FACULTIES OF SCIENCE

University of Amsterdam

Vrije Universiteit Amsterdam

TEACHING AND EXAMINATION REGULATIONS PART B

Academic year 2021-2022

MASTER'S PROGRAMME

Joint Degree Physics and Astronomy

Table of Contents

Chapter 1. General Provisions

Article B-1.1 – Definitions

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

a.	Research project	Compulsory internship including master's thesis and colloquium
b.	Study 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 B-1.2 – General information master's programme

1. The Master's programme Physics and Astronomy (CROHO 65016), is offered on a full-time basis and the language is English.
2. In this document the reader should consider articles referring to the new track names to be applicable to the old tracks as well.
3. The programme has a workload of 120 EC.
4. A component of the programme generally consists of 3 EC or multiples of this number.
5. Within the programme Physics and Astronomy, the following tracks are offered:
    a. Advanced Matter and Energy Physics;
    b. Astronomy and Astrophysics;
    c. Biophysics and Biophotonics;
    d. Gravitation, Astro- and Particle Physics in Amsterdam (GRAPPA);

e. Science for Energy and Sustainability;
f. Theoretical Physics;
g. General Physics and Astronomy.

6. In each Master track the student may choose a major or a minor from the list below (see Article B4.1).
    a. Major Science Communication;
    b. Major Science in Society;
    c. Major Teaching;
    d. Minor Teaching;
    e. Minor Tesla.
7. 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 complete Study Plan has to be submitted to the Examinations Board. The student submits this plan, approved 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 plan the student submits this plan, approved by the track coordinator, to the Examinations Board.

Article B-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 B-2.1 – Aim of the programme

1. The general objective of the Master's programme is to provide students with such 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.
2. 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.
3. The aim of the Master's programme in Physics and Astronomy, 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 B-2.2 – Exit qualifications

1. The graduate of the Master's programme Physics and Astronomy:
    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.
    l. is familiar with the rules of scientific integrity and is acting accordingly.
2. 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. In addition, each graduate in the programme curriculum:
    a. is able to compare and incorporate obtained research results and conclusions within the framework of the results of other scientists;
    b. is able to form a vision on the development of scientific research in the field of physics/astronomy;
    c. 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:
    i. Emergent materials, strongly correlated electron systems and unconventional superconductivity;
    ii. Energy materials and processes for (solar) energy conversion;
    iii. Complex liquids, granular and soft bio-matter and metamaterials;
    iv. High-precision laser spectroscopy, ultracold quantum gases, quantum information and simulation with ultracold atoms or molecules.
    v. Computational methods in hard and soft condensed matter.
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 section b above.

4. 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. a well-founded knowledge of experimental or theoretical approaches in at least one of the following research fields:
        i. Matter near neutron stars and black holes
        ii. Matter inside neutron stars
        iii. Explosions and bursts near neutron stars and black holes
        iv. Exoplanets and planet formation
        v. Stars and stellar populations
        vi. Advanced instrumentation
5. In addition to paragraph 1 and 2, the student who has completed the track Biophysics and Biophotonics 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:
        i. Novel imaging modalities;
        ii. Novel therapeutic applications;
        iii. Cellular biophysics;
        iv. 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 section b above.
6. In addition to paragraph 1 and 2, the student who has completed the track Gravitation, Astro- and Particle Physics in Amsterdam (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:
        i. Standard Model and Beyond the Standard Model Physics;
        ii. Cosmology;
        iii. Dark Matter;
        iv. Gravitational Waves and tests of Gravity;

v. Cosmic Messengers;
vi. (Astro-)Particle Physics Detector R&D.

7. 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.
8. 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 of modern statistical physics and condensed matter theory;
    c. the student is informed about basic concepts and techniques of theoretical physics;
    d. the student is capable of finding the appropriate theoretical framework for a wide range of physics problems.
9. The exit qualifications of the majors and minors are stated in appendix 3.

Chapter 3. Admission to the programme

Article B-3.1 – Entry requirements

1. Students who have successfully completed the following degrees may be admitted:
    a. a Bachelor's degree in Physics and Astronomy, in Physics, in Applied Physics, or in Astronomy, awarded by a Dutch University;
    b. a Bachelor's degree in *Bèta-gamma met een Natuurkunde Major* (Bèta-gamma with a Physics Major), awarded by the University of Amsterdam;
    c. a bachelor's degree awarded by Amsterdam University College with a *Science Major, track Physics*, including the courses Electrodynamics, Quantum Physics and Mathematical Methods in Physics.
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 pre-master's programme of maximum 42 EC as an admission requirement. After completion of this pre-master's programme a letter of admission will be issued, exclusively for the stated master's programme and track.
4. Without prejudice to the provisions of paragraphs 1, 2 and 3, when the Admissions Board decides that the additional required education on Bachelor's-level for a candidate is for not

more than 12 EC, direct admission to the master programme can be granted. In this case the additional course(s) to be taken by the student will be part of the *free* elective components.

Article B-3.2 – Pre-master's programme

1. Holders of a bachelor's degree in a field that sufficiently corresponds with the field of the master's programme may apply for admission to the pre-master's programme. In accordance to Article B-3.1 section 3 the Admissions Board may draw up a pre-master's programme of maximum 42 EC. This pre-master's programme may be taught partially in Dutch and partially in English. The programme must be completed in a maximum of 2 years.
2. The possible content of the pre-master's programme is described in section B of the Teaching and Examination Regulations for the Bachelor's programme Natuur- en Sterrenkunde. It is also listed in Appendix 2 of this TER B.
3. Proof of a successfully completed pre-master's programme shall serve as confirmation of admission to the master's programme specified within it in the subsequent academic year.

Article B-3.3 – Restrictions on the number of students admitted to the master's programme

No restrictions

Article B-3.4 – Intake dates

A request for admission to the master's programme starting in September must be received before June 30, 23.59 CEST in the case of EU/EEA/Swiss students, and before January 31, 23.59 CEST in the case of non-EU/EEA/Swiss students. Under exceptional circumstances, the Admissions Board may consider a request submitted after this closing date.

Article B-3.5 – English Language Requirements

1. The proficiency requirement in English as the official language can be met by the successful completion of one of the following examinations:
    a. Academic IELTS: 6,5, at least 6 on each sub-score (listening/reading/writing/speaking);
    b. TOEFL Internet-based test: 92, at least 22 on each sub-score (listening/reading/writing/speaking);
    The foregoing examination must have been taken within two years before the student's enrolment.
    c. Cambridge Advanced English: C1 Advanced (CAE): minimal score 180; C2 Proficiency (CPE).
    Please note that the TOEFL-code for the University of Amsterdam is 9011.
2. An exemption from the English examination referred to in the first paragraph shall be granted to students who:
    a. have received a diploma in tertiary education in one of the following English-speaking countries: Australia, Canada (English), New Zealand, Ireland, the United Kingdom or the United States of America;
    b. possess a bachelor's degree from a Dutch university satisfying the requirement of sufficient command of the English language;

Chapter 4. Content and organisation of the programme

Article B-4.1 – Organisation of the programme

Depending on 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 1. 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 Appendix 1 and in the course catalogue.

Table 1.

Components	**Regular programme**	**Programme with a major**	**Programme with a minor**
Compulsory[#] and restricted-choice elective components discipline	36EC	Total 24 EC	30 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**

[#] For some of the tracks this includes restricted choice 1.

* The research project is 60 EC. A different organization of the research project requires permission of the Examinations Board. The research project can be split in maximally 2 projects, 1 project is at least 36 EC. Each project is a multiple of 6 EC. The second research project is at least 18 EC.

1. The student can choose between the regular programme and a programme containing a major or a minor. These are:
    a. Major Science Communication (VU);
    b. Major Science in Society (VU).
    c. Major Teaching (UvA or VU);
    d. Minor Teaching (UvA or VU);
    e. Minor Tesla (UvA);
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.
3. Regarding the major Teaching:
   The 60 EC Major Teaching offered by the Interfacultaire Lerarenopleidingen (ILO) results in the first-degree teaching competency (Dutch: eerstegraads bevoegdheid). Students who already have the second-degree teaching competency (tweedegraads bevoegdheid), for example by having completed the Educatieve Minor in the Bachelor, can obtain the first-

degree teaching competency by following a reduced 30 EC program at ILO. The program should then be implemented as a program with minor (see table 1). An alternative implementation may be possible, but only after consultation with both Major- and Track Coordinator and approval by the Examinations Board. The exit qualifications of the major can be found in Appendix 3. Students first have to finish 48 EC of the obligatory research part of the programme before starting the major Teaching.

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 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 in Appendix 3.

Article B-4.2 – Compulsory and restricted-choice 1 elective components

1. The regular programme includes compulsory and restricted-choice 1 elective components with a total study load of at least 12 EC. The contents and format of these components of the various tracks are listed in Appendix 1 and further described in the Course Catalogue, stating the necessary entry requirements for successful participation in the component.
2. On written recommendation of the track coordinator at most one of these components may be replaced by another elective course provided that the exit qualifications of the track are met.

Article B-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 A-1.2 of part A. Appendix 1 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 for a program with a the major, 54 for a program with a minor). The research-related components always include the following compulsory components: a research assignment, a final report and a scientific presentation.

Article B-4.4 – Restricted-choice and free elective components

1. Students choose components in the field of the discipline in consultation with the track coordinator of the master's programme and according to the rules stated in Table 1 above, Appendix 1 and in the Course Catalogue of the study programme. On written recommendation of the track coordinator at most 12 EC of these components may be chosen from another track.
2. Restricted-choice elective components are considered to be those components in the field of the discipline stated in Appendix 1, and included in the Course Catalogue of the discipline, or of components offered by another Dutch or foreign university, being according to the Examinations Board of a comparable level.
3. Students who opt for a regular programme can choose up to 12 EC worth of free elective components either from the Physics and Astronomy programme or from other Master programmes.

4. In exceptional cases, and only after the agreement of the track coordinator, students may choose Bachelor's-level free elective components as part of their programme.
5. In terms of content, restricted-choice and free 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. Course components successfully completed elsewhere or that are not included in Appendix 1 during the programme may supplement the student's examination programme, subject to prior permission from the Examinations Board. The courses have to be followed at an accredited university or institute.

Article B-4.5 – Free curriculum

In consultation with the programme director, the student may compile a curriculum of his/her own choice, which has to be approved by the Examinations Board. The free curriculum must possess at least the extent, breadth and depth of a regular master's programme and must be in line with the learning outcomes of the degree programme. At least one half of the proposed curriculum has to consist of components of the regular programme (see Table 1), including the Research Project.

Article B-4.6 – 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 A-4.4 of part A, this component may not be required as prior knowledge for the subsequent component.

Article B-4.7 – Participation practical training and tutorials

Not applicable

Article B-4.8 – 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 Research Project.
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 B-4.9 – 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. The degree certificate will state that this is a joint degree.

Article B-4.10 – 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
    a. 32 EC Compulsory components;
    b. 72 EC Integrated Research Project Mathematics and Theoretical Physics;
    c. 12 EC Restricted-choice electives theoretical physics courses;
    d. 14 EC Restricted-choice electives specialization mathematics courses;
    e. 38 EC Restricted-choice electives mathematics courses;
    f. 12 EC Free-choice elective courses.
3. The candidate has conducted an Integrated Research Project Mathematics and Theoretical Physics (72 EC), replacing Master Project Mathematics (36 EC) and Research Project Physics and Astronomy (60 EC). The Integrated Research Project Mathematics and Theoretical Physics must be supervised by examiners from both the Master's programmes. Together with examiners from both programmes acting as independent second reader of the Master Thesis, they must assess the project as a pass according to the standards for assessment for the respective programmes.
4. The integrated research project of article B-4.10, point 3 can be replaced by two separate projects: Master Project Mathematics (36 EC), and Research Project Physics and Astronomy (60 EC). In this case the total load of the programme must be at least 192 EC.
5. The compulsory components (32 EC) are
    a. Differential Geometry (8 EC)
    b. Quantum Field Theory 1 and 2 (3+3 EC)
    c. Condensed Matter Theory 1 and 2 (3+3 EC)
    d. Topology in Physics (6 EC)
    e. Student seminar Theoretical Physics (6 EC).
6. The restricted-choice elective physics courses consist of 12 EC from the track Theoretical Physics. The courses Mathematical Methods, Quantum Computing, Quantum Information Theory, and Topology in Physics cannot be taken as part of these 12 EC. The courses Lie Groups and Group Theory cannot both be taken.
7. There are three possible mathematics specializations: Algebra, Geometry & Mathematical Physics (AG&MP), Analysis and Dynamical Systems (AN&DS), and Discrete Mathematics and Quantum Information (DM&QI). The restricted-choice elective courses from the MSc Mathematics consist of 52 EC of which 14 EC depend upon the chosen specialization. For details see article B4.14.4 of the Teaching and Examination Regulations of the MSc Mathematics, part B.

Article B-4.11 – Double Master's programme (two-year programmes)

In case a student combines two master's programmes and their components, the following requirements must be met in order to be awarded two master's degrees:

1. The total programme of the candidate should amount to at least 180 EC. The student follows the Physics and Astronomy Programme with a minor (cf. Table 1) (with 90 EC Physics and Astronomy components) and obtains 30 EC exemptions (instead of the minor) with courses from the other master's programme.
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 four staff members, two from each of the study programmes. All 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 the double master's programme.

Article B-4.12 – Participation in courses and rules for priority admission

1. Every student must enrol for every component. To participate in courses, the student must enrol within the period indicated in Appendix 1 and in the Course Catalogue and according to procedures mentioned there. The student may be refused the opportunity to participate if he/she does not enrol or fails to enrol 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 B-4.13 – Determining results of examination Academic Skills

1. The Academic skills in the Master consist of components with a total 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 Appendix 1 and in the Course Catalogue.

Article B-4.14 – Research Project (including master's Thesis and Colloquium)

1. It is mandatory that the student fills out a proposal in datanose (https://datanose.nl/), together with the examiner. The track coordinator and the examiner evaluate this proposal, and upon approval the student can start the research training. The examiner is a staff member of the VU or UvA Faculty of Science, appointed by the Examinations Board.
2. At the end of the Research Project, the examiner 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 of a second examiner is included, who pays particular attention to the structure and quality of the report and the presentation. The language of both the report and the presentation is English. The second examiner is a staff member of the VU and/or UvA Faculty of Science that is not directly involved with the research project.

Chapter 5. Academic student counselling

Article B-5.1 – Academic student counselling

The academic student counselling for this programme consists of a dedicated study advisor for all students of the programme.

Chapter 6. Teaching evaluation

Article B-6.1 – Teaching evaluation

Teaching evaluation shall take place as follows:

1. Course evaluations with an UvA-Q questionnaire of all compulsory courses, and of courses requested by the Programme Committee (PC);
2. Course evaluations with a VU questionnaire for those courses organized at the VU;
3. Curriculum evaluation of the degree programme and the tracks within the programme;
4. Oral discussion in the Semester Response System (SRS) meetings.

All evaluation reports are discussed within the PC. The PC advises the programme director on the quality of the degree programme.

Chapter 7. Transitional and final provisions

Article B-7.1 – Amendments

1. The dean shall establish amendments to the part B of these Regulations by independent decision – having heard the Programme Committee (PC) and with due regard for the authority of the relevant advisory bodies.
2. An amendment to the Teaching and Examination Regulations requires the approval of the authorised representative advisory body as stated in the WHW.
3. Amendments to the part B of these Regulations do not apply to the current academic year unless they can be reasonably assumed not to damage the student's interest.

Article B-7.2 – Cancelled programme components

1. Cancelled courses:
    a. Fermi Quantum Gases
    b. Mathematica for Physicists
    c. AMEP Lab Project
    d. Showcase 1
    e. Showcase 2
    f. Organic Photovoltaics
    g. Physics Education Project

2. Courses that are not taught in 2021/2022 but will be taught again in 2022/2023:
    a. Stellar Populations
    b. Space Instrumentation for High-Energy Astrophysics
    c. Radio Astronomy
    d. Science in Perspective
3. These courses have been split in two and have changed their name:
    a. Statistical Physics of Soft & Living Matter (old) Fundamental Topics in Statistical Physics 1 & 2 (new)

   b. Statistical Physics and Condensed Matter Theory I (old) Condensed Matter Theory 1 & 2 (new)
   c. Quantum Field Theory (old) Quantum Field Theory 1 & 2 (new)
4. These courses have changed their name:
   a. Quantum Field Theory, extension (old) Quantum Field Theory 3 (new)
   b. Statistical Physics and Condensed Matter Theory, extension (old) Condensed Matter Theory 3 (new)
   c. String Theory (old) String Theory 1 (new)
   d. String Theory, extension (old) String Theory 2 (new)
   e. Field Theory in Particle Physics (old) Field Theory in Particle Physics 1 (new)
   f. Field Theory in Particle Physics, extension (old) Field Theory in Particle Physics 2 (new)

Article B-7.3 – 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 B-7.4 – Effective date

Section B of these Regulations enter into force with effect from 1 September 2021 and applies up to and including 31 August 2022. If no new or amended TER B have been adopted by that date, the current TER B will be extended by a maximum of 6 months.

Thus drawn up by the Dean of the Faculty of Science on 16 November 2021.

Appendix 1 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 2020-2021. The contents of the components are described in the Course Catalogue. The amount of EC required in the schedules below refers to the *Regular programme*. It is different for the *Programme with a major* or the *Programme with a minor*, cf. Table 1.

Schedule 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 code		EC	period	format	assessment
Course	**UvA**	**VU**				
Year 1						
Compulsory: (12 EC)						
Condensed Matter Theory 1	53541CMT3Y		3	1	L,T,CP	PROJ
Fundamental Topics in Statistical Physics 1	5354FTS13Y		3	1	L,T,CP	PROJ
AMEP Seminar	5354AMSE3Y		3	1-5	L	none
Programming for AMEP	5354PRFA3Y		3	1-5	L,T,CP	PROJ
Restricted-choice electives 1: (12 EC required)						
Emergent Energy Materials	5354EMEM6Y		6	1	L, T	W
Quantum Optics	5354QUOP6Y	X_420118	6	2	L, T	W, O
Hydrodynamics	5354HYDR6Y	X_428536	6	4	L, T	W, PROJ, As
Restricted-choice electives 2: (18 EC required)						
Bose Einstein Condensates	5354BOEC6Y		6	2	L, T	W, O
Condensed Matter Theory 2	53542CMT3Y		3	2	L, T	W
Fundamental Topics in Statistical Physics 2	5354FTS23Y		3	5	L, T	W
Machine Learning for Physics and Astronomy	5354MLFP6Y		6	5	L, T, CP	W, As
Nanophotonics	5354NANO6Y		6	5	L, PW	P, O
Photovoltaics	5354PHVO6Y	X_428516	6	4	L, T	O
Quantum simulations with atoms and molecules	5354QSWA3Y		3	5	L, T	W, O
Soft and Porous Matter	5354PHAC6Y		6	5	L, T	P, W, As
Soft Condensed Matter and Biological Physics	53548SCM6Y	X_420167	6	2	L	W, P, O
Superconductivity	5354SUPE6Y	X_428522	6	4	L	W, O
Surface and Interface Science	5354SUIS6Y		6	5	L	As, P
The Science and Technology of Nanolithography	5354NALI6Y		6	2	L, T	W
Topological Materials	5354TOMA3Y		3	6	L, T	W

Ultrafast Laser Physics	53548ULL6Y	X_422556	6	4	L, T	W

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

Free elective components as defined in article B4.4.3 (12 EC required)

Year 2
Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y		36-60	1-6
Research Project Physics and Astronomy 2	53542RP60Y		18-60	1-6

Schedule 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, PROJ: Project

Course	course code UvA	VU	EC	period	format	assessment
Year 1						
Compulsory: (9 EC)						
Astrophysics Colloquium	5214ASCO0Y		0	1-6	L	none
Open Problems in Modern Astrophysics	5354OPIM3Y		3	1	L, T	W, R, O
Statistical Methods for the Physical Sciences	5354SMFT6Y		6	3	L, T, CP	W, PROJ
Restricted-choice electives 1 (18 EC required)						
Atmospheres and Radiative Transfer	5214STAT6Y		6	1	L, T	W
Disks and Accretion	5214HAOC6Y		6	4	L, T, CP	W, R
Extreme Astrophysics	5354EXAS6Y		6	2	L, T, CP	W, PROJ
Structure and Evolution of Stars	5214STES6Y		6	2	L, T, CP	W, R, P
Restricted-choice electives 2 (18 EC required)						
Astroparticle Physics	5354ASPH6Y		6	4	L, T	W
Astrovaria	5214ASTR6Y		6	1-6	PROJ	R, O
Programming for Astronomy & Astrophysics	5214BLCF3Y		3	1	L, CP	R
Cosmology	5214COSM6Y		6	2	L, T	W
General Relativity	5354GERE6Y		6	1	L, T	W, O
GRAPPA Student Seminar	5354GRSS6Y		6	6	L	P, R
Gravitational Waves	5354GRWA3Y		3	5	L, T	W
Machine Learning for Physics and Astronomy	5354MLFP6Y		6	5	L, T, CP	W, As
Observation Project	5214OBPR6		6	1-2	PROJ	R
Astronomical observations from design to proposal	5354AODT3Y		3	6	PROJ	R
Particle Physics I	53541PAP6Y		6	1	L, T	W
Fluid Dynamics	5214FLDY6Y		6	5	L, T	W, P
Planet Formation and Exoplanets	5214STPF66Y		6	4	L, T	W, R, P
Astronomical Interferometry	5354ASIN6Y		6	5	L, T	W, R
Academic Skills: (3 more EC required in addition to Open Problems in Modern Astrophysics)						
See Academic Skills list below						
Free elective components as defined in article B4.4.3 (12 EC required)						
Year 2						
Compulsory: (60 EC required)						
Research Project Physics and Astronomy 1	5354RPP60Y		36- 60	1-6		
Research Project Physics and Astronomy 2	53542RP60Y		18- 60	1-6		

Schedule track Biophysics and Biophotonics

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: (12 EC)						
Light-tissue Interaction	5354LITI6Y		6	1	L, T	W, P, O
Soft Condensed Matter and Biological Physics	53548SCM6Y	X_420167	6	2	L	W, P, O
Restricted-choice electives: (24 EC required)						
Advanced 3D & 4D Medical Imaging	5354A34M6Y		6	5	L, T	W, P
Advanced Medical Image Processing	53548AMI6Y		6	2	L, T, CP	R
Tracer Kinetic Modeling	53548TRK6Y	XM_0014	6	5	L, PW	W
From physics to physiology	53548PHT6Y	X_430112	6	1	L, T, CP	W, P, R
Advanced Biophysics	53548DYB6Y	X_422583	6	4	L	W, R, P
Hydrodynamics	5354HYDR6Y	X_428536	6	4	L, T	W, PROJ, As
Machine Learning for Physics and Astronomy	5354MLFP6Y		6	5	L, T, CP	W, As
Nanophotonics	5354NANO6Y	X_428537	6	5	L, PW	O
Parameter Estimation Applied to Medical and Biological Sciences	53548PEM6Y	X_432631	6	4	L	W
Photosynthesis and Energy	53548PHO6Y	X_422553	6	5	L, CP	W
Quantum Optics	5354QUOP6Y	X_420118	6	2	L, T	W, O
Fundamental Topics in Statistical Physics 1	5354FTS13Y		3	1	L, T	W
Fundamental Topics in Statistical Physics 2	5354FTS23Y		3	5	L, T	W
Stochastic simulation	5284STSI6Y	X_418075	6	2	L, PW	As, W
Track specific compulsory project: (6 EC required)						
Advanced MRI	5354ADMR3Y		6	6	PW	P
Advanced spectroscopy	52548ADS6Y	X_432767	6	6	L, T, PW	W, P, O
Literature Review Biophysics and Biophotonics	5354LBP6Y		6	6	Lit	R
Academic Skills (6 EC required)						
See Academic Skills list below.						

Free elective components as defined in article B4.4.3 (12 EC required)			
Year 2			
Compulsory: (60 EC required)			
Research Project Physics and Astronomy 1	**5354RPP60Y**	**36-60**	**1-6**
Research Project Physics and Astronomy 2	**53542RP00Y**	**18-60**	**1-6**

Schedule 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, PROJ: Project

Course	course code UvA	VU	EC	period	format	assessment
Year 1						
Restricted-choice electives 1: (18 EC required)						
Astroparticle Physics	5354ASPH6Y		6	4	L, T	W
Cosmology	5214COSM6Y		6	2	L, T	W
Extreme Astrophysics	5354EXAS6Y		6	2	L, T	W
General Relativity	5354GERE6Y		6	1	L, T	W, O
Particle Physics I	53541PAP6Y		6	1	L, T	W
Particle Physics II	53542PAP6Y		6	4	L, T	W
Restricted-choice electives 2: (18 EC required)						
Advanced Cosmology	5354ADCO3Y		3	3	L, T	W, O
Advanced Quantum Field Theory	5354AQFT6Y		6	4	L, T	W
Programming for Astronomy & Astrophysics	5214BLCF3Y		3	1	L, CP	R
Beyond the Standard Model	5354BESM3Y	X_420192	6	5	L	R
Disks and Accretion	5214HAOC6Y		6	4	L, T	W
Flavour Physics and CP Violation	53548CPV3Y	X_428539	3	4	L, T	W, P, O
Gravitational Waves	5354GRWA3Y		3	5	L, T	PROJ
Machine Learning for Physics and Astronomy	5354MLFP6Y		6	5	L, T, CP	W, As
Mathematical Methods in Theoretical Physics	5354MMIT6Y		6	4	L, T, CP	W, As
Particle Detection A	5354PADA3Y		3	4	L, T	W, P
Particle Detection B	5354PADB3Y		3	5	L, T	W, P
Programming C++	5354PROG3Y		3	3	L	
Quantum Field Theory 1	53541QFT3Y		3	1	L, T	W
Quantum Field Theory 2	53542QFT3Y		3	2	L, T	W
Quantum Field Theory 3	53543QFT3Y		3	3	L, T	W, O

Statistical Data Analysis	5354STDA6Y	6	1	T	W, O
Statistical Methods for the Physical Sciences	5354SMFT6Y	6	3	L, T	W, PROJ
String Theory 1	53541STT6Y	6	5	L, T	W
Structure and Evolution of Stars	5214STES6Y	6	2	L, T	W, R, O

Track specific compulsory project: (one course out of these courses)					
GRAPPA Student Seminar	5354GRSS6Y	6	6	PROJ	P, R
Nikhef Project	5354NIPR6Y	6	5-6	PROJ	R
CERN Research Project	5354CERP6Y	6	1	PROJ	R, O
Astrovaria	5214ASTR6Y	6	1-6	PROJ	R, O

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

Free elective components as defined in article B4.4.3 (12 EC required)					

Year 2					
Compulsory: (60 EC required)					
Research Project Physics and Astronomy 1	5354RPP60Y	36-60	1-6		
Research Project Physics and Astronomy 2	53542RP60Y	18-60	1-6		

Schedule 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, PROJ: Project

	course code					
Course	**UvA**	**VU**	**EC**	**period**	**format**	**assessment**
Year: 1						
Compulsory: (18 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
SfES project	5354SFPR6Y		6	1-6	PROJ	P, R
Restricted-choice electives: (24 EC required)						
BioSolar Cells	52548BIC6Y	X_428531	6	1	L, T, Lit	R, P
Catalysis for Sustainable Energy	5254CFSE6Y		6	4	L, Lit, As	W, R
Coordination and Organometallic Chemistry	5254COOC6Y		6	2	L	W
Electrochemical Processes and Batteries	5254ELPB6Y		6	5	L	W,P,R
Emergent Energy Materials	5354BIIE6Y		6	1	L, T	W
Energy and Climate Change: Science, Policy and Economics	5264ECCS6Y		6	2	L, T	W, P
Environmental Chemistry	5254ENCH6Y	X_437004	6	3	L, T	W
Green and Circular Chemistry	5254CICH6Y		6	1	L, T, As	W, P
Heterogeneous Catalysis	5254HECA6Y		6	3	L, T, P	W
Homogeneous Catalysis	5254HOCA6Y		6	5	L	W
Machine Learning for Physics and Astronomy	5354MLFP6Y		6	5	L, T, CP	W, As
Management of Sustainable Innovation	52548MAS6Y	X_432739	6	2	L	T, O
Materials Design for Circular Economy	5254MDFC6Y		6	2	L	W,P,R
Photoconversion Materials	53548PHM6Y		6	5	L, Lit	R, P
Photosynthesis and Energy	53548PHO6Y	X_422553	6	5	L, CP	W
Photovoltaics	5354PHVO6Y		6	4	L, T	O
Academic Skills: (6 EC required)						
See Academic Skills list below						
Free elective components as defined in article B4.4.3 (12 EC required)						
Year 2						

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	**5354RPP60Y**	**36- 60**	**1-6**
Research Project Physics and Astronomy 2	**53542RP00Y**	**18- 60**	**1-6**

Schedule 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, PROJ: Project

	course code		EC	period	format	assessment
Course	**UvA**	**VU**				
Year 1						
Compulsory: (15 EC required)						
Condensed Matter Theory 1	53541CMT3Y		3	1	L, T	W
Quantum Field Theory 1	53541QFT3Y		3	1	L, T	W
Condensed Matter Theory 2	53542CMT3Y		3	2	L, T	W
Quantum Field Theory 2	53542QFT3Y		3	2	L, T	W
Quantum Field Theory 3	53543QFT3Y		3	3	L, T	W
Restricted-choice electives: (21 EC required)						
Advanced Computational Condensed Matter	5354ACCM3Y		3	6	L, T, CP	W, O
Advanced Condensed Matter Theory	5354ACMT6Y		6	5	L, T	P, R
Advanced Cosmology	5354ADCO3Y		3	3	L, T	W, O
Advanced Numerical Methods in Many Body Physics	5354ANMI6Y		6	5	L, T, CP	W
Advanced Quantum Field Theory	5354AQFT6Y		6	4	L, T	W
Astroparticle Physics	5354ASPH6Y		6	4	L, T	W
Beyond the Standard Model	5354BESM6Y	X_420192	6	5	L	R
Bose Einstein Condensates	5354BOEC6Y		6	2	L, T	W, O
Condensed Matter Theory 3	53543CMT3Y		3	3	L, PROJ	P, R, As
Cosmology	5214COSM6Y		6	2	L, T	W
Field Theory in Particle Physics 1	53541FTI6Y		6	4-5	L, T	W, O
Field Theory in Particle Physics 2	53541FTI3Y		3	6	L, T	W, O
Flavour Physics and CP Violation	53548CPV3Y	X_428539	3	4	L, T	W/P
Fundamental Topics in Statistical Physics 1	5354FTS13Y		3	1	L, T	W, PROJ, As
Fundamental Topics in Statistical Physics 2	5354FTS23Y		3	5	L, T	W, PROJ, As
General Relativity	5354GERE6Y	X_420128	6	1	L, T	W, O
Gravitational Waves	5354GRWA3Y		3	5	L, T	W
Group Theory	5354GRTH6Y		6	2	L, T	W
Hydrodynamics	5354HYDR6Y	X_428536	6	4	L, T	W, PROJ, As
Introduction to Computational Science	5284ITCS6Y		6	1	L, T, CP	W, PROJ, As

Machine Learning for Physics and Astronomy	5354MLFP6Y		6	5	L, T, CP	W, As
Mathematical Methods in Theoretical Physics	5354MMIT6Y		6	4	L, T, CP	W, As
Particle Physics I	53541PAP6Y		6	1	L, T	W
Particle Physics II	53542PAP6Y		6	4	L, T	W
Philosophy of Physics	5354PHPH6Y		6	2	L, T	W
Philosophy of Science	5354PHSC6Y		6	1	L, T	W
Quantum Computing	5334QUCO8Y		8	4,5	L, T	W
Quantum Information Theory	5334QUIT8Y		8	4,5	L, T	W
Quantum Optics	5354QUOP6Y	X_420118	6	2	L, T	W, O
Soft Condensed Matter and Biological Physics	53548SCM6Y	X_420167	6	2	L	W, P, O
Stochastic Simulation	5284STSI6Y	X_418075	6	2	L, PW	As, W
String Theory 1	53541STT6Y		6	5	L, T	W
String Theory 2	53542STT6Y		3	6	L, T	W, O
Theory of Complex Systems	5284THCS6Y		6	4	L, T	W, PROJ, As
Topological Materials	5354TOMA3Y		3	6	L, T	W
Topology in Physics	5354TOIP6Y		6	4-5	L, T	W
Understanding Molecular Simulation	5254UNMS6Y		6	3	L, T	W, PROJ, As

Academic Skills: (6 EC required)

See Academic Skills list below

Free elective components as defined in article B4.4.3 (12 EC required)

Year 2

Track specific compulsory project

Student Seminar Theoretical Physics	5354SSPH6Y		6	1-2	L, PROJ	P, R

Advanced Topics (0 EC required)

Advanced Topics in Theoretical Physics 1	5354ATIT6Y		6	1-2	L, T	W, O, R
Advanced Topics in Theoretical Physics 2	53542ATT6Y		6	4-5	L, T	W, O, R

Compulsory: (60 EC required)

Research Project Physics and Astronomy 1	5354RPP60Y		36-60	1-6		
Research Project Physics and Astronomy 2	53542RP00Y		18-60	1-6		

Schedule track General Physics and Astronomy

The schedule of this track (Table 1A) is more flexible, and is especially suited for students opting for a major.

Table 1A. Adaptation of Table 1 for the track General Physics and Astronomy

Components	Regular programme	Programme with a major	Programme with a minor
Restricted-choice elective components discipline	36 EC	24 EC	36 EC
Research Project (incl. thesis and colloquium)	60* EC	36 EC	54 EC
Free elective components	18 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 Examinations Board. The research project can be split in maximally 2 projects, 1 project is at least 36 EC. Each project is a multiple of 6 EC. The second research project is at least 18 EC.

Restricted-choice elective components of the discipline Physics and Astronomy can be chosen from the compulsory and the restricted-choice elective courses of the tracks AMEP, A&A, BB, GRAPPA, SfES and Theory. In addition, for students that are interested in Computational Physics it is recommended to choose courses from the **Computational Physics of Soft and Living Matter** route:

	course code		EC	period		assessment
Course	**UvA**	**VU**			**format**	
Fundamental Topics in Statistical Physics 1	**5354FTS13Y**		**3**	**1**	**L, T**	**W**
Soft Condensed Matter and Biological Physics	**53548SCM6Y**	**X_420167**	**6**	**2**	**L**	**W, P, O**
Stochastic simulation	**5284STSI6Y**	**X_418075**	**6**	**2**	**L, PW**	**As, W**
Understanding Molecular Simulation	**5254UNMS6Y**		**6**	**3**		
Hydrodynamics	**5354HYDR6Y**	**X_428536**	**6**	**4**	**L, T**	**W, PROJ, As**
Theory of Complex Systems	**5284THCS6Y**		**6**	**4**		
Fundamental Topics in Statistical Physics 2	**5354FTS23Y**		**3**	**5**	**L, T**	**W**
Advanced Computational Condensed Matter	**5354ACCM3Y**		**3**	**6**	**L, T, CP**	**W, O**

List of Academic Skills courses

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		EC	period	format	assessment
	UvA	VU				
Academic skills; individual project[a]	5354ASIP3Y		3-6	1-6		PROJ
Academic skills; individual project 2	53542ASI3Y		3	1-6		PROJ
Communication, Organization and Management	55348COO6Y	AM_470572	6	2	L, T, PW	W, R, O
Quantum in Business and Society	5354QIBS3Y		3	6		
Entrepreneurship for Physicists	53548ENF6Y	X_422600	6	3	L, T, As	W
Entrepreneurship in Biomedical Physics and Technology	53548EIB6Y	XM_0013	6	2	L, T, As	W
Open Problems in Modern Astrophysics	5354OPIM3Y		3	1	L, T	P, R, O
Open Problems in Advanced Matter and Energy Physics	5354OPIA3Y		3	3	L, T, Lit, As	P, R
Project Academic Skills for Research	5354PASF6Y		6	5		
Managing Science and Technology in Society	55348MST6Y	AM_470586	6	1	L, T, PW	R, O, PROJ
Research Methods for Analyzing Complex Problems	55348RMF6Y	AM_1182	6	1	L, T, PROJ	W, PROJ
Science and Communication	52648SCC6Y	AM_470587	6	1	L, T	W, O, PROJ
Science in Dialogue	52648SCI6Y	AM_1002	6	3	L, T, PROJ	PROJ, W, R
Science Journalism	52648SCJ6Y	AM_471014	6	2	L, T	W, R, O
Scientific Writing in English	55248SWE3Y	X_400592	3	2,6	W	O
Tutoring Students	52548TUS3Y	X_432625	3	2	L, T	R, O
Professional Skills[b]			3[b]			

[a]this course can be 3 EC or 6 EC. The 6 EC course should be approved by the Examinations Board before the start of your project. Two individual projects of 3 EC should be approved by the Track Coordinator before the start of your projects. [b]see the Table below

Professional Skills*	Code	3 EC*	Period
Professional Skills - *Data Management and Visualization*	5224PSDM2Y	1,5 EC	5, 6
Professional Skills - *Effective Communication and Presentation*	5224PSEC2Y	1,5 EC	3
Professional Skills - *Explore Your Options*	5224PSEY2Y	1,5 EC	1,2,4,5
Professional Skills - *Project Management*	5224PSPM2Y	1,5 EC	3,4,5,6
Professional Skills - *Science Connect*	5224PSSC2Y	1,5 EC	1-6
Professional Skills – *Scientific Writing*	5224PSSW2Y	1,5 EC	1,2,4,6

**The student is obliged to choose 2 courses from this list (3 EC in total) in order to have these counted as academic skills courses.*

List of courses not graded with a mark, but with Pass or Fail

Advanced Cosmology

Advanced Computational Condensed Matter

Advanced Topics in Theoretical Physics 1

Advanced Topics in Theoretical Physics 2

AMEP Seminar

Astrophysics Colloquium

CERN Research Project

Condensed Matter Theory 3

Open Problems in Advanced Matter and Energy Physics

Professional Skills

Programming for AMEP

Programming for Astronomy and Astrophysics

Project Academic Skills for Research

Quantum in Business and Society

String Theory 2

Student Seminar Theoretical Physics

Schedule Physics Majors and Minors

Major Science in Society

The Master's graduate with a specialization Science in Society combines an academic approach with the skills and competences that will allow him or her to perform scientific research at the interface of the biomedical sciences and society. The specialization aims to develop strategies that contribute to an understanding of complex societal problems and strategies to solve complex societal problems through interdisciplinary research. In addition, the programme analyses the social, economic and ethical aspects of new developments in the biomedical sciences, so as to assess their implications for society. Master's graduates have the necessary skills to collaborate and communicate with researchers from various scientific disciplines (including but not limited to those in the life sciences) and societal actors, and the ability to use these academic insights.

More information of the majors and minors can be found on https://student.uva.nl/phys-astro/shared/studentensites/fnwi/ew-gedeelde-content/en/az/majors-and-minors/majors-and-minors.html

Major Science Communication

Communication about science takes place between academic peers and between scientists and the general public. This makes the Communication specialization a complex and dynamic field of research and practice, for example on patient participation in health research, the use and effects of media metaphors and hype, and public understanding of emergent technologies. The Master's graduate with this specialization has a theoretical understanding of the complex problems that arise during such communication processes and has developed the necessary skills to act professionally at this interface to enhance communication and the outcomes of communication between scientific actors and society.

More information of the majors and minors can be found on https://student.uva.nl/phys-astro/shared/studentensites/fnwi/ew-gedeelde-content/en/az/majors-and-minors/majors-and-minors.html

Major Teaching

Courses are taught in Dutch.

Met de opleiding wordt beoogd studenten op te leiden tot Leraar Voorbereidend Hoger Onderwijs. De opleiding combineert het ambachtelijke met het academische: studenten ontwikkelen een stevige kennisbasis en een onderzoekende houding in het vak en beroep, en staan tegelijkertijd met twee benen in de praktijk waar ze het 'ambacht' leren. Studenten worden opgeleid tot teamwerkers die initiatief nemen en draagvlak zoeken, en die zichzelf én een rolmodel voor leerlingen durven te zijn. Zij zijn gericht op innovatie en dragen actief bij aan het creëren van nieuwe kennis en aan schoolvak- en onderwijsontwikkeling.

More information of the majors and minors can be found on https://student.uva.nl/phys-astro/shared/studentensites/fnwi/ew-gedeelde-content/en/az/majors-and-minors/majors-and-minors.html

Appendix 2 Courses for the pre-master's programme

As explained in §B3.1.3 the Admissions Board may draw up a premaster's programme of maximum 42 EC. The pre-master's programme consists of a selection of the components from the table below. Depending upon the track, courses from the top six rows may be compulsory. Courses with Dutch names will be taught in Dutch, the other courses will be taught in English.

Format (werkvorm): HC: hoorcollege, WC: werkcollege.

Naam onderwijsonderdeel[#]	vakcode	ECTS	Periode	Werkvorm	Toetsvorm	Niveau
Wiskunde N2	5092WIN26Y	6	1	HC, WC	schriftelijk	2e jaars
Klassieke mechanica 2	50922KLM3Y	3	2	HC, WC	schriftelijk	2e jaars
Quantum Concepten	5092QUCO3Y	3	3	HC, WC	mondeling, schriftelijk	2e jaars
Quantum physics 2	50922QUA6Y	6	4	HC, WC	schriftelijk	2e jaars
Electrodynamics	5092ELEC6Y	6	4	HC, WC	schriftelijk	2e jaars
Statistische fysica	5092STFY6Y	6	5	HC, WC	schriftelijk	2e jaars
Research practicum	5092REPR3Y	3	3	PR, WC	schriftelijk	2e jaars
Astrofysica	5092ASTR6Y	6	1	HC, WC	schriftelijk	2e jaars
Gecondenseerde materie 1	50921GEM6Y	6	1	HC, WC	schriftelijk	2e jaars
Biofysica	5092BIOF6Y	6	1	HC, WC	schriftelijk	2e jaars
Planetary Systems	5092PLSY6Y	6	5	HC, WC	schriftelijk	2e jaars
Fundamentals of Photonics	5092PLKE6Y	6	5	HC, WC	schriftelijk	2e jaars
Inleiding in de elementaire (astro) deeltjesfysica	5092IEDF6Y	6	5	HC, WC	schriftelijk	2e jaars
Advanced Quantum Physics	5092ADQP6Y	6	1	HC, WC	schriftelijk	3e jaars
Introduction to Cosmology	5092INTC6Y	6	1	HC, WC	schriftelijk	3e jaars
Medische Beeldvorming	50928MEB6Y	6	1	HC, WC	schriftelijk	3e jaars
Photosynthesis	5092PHOT6Y	6	4	HC, WC	schriftelijk	3e jaars
Electronics and Signal Processing	5092FECK6Y	6	4	HC, WC	schriftelijk	3e jaars
Atomic Physics	5092ATOO6Y	6	2	HC, WC	schriftelijk	3e jaars
Fluids and Soft Matter	5092FLSM6Y	6	2	HC, WC	schriftelijk	3e jaars
Introductie medische beeldbewerking	50928INM6Y	6	2	HC, WC	schriftelijk	3e jaars
Mathematical Methods 3	5092WIN36Y	6	2	HC, WC	schriftelijk	3e jaars
Mechanics and Thermodynamics in the Cell	51128MTI6Y	6	2	HC, WC	schriftelijk	3e jaars
Workshop Physics and Astronomy	5092WOPA6Y	6	3	Proj	schriftelijk/ mondeling	3e jaars
Advanced Electrodynamic and Special Relativity	50922ERT6Y	6	4	HC, WC	schriftelijk	3e jaars
Black Holes and Compact Stars	5092COST6Y	6	4	HC, WC	schriftelijk	3e jaars
Condensed Matter 2	50922GEM6Y	6	1	HC, WC	schriftelijk	3e jaars
Quantum optics and lasers	5092QUOP6Y	6	4	HC, WC	schriftelijk	3e jaars
Standard Model of Elementary Particles	5092STED6Y	6	2	HC, WC	schriftelijk	3e jaars

Appendix 3 Final attainment levels of the Major Teaching, and learning objectives minor TESLA and the minor Teaching

Final attainments levels of the Major Teaching

(this section is in Dutch because the whole Major Teaching is in Dutch)
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 bekwaamheidseisen zijn vastgelegd in de Wet op het voortgezet onderwijs (artikel 36 e.v.) en het Besluit bekwaamheidseisen onderwijspersoneel (zie 'Besluit bekwaamheidseisen onderwijspersoneel' (https://wetten.overheid.nl/BWBR0018692).) en 'Besluit van 16 maart 2017 tot wijziging van het Besluit bekwaamheidseisen onderwijspersoneel en het Besluit bekwaamheidseisen onderwijspersoneel BES in verband met de herijking van de bekwaamheidseisen voor leraren en docenten' (https://zoek.officielebekendmakingen.nl/stb-2017-148.html)).

De eindtermen zijn geordend in twee categorieën:

- Eindtermen die rechtstreeks te maken hebben met de kern van het beroep: het onderwijsleerproces en het leren van leerlingen, te weten de vakinhoudelijke, vakdidactische en pedagogische bekwaamheid (eindterm 1 t/m 3).
- Eindtermen die betrekking hebben op meer algemene aspecten van professioneel handelen ten dienste van die kern van het beroep: te weten samenwerking met collega's en de omgeving van de school en met reflectie en persoonlijke en professionele ontwikkeling (eindterm 4 t/m 5).

De opleiding draagt er zorg voor dat de afgestudeerde Leraar VHO in ieder geval:

1. aantoonbaar beschikt over vakinhoudelijke kennis en vaardigheden die het wo-bachelorniveau overstijgen dan wel verdiepen. Dat wil zeggen dat de afgestudeerde eerstegraads leraar:
    a. de inhoud van vak beheerst / boven de leerstof staat;
    b. daardoor de leerstof, voor het schooltype waarin hij werkzaam is, zo kan samenstellen, kiezen of bewerken dat zijn leerlingen die kunnen leren;
    c. vanuit zijn vakinhoudelijke expertise verbanden kan leggen met het dagelijks leven, met werk en met wetenschap en het onderwijs betekenisvol kan maken voor de leerlingen;
    d. daarmee kan bijdragen aan de algemene vorming van zijn leerlingen.
2. aantoonbaar beschikt over vakdidactische kennis en vaardigheden. Dat wil zeggen dat de afgestudeerde Leraar VHO:
    a. de vakinhoud weet te vertalen in leerplannen of leertrajecten en dat doet op een professionele, ontwikkelingsgerichte werkwijze;
    b. de vakinhoud leerbaar maakt voor en afstemt op het niveau en kenmerken van zijn leerlingen, daarbij doelmatig gebruikmakend van (digitale) beschikbare leermiddelen;
    c. het onderwijs kan ontwikkelen en evalueren;
    d. het onderwijs doelmatig kan uitvoeren en het leren van leerlingen kan organiseren;
    e. de vak inhoud/didactiek afstemt met zijn collega's en laat aansluiten bij de visie en missie van zijn school.

3. aantoonbaar beschikt over pedagogische kennis en vaardigheden. Dat wil zeggen dat de afgestudeerde Leraar VHO:
    a. de ontwikkeling van zijn leerlingen volgt in hun leren en gedrag en daarop zijn handelen afstemt;
    b. bijdraagt aan de sociaal-emotionele en morele ontwikkeling van zijn leerlingen;
    c. bijdraagt aan de burgerschapsvorming en de ontwikkeling van de leerling tot een zelfstandige en verantwoordelijke volwassene;
    d. met een professionele, ontwikkelingsgerichte werkwijze en in samenwerking met zijn collega's een veilig, ondersteunend en stimulerend leerklimaat voor zijn leerlingen kan realiseren;
    e. in staat is om oordelen te formuleren, rekening houdend met de sociaal-maatschappelijke en ethische verantwoordelijkheden die horen bij het beroep.
4. aantoonbaar reflecteert ten behoeve van persoonlijke en professionele ontwikkeling. Dat wil zeggen dat de afgestudeerde Leraar VHO:
    a. in staat is kritisch te reflecteren op alle aspecten die met zijn persoonlijkheid, zijn motivatie, attitudes, verwachtingen en cognities te maken hebben (die onder meer tot uiting komen in het pedagogisch handelen) en feedback hieromtrent ter harte te nemen
    b. op onderzoeksmatige wijze de (eigen) onderwijspraktijk verbetert en blijft ontwikkelen;
    c. zijn (vak)kennis en -kunde actueel houdt;
    d. in staat is zijn eigen positie te bepalen ten aanzien van de missie en visie van de school/instelling waar hij werkzaam is en bereid is een constructieve bijdrage te leveren aan de ontwikkeling van zijn vak/het onderwijs in de school.
5. aantoonbaar samenwerkt en communiceert met collega's en omgeving. Dat wil zeggen dat de afgestudeerde Leraar VHO:
    a. zijn pedagogisch handelen kan afstemmen met zijn collega's en met anderen die voor de ontwikkeling van de leerling verantwoordelijk zijn;
    b. de ontwikkeling van zijn vak/curriculum in de school kan afstemmen met zijn collega's en met anderen die voor de ontwikkeling van de leerling verantwoordelijk zijn.
6. Onverminderd het bepaalde in lid 1 heeft de afgestudeerde van afstudeerrichting Biologie een gedegen vakinhoudelijke kennis van en inzicht in het vakgebied en de vakdidactiek van Biologie en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren voor het schoolvak Biologie in de onderbouw en/of bovenbouw.
7. Onverminderd het bepaalde in lid 1 heeft de afgestudeerde van afstudeerrichting Natuurkunde een gedegen vakinhoudelijke kennis van en inzicht in het vakgebied en de vakdidactiek van Natuurkunde en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren voor het schoolvak Natuurkunde in de onderbouw en/of bovenbouw.
8. Onverminderd het bepaalde in lid 1 heeft de afgestudeerde van afstudeerrichting Scheikunde een gedegen vakinhoudelijke kennis van en inzicht in het vakgebied en de vakdidactiek van Scheikunde en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren voor het schoolvak Scheikunde in de onderbouw en/of bovenbouw.
9. Onverminderd het bepaalde in lid 1 heeft de afgestudeerde van afstudeerrichting Wiskunde een gedegen vakinhoudelijke kennis van en inzicht in het vakgebied en de vakdidactiek van

Wiskunde en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren voor het schoolvak Wiskunde in de onderbouw en/of bovenbouw.

10. Onverminderd het bepaalde in lid 1 heeft de afgestudeerde van afstudeerrichting Aardrijkskunde een gedegen vakinhoudelijke kennis van en inzicht in het vakgebied en de vakdidactiek van Aardrijkskunde en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren voor het schoolvak Aardrijkskunde in de onderbouw en/of bovenbouw.
11. Onverminderd het bepaalde in lid 1 heeft de afgestudeerde van afstudeerrichting Informatica een gedegen vakinhoudelijke kennis van en inzicht in het vakgebied en de vakdidactiek van Informatica en kan op basis daarvan aantrekkelijke, effectieve en efficiënte leeractiviteiten ontwerpen, uitvoeren, begeleiden en evalueren voor het schoolvak Informatica in de onderbouw en/of bovenbouw.

Learning objectives of the minor Tesla

By completing the Tesla Minor the graduate is fit to start a career in demanding environments which require abilities to utilize the disciplinary science background in research, corporate, civil society, governmental and advisory work environments.

All learning objectives fall into at least one of the following categories: (1) Information processing (2) Teamwork (3) Project Work (4) Communication (5) Self-reflection.

Further information about the minor Tesla can be found in the study guide
http://www.teslaminor.nl

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.

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.