate, and if the Admissions Board has decided additional education feasible, the Admissions Board may draw up a programme of maximum 30 EC as an admission requirement, a so called 'preparatory programme'. After completion of this preparatory programme a letter of admission will be issued, exclusively for the stated Master's programme and track.
4. When the programme commences, the student must have fully completed the Bachelor's programme allowing admission to this programme.

Article 3.2 – Premaster's programme

Not applicable

Article 3.3 – Restrictions on the number of students admitted to the Master's programme

No restrictions

Article 3.4 – Intake dates

A request for admission to the Master's programme starting in September must be received before 1 May in the case of EU students (including Dutch students) and before 1 February in the case of non-EU students. Under exceptional circumstances, the Admissions Board may consider a request submitted after this closing date.

Article 3.5 – English Language Requirements

1. Admission to the programme requires sufficient command of the English language. A student may take one of the following tests to establish language competence:
 - IELTS: 6.5, at least 6.0 on sub-scores
 - TOEFL paper based test: 580
 - TOEFL internet based test: 92
 - Cambridge Advanced English: A,B
2. Those possessing a Bachelor's degree from a Dutch university satisfy the requirement of sufficient command of the English language.

Article 3.6 – Free curriculum

The student may compile a curriculum of his/her own choice, which has to be approved by the Examinations Board. At least one half of the proposed curriculum has to consist of components of the regular programme, including the Research Project.

Chapter 4. Content and organisation of the programme

Article 4.1 – Organisation of the programme

Depending of the specialization programme the study programme is composed of components according to table 1.

A complete list of courses provided by the Master's programme can be found in Appendix 2. Every component will be tested. Within the Master's programme different types of testing and different types of teaching methods are used. These are described per component in the course catalogue.

Table 1

Components	Regular programme (EC)	Programme with a major (EC)	Programme with a minor (EC)
Compulsory components for the track	At least 12 EC**	Total: 24 EC	12 EC
Elective components discipline	Max 24 EC**		18 EC
Track specific compulsory project	6 EC		6 EC
Research Project (incl. thesis and colloquium)	60* EC	36 EC	54 EC
Free elective components	12 EC		
Academic skills in the Master	6 EC		
Major or minor programme		60 EC	30 EC
Total EC	120 EC	120 EC	120 EC

* The research project is 60 EC. A different organization of the research project requires permission of the Examination Board. The research project can be split in maximal 2 projects, 1 project is at least 36 EC. Each project is a multiple of 6 EC.

** Both components (compulsory and elective) together must be 36 EC, including at least 12 EC compulsory components.

1. The student can choose between the regular programme and a programme containing a major or a minor. These are:
 - a. Major Teaching;
 - b. Minor Tesla;
 - c. Minor Teaching;
 - d. Major Science Communication (VU);
 - e. Major Science in Society (VU).
2. Regarding majors:

A major consists of 60 EC. It has to be combined with disciplinary components as listed in table 1, with the general compulsory components in order to meet the general requirements of the programme. Students have to go through a separate intake procedure for admission to a major. Students first have to finish the obligatory research part of the programme before starting a major.
3. Regarding the major Teaching:

Students who have completed an Educative Minor of 30 EC during their Bachelor's

programme may submit a non-standard study programme for approval to the Examinations Board of the *Interfacultaire Lerarenopleidingen*, after discussing this non-standard study programme with the coordinator of the major Teaching and the track coordinator of the Master's programme. The exit qualifications of the major can be found in Appendix 1.

4. Regarding the minor Tesla:

The minor Tesla consists of 30 EC. It must be combined with a regular programme, comprising at least 90 EC. The minor consists of a course component and a project-based component. This project-based component has to be supervised by a Faculty of Science examiner and is subject to prior approval of appropriateness to MSc Physics & Astronomy by the Physics & Astronomy programme director, as well as the Examinations Board. An examiner from the research programme has to be appointed as a second assessor. The learning objectives of this minor can be found as in Appendix 1.

Article 4.2 – Compulsory components

The regular programme includes compulsory components with a total study load of at least 12 EC. The contents and format of the compulsory components of the various tracks are further described in the Course Catalogue, stating the necessary entry requirements for successful participation in the component.

Article 4.3 – Practical components

1. In addition to, or instead of, classes in the form of lectures, the elements of the master's examination programme often include a practical component as defined in article 1.2 of part A. The Course Catalogue contains information on the types of classes in each part of the programme. Attendance during practical components is mandatory.
2. When performing practical components, students must adhere to the faculty's safety regulations.
3. The programme consists of research-related components with a study load of at least 60 EC (36 in the major, 54 in the minor). The research-related components always include the compulsory components: a research assignment of at least 54 EC (30 in the major, 48 in the minor) and a final report and a scientific presentation with a study load of 6 EC.

Article 4.4 – Elective components

1. Students choose components in the field of the discipline with a study load of at least 24 EC in consultation with and accordance of the track coordinator of the Master's programme and according to the rules stated in the Course Catalogue of the study programme.
2. Elective components are considered to be those components in the field of the discipline stated in Appendix 2, and included in the Course Catalogue of the discipline, or of components offered by another Dutch or foreign university, being according to the Examination Board of a comparable level.
3. Course components successfully completed elsewhere or that are not included in attachment 1 during the programme may supplement the student's examination programme, subject to prior permission from the Examinations Board.
 - a. The courses have to be followed at an accredited university or institute
 - b. The course has to be relevant to the master chosen.
4. In exceptional cases students may choose Bachelor's-level free elective components as part of their programme. The Examinations Board will determine whether a free elective component at the Bachelor's level will be seen as part of the programme and the number of credits that will be allocated to the elective component.
5. In terms of content, elective components must not show too much similarity to other components of the student's curriculum. The acceptable degree of similarity will be decided by the Examinations Board.
6. A free elective component will only be seen as part of the programme if the Examinations

Board has given its prior approval.

Article 4.5 – Sequence and admission requirements

1. Participation in a course may be restricted to students that have completed certain other programme components. Information about sequence and admission requirements can be found in the course catalogue.
2. In cases where the result of a component has not been determined within the time periods mentioned in Article 4.4 of part A, this component may not be required as prior knowledge for the subsequent component.

Article 4.6 – Participation practical training and tutorials

Not applicable

Article 4.7 – Exemption

1. At the written request of the student, the Examinations Board may exempt the student from taking one or more examination components, if the student:
 - a. Has passed a component of an academic or higher professional education programme that is equivalent in both content and level;
 - b. Has demonstrated through his/her work and/or professional experience that he/she has sufficient knowledge and skills with regard to the relevant component.
2. This exemption does not apply to the Master's thesis.
3. Exemptions from examinations (or parts thereof), if granted, will be valid for the same period of examinations.
4. A maximum of 60 EC can be accumulated through granted exemptions.

Article 4.8 – Degree

A student who passes the final examination of a programme is awarded a Master of Science degree. The degree awarded is stated on the diploma.

Article 4.9 – Double Master's Degree Mathematics and Physics and Astronomy/ track Theoretical Physics

1. The candidate must be admitted to both Master programmes.
2. The total study load of the programme of the candidate should amount to at least 180 EC, comprising
 - 40 EC Compulsory components
 - 72 EC Master Project Mathematics and Theoretical Physics
 - 12 EC Constrained choice physics courses
 - 44 EC Constrained choice mathematics courses
 - 12 EC Free elective courses
3. The candidate has conducted an integrated research project Master Project Mathematics and Theoretical Physics (72 EC), replacing Master Project Mathematics (36EC) and Research Project Physics and Astronomy (60EC). This must be supervised by staff members from the two study programmes; both staff members must assess the work as a pass, according to the standards for a research project in their respective master degrees.
4. The integrated research project of article 4.10, point 3 can be replaced by two separate projects: Master Project Mathematics (36 EC), and Research Project Physics and Astronomy (60EC). In this case the total load of the programme has to be at least 192 EC.
5. The compulsory components are
 - Differential Geometry (8EC, replaces Mathematical Methods from MSc Physics&Astronomy)
 - Lie Groups and Lie Algebras (8EC, replaces Group Theory from MSc

Physics&Astronomy)

- Quantum Field Theory (6EC)
 - Statistical Physics & Condensed Matter Theory 1 (6EC)
 - A joint course in Mathematics and Theoretical Physics (6EC). In 2017/18 the course will be Topology in Physics, 6EC
 - A joint seminar in Mathematics and Theoretical Physics (6EC). This will be offered for the first time in 2018/19
6. The constrained choice physics courses consist of 12 EC of physics courses from the MSc Physics & Astronomy, including at least 6 EC from the track Theoretical Physics. The courses Mathematical Methods and Group Theory cannot be taken as part of these 12 EC. The Teaching and Examination Regulations of the MSc Physics & Astronomy contains the list of courses of the MSc Physics & Astronomy, and the sublist of courses from the track Theoretical Physics.
 7. The constrained choice courses from MSc Mathematics consists of 44 EC of mathematics courses from the MSc Mathematics, including at least 4 courses from the specializations Algebra & Geometry and Mathematical Physics. At least one of the courses Algebraic Topology, Algebraic Geometry 1 and Riemann Surfaces have to be taken. The Teaching and Examination Regulations of the MSc Mathematics contains the list of courses of the MSc Mathematics, and the sublist of courses from the specializations Algebra & Geometry and Mathematical Physics.

Article 4.10 – Double Master’s programme (two-year programmes)

In order to be awarded two Master’s degrees or to have stated on the Master’s diploma that two Master’s programmes have been completed within the discipline, the following requirements must be met:

1. The total programme of the candidate should amount to at least 180 ECTS credits.
2. The candidate’s work for the programme (lectures, research work, etc.) must be of such a standard that all the compulsory requirements of each of the two programmes have been met.
3. The candidate must have conducted separate research work for both Master’s degrees. This may consist of two separate research projects (incl. thesis and colloquium) with supervisors from the respective study programmes. In the case of an integrated research project, this must be supervised by two staff members appointed from the two study programmes. Both staff members must assess the work as a pass. The total number of credits given for an integrated research project (incl. thesis and colloquium) is 3/4 of the sum of the credits given for two independent research projects.
4. The Examinations Boards of both study programmes must approve the student’s double Master’s programme before the student commences on the double Master’s programme.

Article 4.11 – Participation in courses and rules for priority admission

1. Every student must enroll for every component. To participate in courses, the student must enroll within the period indicated in the Course Catalogue and according to procedures mentioned there. The student may be refused the opportunity to participate if he/she does not enroll or fails to enroll in time.
2. Admission to courses with limited capacity takes place based on previously established and published admission criteria and rules for priority admission, on the understanding that students enrolled in the programme are given priority over others when enrolling for courses in the compulsory part of their programme.
3. Persons who are not enrolled at the University have no right to participate in teaching and examination activities.

Article 4.12 – Determining results of examination Academic Skills

1. The Academic skills in the Master consist of components with a study load of 6 EC.
2. The student may complete the Academic skills in the Master by participating in the relevant components as described in the Course Catalogue.

The student cannot do both the English Academic Course and the course Scientific Writing in English (3EC).

Article 4.13 – Research Project (including Master's Thesis and Colloquium)

1. It is mandatory that the student fills out an online research training contract, together with the supervisor, before the student starts the research training. The track coordinator and the supervisor evaluate this proposal, and upon approval the student can start the research training. The supervisor is permanent staff member of the VU and UvA Faculty of Science, appointed as an examiner by the Examinations Board.
2. At the end of the Research Project the supervisor checks on the basis of the assessment form, if the student has sufficiently achieved the set exit qualifications.
3. For the assessment of the Research Project the advice and judgement, in particular on structure and quality of reporting and presentation, a second examiner is included in the assessment. A second examiner is a staff member of the VU or UvA Faculty of Science that is not directly involved with the research project
4. If the mark for the Research Project is 8 or higher, the supervisor and the second examiner provide the examinations board with a written statement explaining their assessment results in more detail and their agreement with a potential Cum Laude.

Chapter 5. Transitional and final provisions

Article 5.1 – Amendments

1. Any amendment to the Education and Examination Regulations will be adopted by the dean after taking advice, and if necessary approval by the relevant Board of Studies. A copy of the advice will be sent to the authorised representative advisory body.
2. An amendment to the Education and Examination Regulations requires the approval of the authorised representative advisory body as stated in the WHW.
3. An amendment to the Education and Examination Regulations is only permitted to concern an academic year already in progress if this does not demonstrably damage the interests of students.

Article 5.2 – Cancelled programme components

Courses:

Preparation Research Project at CERN

Strong Interactions I

Strong Interactions II

Mathematical Methods in Theoretical Physics I

Mathematical Methods in Theoretical Physics II

Interstellar and Circumstellar Matter

Radio Astronomy

HEA: Accretion onto Compact Objects

Article 5.3 - Publication

1. The dean shall ensure a fitting publication of part A and B of these Regulations and the rules and guideline referred to in the Act.
2. These regulations can be accessed at the website of the Faculty.

Article 5.4 – Effective date

These Regulations enter into force with effect from 1 September 2017.
Thus drawn up by the Dean of the Faculty of Science on 30 August 2017 and by the Faculty board (VU) on 21 July 2017.

Appendix 1 Final attainment levels of the Major Teaching, and learning objectives minor TESLA and the minor Teaching

A. The major Teaching programme is in Dutch. The regulations of the major Teaching are as well in Dutch.

Eindtermen major Teaching

De bekwaamheidseisen leraar Voorbereidend Hoger Onderwijs zijn, naast de voor alle wo-masteropleidingen geldende Dublin-descriptoren en algemene wettelijke eisen, richtinggevend voor de doelstellingen en eindtermen van de lerarenopleidingen Voorbereidend Hoger Onderwijs. Deze zijn vastgelegd in de Wet op het voortgezet onderwijs (artikel 36 e.v.) en het Besluit bekwaamheidseisen onderwijspersoneel (met name titel 4, bekwaamheidseisen bovenbouw havo en vwo). In dat besluit worden zeven competenties beschreven:

- *Interpersoonlijk competent*
De leraar kan in het contact met leerlingen (en ook met anderen) leiden, begeleiden, bemiddelen, stimuleren en confronteren, waarmee een klimaat met open communicatie en een sfeer van samenwerking en wederzijds vertrouwen bereikt wordt.
- *Pedagogisch competent*
De leraar kan benaderingen ontwerpen, uitvoeren en evalueren om het welbevinden van leerlingen te bevorderen, om ontwikkelings- en gedragsproblemen te signaleren en om groepen en individuen te begeleiden, waarmee een veilige leeromgeving gecreëerd wordt waarin leerlingen zich kunnen ontwikkelen tot zelfstandige en verantwoordelijke personen.
- *Vakinhoudelijk en didactisch competent*
De leraar heeft een gedegen beheersing van het eigen vak, en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren, waarmee een krachtige leeromgeving voor leerlingen bereikt wordt.
- *Organisatorisch competent*
De leraar kan concrete en functionele procedures en afspraken hanteren, kan de leeromgeving en het leren van leerlingen organiseren en faciliteren en kan de planning bewaken en bijstellen, waarmee een overzichtelijke, ordelijke en taakgerichte leeromgeving bereikt wordt.
- *Competent in het samenwerken met collega's*
De leraar kan informatie delen met collega's, kan actief bijdragen aan overleg en samenwerkingsverbanden en neemt deel aan collegiale consultatie, waarmee een collegiale en harmonieuze werksfeer bevorderd wordt.
- *Competent in het samenwerken met de omgeving*
De leraar onderhoudt doelmatige contacten met ouders (verzorgers), en andere personen en instanties die te maken hebben met de zorg voor en de opleiding van leerlingen, waarmee de ontwikkeling van leerlingen op een realistische en constructieve manier wordt ondersteund en eventuele problemen tijdig worden onderkend en opgelost.
- *Competent in reflectie en onderzoek ten dienste van ontwikkeling*
De leraar stelt handelingen planmatig bij op grond van ervaringen in beroepssituaties, waarmee het eigen professioneel leren en de eigen ontwikkeling bereikt wordt. De leraar is daarnaast in staat om de beroepspraktijk in het algemeen en de eigen beroepspraktijk in het bijzonder te kunnen analyseren met distantie en met onderzoeksmatige deskundigheid, en bevordert zo de ontwikkeling van de school, van de didactiek van het vak en/of de eigen professionele ontwikkeling.

Bron: Onderwijs- en Examenregeling Masteropleidingen Leraar Voorbereidend Hoger Onderwijs, Masteropleidingen van de Faculteit der Maatschappij- en Gedragwetenschappen, Universiteit van Amsterdam. Studiejaar 2017-2018 (concept)

B.

The learning objectives of the minor Tesla are included in the study guide.

C. Minor teaching na een bachelor met een educatieve minor

De student volgt het tweede semester van de master leraar Voorbereidend Hoger Onderwijs (VHO) die de Interfacultaire Lerarenopleidingen (ILO) aanbiedt. De eindtermen komen overeen met die van de major teaching, zie hierboven.

D. Minor teaching na een bachelor zonder educatieve minor

De student volgt het eerste semester van de master leraar VHO die de ILO aanbiedt.

De opleiding leidt niet tot een bevoegdheid.

De eindtermen komen grotendeels overeen met die van de educatieve minor die de ILO aanbiedt.

De student is op basis van voldoende theoretisch inzicht, een professionele houding en voldoende vaardigheid in staat om:

1. een goede samenwerking met en tussen leerlingen tot stand te brengen;
2. voor groepen en voor individuele leerlingen een veilige leeromgeving te creëren;
3. voor groepen en voor individuele leerlingen een krachtige leeromgeving in te richten waarin leerlingen zich op een goede manier leerinhouden van het vakgebied eigen maken;
4. in groepen en in andere contacten met leerlingen een overzichtelijk, ordelijk en taakgericht leer- en werkklimaat tot stand te brengen;
5. relevante informatie uit te wisselen met collega's in de school en uitkomsten daarvan te benutten;
6. relevante informatie uit te wisselen met verzorgers van leerlingen buiten school en daarin te zorgen voor afstemming;
7. eigen opvattingen over het leraarschap en de eigen bekwaamheden als leraar, te expliciteren, kritisch te onderzoeken en verder te ontwikkelen op basis van theoretische inzichten en empirische gegevens.

Appendix 2. Description of the content and study load of the components

This list comprises the curriculum components of the Physics and Astronomy Master's programme tracks in the academic year 2017-2018. The contents of the components are described in the Course Catalogue.

Schedule Physics & Astronomy Master track Advanced Matter and Energy Physics

Format: L: lectures; T: tutorials; CP: computer practicum.; Lit: literature study; As: assignment;

Exp: experimental work; PW: practical work; PROJ: Project

Assessment: W: written exam; O: oral exam; P: presentation; R: report, PROJ: Project

Course	course code UvA	course code VU	EC	period	format	assessment
Year 1						
Compulsory: (24 EC)						
AMEP Lab Project	5354AML6Y		6	1-6		
Emergent Energy Materials	5354EMEM6Y		6	1		
Hydrodynamics	5354HYDR6Y	X_428536	6	4		
Quantum Optics	5354QUOP6Y	X_420118	6	2	L, T	W, O
Showcase 1	53541SHO0Y		0	1		
Showcase 2	53548SHO0Y		0	2		
Core 1: (18 EC required)						
Bose Einstein Condensates	5354BOEC6Y		6	2	L, T	W, O
Fermi Quantum Gases	5354FEQG6Y	X_428514	6	5	L, T	W, O
Mathematica for Physicists	5354MAFP3Y	X_428533	3	3, 6	L, T	PROJ
Nanophotonics	5354NANO6Y		6	5	L, PW	P, O
Photosynthesis and Energy	53548PHO6Y	X_422553	6	5	L, T	P, R
Photovoltaics	5354PHVO6Y	X_428516	6	4	L, T	o
Soft and Porous Matter	5354PHAC6Y		6	5		
Soft Condensed Matter and Biological Physics	53548SCM6Y	X_420167	6	2	L	W, P, O
Superconductivity	5354SUPE6Y	X_428522	6	2	L	W, O
Surface and Interface Science	5354SUIS6Y		6	5		
The Science and Technology of Nanolithography	5354NALI6Y		6	6		
Ultrafast Laser Physics	53548ULL6Y	X_422556	6	4	L, T	W
Core 2: (6 EC required)						
Statistical Physics and Condensed Matter Theory I	53541SPC6Y	X_420083	6	1	L, T	W

Statistical Physics of Soft & Living Matter	5354SPSL6Y	6	4
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Track specific compulsory project: AMEP lab project	5354AML6Y	6	1-6	PROJ	P, R
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Academic Skills: (6 EC required)

See Academic Skills list below

Year: 2

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y	60	1-6
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Research Project Physics and Astronomy 2	53542RP60Y	60	1-6
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Schedule Physics & Astronomy Master track Astronomy & Astrophysics

Format: L: lectures; T: tutorials; CP: computer practicum.; Lit: literature study; As: assignment;
Exp: experimental work; PW: practical work; PROJ: Project

Assessment: W: written exam; O: oral exam; P: presentation; R: report

Course	course code UvA	course code VU	EC	period	format	assessment
Year 1						
Compulsory: (24 EC)						
Astrophysics Colloquium	5214ASCO0Y		0	1-6	L	
Basic Linux and Coding for AA	5214BLCF3Y		3	1	L, CP	W
Open Problems in Modern Astrophysics	5354OPIM3Y		3	1	L, T	W, R, O
Statistical Methods for the Physical Sciences	5354SMFT6Y		6	2	L, T	R, O
Stellar Atmospheres	5214STAT6Y		6	1-2	L, T	W
Structure and Evolution of Stars	5214STES6Y		6	4	L, T	W, R, O
Constrained choice: (24 EC required)						
Astronomical Interferometry	5354ASIN6Y		6	5		
Astroparticle Physics	5354ASPH6Y		6	4	L, T	W
Astrovaria	5214ASTR6Y		6	1-6	PROJ	R, O
Computational Astrophysics	52148COA6Y		6	3,6	L, T	PROJ, O, R
Cosmology	5214COSM6Y		6	2	L, T	W
Fluid Dynamics	5214FLDY6Y		6	5	L, T	W, O, PROJ
General Relativity	5354GERE6Y		6	1	L, T	W, O
HEA: Radiative Processes and Relativistic Flows	5214HRPR6Y		6	4-5	L, T	W, P, PROJ
Inter-University Lectures	4214INUL6Y					
Observation Project	5214OBPR6		6	1,6	L	PROJ
Particle Physics I	53541PAP6Y		6	1	L, T	W
Star and Planet Formation	5214STPF6Y		6	4	L, T	W, O, PROJ
Track specific compulsory project	One course out of these courses		6	1-6	PROJ	P, R
Open Problems						
Basis Linux and Coding						
Observation Project						
Academic Skills: (6 EC required)						
See Academic Skills list below						
Year 2						
Compulsory: (60 EC required)						

Research Project Physics and Astronomy 1	5354RPP60Y	Ma x 60	1-6
Research Project Physics and Astronomy 2	53542RP60Y	Ma x 60	1-6

Schedule Physics & Astronomy Master track GRAPPA

Format: L: lectures; T: tutorials; CP: computer practicum.; Lit: literature study; As: assignment;
Exp: experimental work; PW: practical work; PROJ: Project

Assessment: W: written exam; O: oral exam; P: presentation; R: report

Course	course code UvA	course code VU	EC	period	format	assessment
Year 1						
Compulsory: (6 EC)						
Cosmology	5214COSM6Y		6	2	L,T	W,P
Choice of GRAPPA profile:						
Profile Particle: (12 EC required)						
Particle Physics I	53541PAP6Y		6	1	L, T	W
Particle Physics II	53542PAP6Y		6	4	L, T	W
Profile Astro: (12 EC required)						
Astroparticle Physics	5354ASPH6Y		6	4	L, T	W
General Relativity	5354GERE6Y		6	4	L, T	W, O
Electives: (18 EC required)						
Advanced Cosmology	5354ADCO3Y		3	6		
Advanced Quantum Field Theory	5354AQFT6Y,		6	4		
Advanced Statistics	5354ADST3Y		3	3		
Astroparticle Physics	5354ASPH6Y		6	4	L, T	W
Basic Linux and Coding for AA	5214BLCF3Y		3	1		
Beyond the Standard Model	5354BESM3Y	X_420192	6	5	L	R
CERN Research Project	5354CERP6Y		6	1	PROJ	R, O
Computational Astrophysics	52148COA6Y		6	3,6		
Computational Methods	53548COM6Y	X_420014	6	4	L, T	O
Computational Methods, extension	53548COM6Y	X_420014	3		L, T	O
Flavour Physics and CP Violation	53548CPV3Y	X_428539	3	4		W, P, O

GRAPPA Student Seminar	5354GRSS6Y		6	6		
Gravitational Waves	5354GRWA3Y		3	5		
HEA: Radiative Processes and Relativistic Flows	5214HRPR6Y		6	4-5		
Mathematical Methods in Theoretical Physics	?		6	2		
Nikhef Project	5354NIPR6Y		6	4-6	PROJ	W
Open Problems in Modern Astrophysics	5214OPMA6Y		6	1	L, T	P, R, O
Particle Detection	5354PADE6Y		6	5	L, T	O
Programming C++	5354PROG3Y		3	3		
Quantum Field Theory	5354QUFT6Y		6	2	L, T	W, O
Quantum Field Theory, extension	5354QFTE3Y	X_422554	3	3		
Statistical Data Analysis	5354STDA6Y		6	1	T	W, O
Statistical Methods for the Physical Sciences	5354SMFT6Y		6	2	L, T	R, O
String Theory	5354STTH6Y	X_400242	6	5	L, T	W
Structure and Evolution of Stars	5214STES6Y		6	4	L, T	W, R, O

Track specific compulsory project :

6 1-6 PROJ P, R

Several courses of projects that add up to 6EC together. The guarantee is part of the intake interview (examples of projects with projects: Nikhef Project, GRAPPA Seminar, Beyond Standard Model, Particle Detection).

Academic Skills: (6 EC required)

See Academic Skills list below

Year 2

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y		Max 60	1-6		
Research Project Physics and Astronomy 2	53542RP60Y		Max 60	1-6		

Schedule Physics & Astronomy track Physics of Life and Health

Format: L: lectures; T: tutorials; CP: computer practicum.; Lit: literature study; As: assignment;

Exp: experimental work; PW: practical work; PROJ: Project

Assessment: W: written exam; O: oral exam; P: presentation; R: report

Course	course code UvA	course code VU	EC	period	format	assessment
Year 1						
Compulsory: (12 EC)						
Light-tissue Interaction	5354LIT6Y		6	1	L, T	W, P, O
Soft Condensed Matter and Biological Physics	53548SCM6Y	X_420167	6	2	L	W, P, O
Constrained Choice: (24 EC required)						
Advanced 3D & 4D Medical Imaging	5354A34M6Y		6	5		
Advanced Medical Image Processing	53548AMI6Y		6	2		
Advanced Medical Technology	53548ADM6Y	X_437026	6	5	L, PW	
Biomedical Modelling and Simulation	53548MSM6Y	X_430112	6	1	L, T	W, P, O
Dynamics of Biomolecules and Cells	53548DYB6Y	X_422583	6	4	L	W, R, O
Hydrodynamics	5354HYDR6Y	X_428536	6	4		
Mathematica for Physicists	5354MAFP3Y	X_428533	3	3,6	L, T	PROJ
Nanophotonics	5354NANO6Y	X_428537	6	5	L, PW	O
Parameter Estimation Applied to Medical and Biological Sciences	53548PEM6Y	X_432631	6	4	L	W
Physics of organs 1: Cardio-Pulmonary Physics	53541PHO6Y	X_428527	6	1	L, T	W
Physics of organs 2: Sensory Organs and Bioelectricity	53542PHO6Y	X_428528	6	2	L, T	W
Statistical Physics of Soft & Living Matter	5354SPPL6Y		6	4		
Stochastic simulation	5284STSI6Y	X_418075	6	2	L, PW	As, W
Compulsory Choice: (6 EC required)						
Advanced MRI	5354ADMR3Y		3	6	PW	P
Advanced spectroscopy	52548ADS6Y	X_432767	6	6	L, T, PW	W, P, O
From Genome to Physiome	5354GETP3Y		3	6	PW	P
Laboratory challenge	53548LAC3Y		3	6	PW	P
Literature Review Biomedical Physics	5354LBP6Y		6	6		
Track specific compulsory project	One course out of these courses:		6	1-6	PROJ	P, R
Advanced MRI						

Advanced spectroscopy
 From Genome to Physiome
 Laboratory challenge
 Literature Review Biomedical Physics

Academic Skills PLH (suggested): (6 EC required)

Entrepreneurship for Physicists	53548ENF6Y,	6	3
Ethics in biomedical research	53548EIB3Y	3	3
Innovation in Medical Technology to Improve Health Care System	5354IIMT6Y	6	6

Academic Skills: (6 EC required)
 See also Academic Skills list below

Year 2

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y	Max 60	1-6
Research Project Physics and Astronomy 2	53542RP00Y	Max 60	1-6

Schedule Physics & Astronomy track Science for Energy and Sustainability

Format: L: lectures; T: tutorials; CP: computer practicum.; Lit: literature study; As: assignment;
 Exp: experimental work; PW: practical work; PROJ: Project

Assessment: W: written exam; O: oral exam; P: presentation; R: report

Course	course code UvA	course code VU	EC	period	format	assessment
Year: 1						
Compulsory: (12 EC)						
Current Sustainable Energy Technologies	52548CSE6Y	X_4225826	6	3	L, T	R
Project Sustainable Future	52548PRS6Y	X_432784	6	6	L,T, PROJ	W,R, O
Constrained Choice: (24 EC required)						
BioSolar Cells	52548BIC6Y	X_428531	6	1	L, T	
Catalysis for Sustainable Energy	5254CFSE6Y		6	4		
Coordination and Organometallic Chemistry	5254COO6Y		6	2		
Emergent Energy Materials	5354BIIE6Y		6	1		

Energy and Climate Change: Science, Policy and Economics	5264ECCS6Y		6	2		
Environmental Chemistry	5254ENCH6Y	X_437004	6	1		
Green Chemistry	52548GRC6Y	X_430557	6	1		
Heterogeneous Catalysis	5254HECA6Y		6	3		
Homogeneous Catalysis	5254HOCA6Y		6	5		
Management of Sustainable Innovation	52548MAS6Y	X_432739	6	2		
Open Innovation in Science and Sustainability	53548OII6Y	New	6	2		
Organic Photovoltaics	53548ORP6Y	X_422590	6	5		
Photosynthesis and Energy	53548PHO6Y	X_422553	6	5		
Photovoltaics	5354PHVO6Y		6	4		
Track specific compulsory project	Literature thesis		6	1-6	PROJ	P, R

Academic Skills: (6 EC required)

See Academic Skills list below

Year 2

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y		Max 60	1-6		
Research Project Physics and Astronomy 2	53542RP00Y		Max 60	1-6		

Schedule Physics & Astronomy Master track: Theoretical Physics

Format: L: lectures; T: tutorials; CP: computer practicum.; Lit: literature study; As: assignment;
Exp: experimental work; PW: practical work; PROJ: Project

Assessment: W: written exam; O: oral exam; P: presentation; R: report

Course	course code UvA	course code VU	EC	period	format	assessment
Year 1						
Compulsory: (18 EC required)						
Quantum Field Theory	5354QUFT6Y	X_420081	6	2	L, T	W, O

Statistical Physics and Condensed Matter Theory I	53541SPC6Y	X_420083	6	1	L, T	W
Student Seminar Theoretical Physics	5354SSPH6Y		6	4-5		O

Core 1: (0 EC required)

Advanced Computational Condensed Matter	?		3	6		
Advanced Cosmology	5354ADCO3Y		3	6		
Advanced Numerical Methods in Many Body Physics	5354ANMI6Y		6	5		
Advanced Quantum Field Theory	5354AQFT6Y		6	4		
Advanced Statistics	5354ADST3Y		3	3		
Advanced Topics in Theoretical Physics 1	5354ATIT6Y		6	1-2	L, T	
Advanced Topics in Theoretical Physics 2	?		6	4-5		
Cosmology	5214COSM6Y		6	2		
General Relativity	5354GERE6Y	X_420128	6	1	L, T	W, O
Mathematical Methods in Theoretical Physics	?		6	2		
Particles and Fields	5354PAFI6Y	X_420112	6	4-5	L, T	W, O
Particles and Fields, extension	5354PAFE2Y		3	6		
Quantum Field Theory, extension	5354QFTE3Y	X_422554	3	3		
Statistical Physics and Condensed Matter Theory II	53542SPC6Y	X_420100	6	4-5	L, T	P, R
Statistical Physics and Condensed Matter Theory, extension	5354SPCM3Y	X_420083	3	3		
Statistical Physics of Soft & Living Matter	5354SPSL6Y,		6	4		
String Theory	5354STTH6Y	X_400242	6	5	L, T	W
String Theory, extension	5354STTE3Y		3	6		
Topology in Physics	?		6	4-5		

Core 2: (0 EC required)

Beyond the Standard Model	5354BESM6Y	X_420192	6	5	L	R
Bose Einstein Condensates	5354BOEC6Y		6	2	L, T	W, O
Computational Methods	53548COM6Y	X_420014	6	4	L, T	W
Cosmology	5214COSM6Y		6	2		
Fermi Quantum Gases	5354FEQG6Y	X_428514	6	5	L, T	W, O
Flavour Physics and CP Violation	53548CPV3Y	X_428539	3	4		W/P
Introduction to BV Quantization	5324ITBQ3Y		3			
Particle Physics I	53541PAP6Y		6	1	L, T	W

Track specific compulsory project	Student Seminar TP		6	1-6	PROJ	P, R
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Academic Skills: (6 EC required)

See Academic Skills list below

Year 2

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y,	Max 60	1-6
Research Project Physics and Astronomy 2	53542RP00Y	Max 60	1-6

Schedule Science, Business & Innovation

The schedule can be found in the TER of the master SBI

ACADEMIC SKILLS COURSES: 6 EC required out of list below (except for the SBI track)

Course	course code UvA	course code VU	EC	period	format	assessment
English Academic Course*	5524ENAC3Y	X_437028	3	1-2		O, P
Communication, Organization and Management		AM_470572	6	2	L, T, PW	W, R, O
Entrepreneurship for Physicists		X_422600	6	3		
Ethics in Life Sciences		AM_470707	3	3	L, T	W, P, O
Ethics in Biomedical Research		X_422592	3	3	L, T	W, P
Physics Education Project		X_420523	3	1-6		
Innovation in Medical Technology to Improve the Health Care System		X_430602	6	6	L, T	P, R
Managing Science and Technology in Society		AM_470586	6	1	L, T, PW	R, O, PROJ
Academic skills; individual project			3	1-6		PROJ
Research Methods for Analyzing Complex Problems		AM_1182	6	1		
Science and Communication		AM_470587	6	1	L, T	W, O, PROJ
Science in Dialogue		AM_1002	6	2	h, w, prac	PROJ, W, R
Science in Perspective	5524SCPE6Y	X_437030	6	4-5	L, T	W, R, O

Science Journalism	AM_471014	6	2	L, T	W, R, O
Scientific Writing in English	X_400592	3	2,6	w	O
Tutoring Students	X_432625	3	2	L, T	R, O
Wetenschapscommunicatie voor Bèta-onderzoekers	AB_470185	6	5	L, T	W, O, PROJ
Academic Skills; Critical Thinking *	5524ASCT3Y		6	L, T	W, R

* if less than 20 students, the course is canceled. Students can not do both the English Academic Course and the course Scientific writing in English.

Schedule Physics Majors and Minors

Major Science in Society

Compulsory courses

Educational component	Subject code	EC	Period	Type	Assessment
Analysis of Governmental Policy	AM_470571	6	1	L, T	W, R, P
Research Methods for Analyzing Complex Problems	AM_1182	6	1	L, T	-
Business Management in Health and Life Sciences	AM_470584	6	2	L	W, R
Communication, Organization and Management	AM_470572	6	2	L, T	W, R
Disability and Development	AM_470588	6	2	L, T	W, R
Entrepreneurship in Health and Life Sciences	AM_470575	6	2	L, T	W, O
Health, Globalisation and Human Rights	AM_470818	6	2	L, T	W, PROJ
Policy, Politics and Participation	AM_470589	6	2	L, T	P, R
Science in Dialogue	AM_1002	6	2	L, T	W, R, O
Clinical development and clinical trials	AM_470585	6	3	L, T	W
Internship Science in Society	AM_1134	30	1-6	-	-

Major Science communication

Educational component	Subject code	EC	Period	Type	Assessment
Internship Communication Specialisation	AM_471148	30	1-6	-	-

Major Teaching

Educational component	Subject code	EC	Period	Type	Assessment
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Didactiek 1	O_MLDIDAC_1	6	1	L, T	-
Didactiek 2	O_MLDIDAC_2	6	2,3	L, T	-
Didactiek 3	O_MLDIDAC_3	9	4-6	L, T	-
Peergroup 1	O_MLPEERGR_1	0	1-3	T	-
Peergroup 2	O_MLPEERGR_2	0	3-5	T	-
Praktijk 1	O_MLPRAK_1	6	1	L	-
Praktijk 2	O_MLPRAK_2	9	2,3	-	-
Praktijk 3	O_MLPRAK_3	15	4-6	-	-
Praktijk onderzoek 1	O_MLPROZ_1	3	3	L, T	-
Praktijk onderzoek 2	O_MLPROZ_2	6	4-6	-	-