

**Utrecht University
Graduate School Natural Sciences**

**Programme Annex
to the
Education and Examination Regulations 2012-2013**

Contents

Astrophysics and Space Research	3
Business Informatics.....	5
Computing Science	8
Game and Media Technology	12
History and Philosophy of Science.....	15
Mathematical Sciences	18
Meteorology, Physical Oceanography and Climate (MPOC)	22
Nanomaterials: Chemistry & Physics	25
Particle Physics	28
Science and Business Management	30
Science Education and Communication	33
Technical Artificial Intelligence	36
Theoretical Physics	39
Honours programme Mathematical Sciences and Theoretical Physics	42

Astrophysics and Space Research

Admission Criteria

There is no admission possible anymore to this master's programme.

Learning outcomes

Graduates have a profound knowledge of and insights into:

- the theoretical and observational aspects of the physics of stars, galaxies and the universe
- at least one area in the field of astrophysics or space research such that they can understand the international research literature

Graduates have the skills to:

- give a concise summary of the relevant observations, the observational techniques used and the relevant theories used to explain the observations;
- execute a research project under the supervision of a staff member and present the results of this project both in an oral presentation and in writing in English;
- independently formulate a scientific hypothesis, or develop a consistent model, as an explanation of an observed phenomenon or result of a numerical model;
- develop a sound judgment of and a critical attitude toward the interpretation of observational and model-based data in terms of fundamental physical principles, statistical and numerical approaches.
- design, perform and analyze astronomical observations;
- apply theoretical concepts that allow a quantification of astrophysical processes and phenomena;
- develop a (simple) numerical model of the observed objects;
- recognise and be aware of recent scientific developments in the field of astrophysics and space research.

Graduates display attitudes that enable them to

- apply knowledge and insight in a way that demonstrates a professional approach to his or her work or profession;
- work together in a team of experts with different nationalities and backgrounds;
- work independently and take initiatives where necessary;
- enrol in a PhD programme in the field of astrophysics or space research
- continue their careers in research-oriented organizations or industrial research and development.

Contents

Mandatory courses	37.5 ECTS
Primary electives	15 ECTS
Secondary electives	7,5 ECTS
Research part	60 ECTS
Total	120 ECTS

Mandatory courses

1. Stellar evolution (NS-AP434M)
2. Galaxies (NS-AP432M)
3. Astronomical Data Analysis (NS-AP433M)
4. Stellar atmospheres (NS-AP426M)
5. Theoretical astrophysics (NS-AP402M)

Primary Electives

1. Astronomical Telescopes and Instruments (NS-AP443M)
2. Nucleosynthesis (NS-AP437M)
3. IAC (NS-AP428M)
4. Solar Physics (NS-AP439M)

Secondary Electives

Astrophysics courses from other NOVA Master's programmes and MSc courses offered by the Graduate School of Natural Sciences when approved in advance by the programme coordinator.

Research part

Research Part:	60 ECTS
Thesis & Seminar in Astrophysics	60 ECTS

The research part of the Master's programme in Astrophysics consists of a full year of research under the supervision of a staff member of the *Astronomical Institute Utrecht* or - after approval by the programme coordinator - an external staff member in any research institute in the Netherlands or abroad.

Business Informatics

Admission Criteria

Admission to the degree information science

Applicants should possess:

- solid basic knowledge in the field of information and computing sciences (including programming languages, data models, exchange languages and object-oriented modeling);
- solid basic knowledge of research methods;
- solid basic knowledge of cognitive and communication science;
- solid basic knowledge of organization science;
- the ability to communicate facts and findings verbally and in writing, also using information and communication technology and audio-visual means.

Applicants are therefore expected to hold one of the following degrees:

- a BSc in Information Science;
- a BSc in Computer Science ;
- a BSc in other Science (with specific prerequisites);
- a professional Bachelor in ICT, or an HBO-(Bedrijfskundige) Informatica or a HIO diploma.

Applicants holding one of the following degrees of Utrecht University:

- A major in Information Science;
- A major in Computer Science, mathematics, artificial intelligence with a minor in information science

have a legal right under Dutch Law (doorstroomrecht) to be admitted to the Information Science degree.

Admission to the programme

Students admitted to the degree in Information Science qualify for admission to this programme if they satisfy the following skills and knowledge:

- basic knowledge of product software development, delivery, implementation and use;
- basic knowledge of design methods and modeling.

Students with a HBO-background need an average score of at least 7 for their professional bachelor programme, and a score of at least 7 for their thesis project as well.

There is room in this programme (max. 15 ECTS) to remedy possible deficiencies of the student in the above mentioned areas.

Learning outcomes

Knowledge and understanding	
1a.	Has theoretical and practical knowledge of advanced general subjects such as Methodology of development, implementation and entrepreneurship of software products, ICT entrepreneurship.
1b.	Is able with this knowledge to contribute to scientific research in these areas using an appropriate methodology.
2a.	Is aware of important recent developments on subjects such as Methodology of development, implementation and entrepreneurship of software products, ICT entrepreneurship.
2b.	Understands the relevance of these developments for his/her scientific discipline.
3.	Has the skills to understand the specialized literature on at least one area in the field of: software product development methodology; implementation and adoption of systems; ICT entrepreneurship. Has the skills to relate this literature to his/her own research.
Applying knowledge and understanding	
4.	Is able to formulate together with the supervisor an original research question in the field of Business Informatics in general or for product software in particular.

5. Is able to design, under supervision of a member of the scientific staff, a research plan that addresses a research question and that conforms to the methodological and scientific standards of the discipline.
6a. Is able to carry out this research plan under the supervision of a member of the scientific staff according to the rules of good experimental practice and ethics. 6b. Is able to analyze and interpret the acquired materials and/or data according to scientific standards.
Making judgements
7. Is able to participate critically and constructively in the scientific debate.
8. Is able to indicate the relevance of his/her research to solve problems and issues in the field of Business Informatics, both from a scientific and a societal point of view.
9. Is able to reflect critically upon his/her own research contribution from a societal point of view.
Communication
10. Has the skills to communicate research results, both in written and spoken English and Dutch, to an audience of specialists or non-specialists.
11. Is able to function effectively in a possibly multidisciplinary team of experts working in the field of Business Informatics.
Learning skills
12. Has the skills to evaluate his/her own learning and development process and to adjust this process if necessary.
13. Has a result oriented working attitude that enables him/her to work as a professional in the field of information technology.
14a. Has the qualifications to enroll in a PhD programme in the field of Business Informatics. 14b. Is qualified to acquire a position as a professional in the field of information technology.

Contents

Mandatory courses	23.5 ECTS
Primary electives	15-52.5 ECTS
Secondary electives	0-37.5 ECTS
Research part	44 ECTS
Total	120 ECTS

Mandatory courses

- Enterprise Architecture (INFOEAR)
- Method Engineering (INFOME)
- Knowledge Management (INFOKMT)
- Introduction to Business Informatics (INFOSPMBI)

Primary elective

- Advanced Research Methods (INFOARM)
- Business Informatics Summer School (INFOBISS)
- Financial Management (ECMINFIN)
- ICT entrepreneurship (INFOIE)
- Seminar ICT in Life Science Innovations (INFOMILSI)
- Seminar Medical Informatics (INFOMSMI)
- Seminar Multimodal Interaction (INFOMMMI)
- Seminar Software Patterns (INFOMSSP)
- Simulation (INFOSIM)

Secondary electives

- Possible deficiencies (at most 15 ECTS): Deficiency courses will be defined by the programme coordinator.
- Any MSc course from the Computer Science curriculum
- Any related MSc course offered by Utrecht University when approved in advance by the programme director
- Capita Selecta (INFOCSM)

Research part

- Thesis Project (INFOMMBI): 40 ECTS
- MBI Colloquium (INFOCQMBI4):4 ECTS

The Research Part or Thesis Project includes participation in the bi-weekly MBI Colloquium (at the end of the master programme).

Research can be done in the following directions:

All subjects related to the list of mandatory courses for example:

- Product software development, deployment and requirement management
- The management of product software companies and markets
- Adoption, implementation and use of IS/IT
- Enterprise architecture and IS/IT architecture
- IT management and IT governance
- Business/IT alignment and IT maturity

Special provisions for students enrolled in the programme Content and Knowledge Engineering in the year 2010-2011

Due to the admission stop as of September 2010, students that have chosen the CKE master programme (possible until September 2010) are subject to the following rules concerning the courses.

Mandatory courses

- Introduction to Business Informatics

Primary elective courses (you have to choose *at least three* of this list)

- Advanced Research Methods
- Semantic Web
- Knowledge Management
- Enterprise Architecture
- Method Engineering
- Software Product Management.

Secondary elective courses

- Seminar Intelligent User Interfaces
- Seminar Medical Informatics

Research part

Thesis Project: 40 ECTS
MBI Colloquium: 4 ECTS

Computing Science

Admission Criteria

Admission to the degree Computer Science

Applicants should possess:

- solid basic knowledge of computer science and logic;
- the ability to analyze and model computer science problems;
- the ability to communicate facts and findings verbally and in writing, also using information and communication technology and audio-visual means

Degrees in all probability meeting these requirements are:

- A BSc with a major in Computer Science or Artificial Intelligence;
- A BSc with a science major and (a) a minor in Computer Science or (b) a minor in Technical Artificial Intelligence or (c) a comparable use of the non-major part ('profielingsruimte') of the bachelor programme;
- A HBO-diploma 'Hogere Informatica Opleiding' (HIO) or (Technical) Computer Science

Applicants holding one of the following degrees of Utrecht University: A BSc in Computer Science or Artificial Intelligence have a legal right under Dutch Law (doorstroomrecht) to be admitted to the computer science degree.

Admission to the programme

Students admitted to the computer science degree qualify for admission to this programme if they possess the following skills and knowledge:

- have a reasonable experience in the use of several programming languages (amongst which functional and object-oriented languages);
- have a basic knowledge of modern software construction;
- have a basic knowledge of algorithms and data structures, their design and analysis;
- have adequate knowledge of the working of computer systems and information networks;
- have a basic knowledge of computer science and logic;
- be able to reason formally;
- be able to communicate facts and findings verbally and in writing, including using information and communication technology and audio-visual means.

The following BSc degrees satisfies these qualifications:

- UU BSc degree in Computer Science

This degree is the standard for the programme ('doorstroom'), but the BSc degrees in Informatics (Computer Science) at many regular universities in the Netherlands and abroad are nowadays equivalent to it to the extent that is needed for entry in the master's programme 'Computing Science'. Suitable standards must be achieved in basic backgrounds, as in the UU major, in the domains of programming (Java, C#, Haskell, software engineering) and algorithmic and formal methods (data structures, discrete mathematical methods, complexity). *Other* BSc programs that likely satisfy the entrance requirements include:

- a BSc in Mathematics (with a minor in informatics) or Artificial Intelligence,
- a HBO-bachelor in the 'HBO-opleiding Informatica',
- a HBO-bachelor in Informatics/Information Technology other than the 'HBO-opleiding Informatica',

in all cases depending on the particular programme followed.

Small deficiencies (15 ECTS or less) are facilitated in the 'homologatie' in the first period of the program. If the entrance requirements are not fully met by a student and the deficiency is larger, but motivation and other indicators are convincing, the Admissions Committee may allow a student to prepare for entrance by means of an individual pre-master programme of at most three (bachelor-level) courses which must be passed before qualifying for entrance in the master program. With HBO's whose bachelor program(s) in informatics do not meet the entrance requirements fully as a rule, a standard pre-master package can be agreed which students can embed in their individual study programme in the HBO if they wish to qualify for entrance beforehand.

Learning outcomes

The graduate of the master programme Computing Science:

Knowledge and understanding
1. Can use his or her knowledge of computer science to make a substantial contribution to the development and/or application of scientific concepts and methods, often in a research context.
2. Is capable of understanding important recent developments in computer science, and of indicating their implications for society and the research field.
3. Is capable of interpreting and using specialized literature in the field of computing science.
Applying knowledge and understanding
4. Is capable of translating a problem from the area of computer science or an application into a research question that is relevant to and suited for scientific development, product development or education.
5. Is capable of translating this research question into an appropriate research plan in accordance with the required scientific and methodological standards.
6. Is capable of independently performing this research with the required care and ethical responsibility and to process, interpret and evaluate the empirical data and other outcomes thus obtained in the appropriate manner.
Judgement
7. Is capable of discussing the outcomes of empirical and theoretical research and to relate them to the current scientific state-of-the-art and literature.
8. Is capable of indicating the relevance of this research to the solution of problems in the area of computer science, also from the viewpoint of society wherever possible.
9. Has the capability to reflect critically on his or her own efforts as a researcher in the area of computer science from the viewpoint of society.
Communication skills
10. Is capable of clearly communicating the results of research, in writing as well as orally, to an audience of specialists and laymen, in an international context.
11. Is capable of functioning effectively in a research team of possibly multi-disciplinary composition.
Learning skills
12. Has the capability to evaluate his or her own learning- and development process during the study, and if necessary to motivate and adjust his- or herself.
13. Has acquired an effective and result driven way of working that allows him or her to function independently in a competitive labor market.
14. Has the qualification to obtain a PhD position as well as a job in business and industry.

Contents

Mandatory courses	0 ects
Primary electives	37.5 ects
Secondary electives	37.5 ects
Research part	45 ects
Total	120 ects

Format

Study paths

Students follow individual study paths, under approval of the programme coordinator(s). The following study paths are pre-defined and set the standard for the program, with options depending on the specific research orientation of the student:

- Programming technology
- Algorithm design and analysis
- Advanced planning and decision making
- Algorithmic data analysis

Primary Electives

The primary electives consist of a coherent set of five courses. Students can follow an individual study path, with five courses selected from the core courses offered in the Computing Science programme. Students can either follow one of the pre-defined study paths, or have a set of five courses approved by the programme coordinator(s).

The pre-defined study paths are:

- Programming technology:
Advanced functional programming, compiler construction, program verification, generic programming, automatic program analysis
- Algorithm design and analysis:
Geometric algorithms, algorithms and networks, scheduling and time-tabling, computational sustainability, simulation
- Advanced planning and decision making:
Probabilistic reasoning, algorithms and networks, evolutionary computing, scheduling and time-tabling, simulation
- Algorithmic data analysis:
Data mining, multimedia retrieval, pattern recognition, queries and retrieval, experimentation project ADA

Secondary Electives

To be chosen in agreement with the chosen study path from the following list:

- Courses listed under core courses that are not part of the primary elective courses in the chosen study path.
- An experimentation project of either 7.5 or 15 ECTS.
- A literature study under supervision of a CS staff member (Capita selecta) of 7.5 ECTS.
- Any MSc course from the Computer Science curriculum
- Any MSc course offered by Universiteit Utrecht: a student may take up to 15 ECTS worth of relevant courses outside of the regular Computer Science curriculum upon approval in advance of the programme director

Mandatory Research part

The research part consists of a MSc thesis project of 40 ECTS and the Computing Science colloquium (5 ECTS). Research can be done in the following directions: all subjects related to the research programs of the Software Technology chair, the Algorithmic Data Analysis chair, the Algorithmic Systems chair, or the Decision Support Systems chair (internally or externally). In particular, all subjects related to the list of core courses.

Core courses in the Computing Science programme

All courses are 7.5 ECTS

Data mining (INFOMDM)
Advanced functional programming (INFOAFP)
Computational Sustainability (INFOMCS)
Experimentation project ADA (INFOMEADA)
Algorithms and networks (INFOAN)
Automatic program analysis (INFOAPA)
Compiler construction (INFOMCCO)
Evolutionary computing (INFOEA)
Generic programming (INFOGP)
Geometric Algorithms (INFOGA)
Multimedia retrieval (INFOMR)
Pattern recognition (INFOMPR)
Probabilistic reasoning (INFOPROB)
Program verification (INFOPV)
Queries and retrieval (INFOMQR)
Scheduling and time tabling (INFOSTT)
Simulation (INFOSIM)
Software technology for games, media, and artificial intelligence (INFOMSTG)
Social Simulation (INFOMSACS)

Game and Media Technology

Admission Criteria

Admission to the degree computer science

At the start of their master studies, students should possess:

- Solid basic knowledge of computer science and logic;
- The ability to analyze and model computer science problems;
- The ability to communicate facts and findings verbally and in writing, also using information and communication technology and audio-visual means.

Degrees in all probability meeting these requirements are:

- A BSc with a major in Computer Science or Artificial Intelligence;
- A BSc with a science major and (a) a minor in Computer Science or (b) a minor in Technical Artificial Intelligence or (c) a comparable use of the non-major part ('profielingsruimte') of the bachelor programme;
- A HBO-diploma 'Hogere Informatica Opleiding' (HIO) or (Technical) Computer Science;

Applicants holding one of the following degrees of Utrecht University:

- A BSc in Computer Science or Artificial Intelligence;
have a legal right under Dutch Law (doorstroomrecht) to be admitted to the computer science degree.

Admission to the programme

Students admitted to the computer science degree qualify for admission to this programme if they possess (in addition to the degree criteria) the following skills and knowledge:

- the ability to make a computer programme of reasonable complexity and size, in an object-oriented programming language such as Java or C++;
- knowledge of data structures, algorithms and related concepts of reasonable complexity, such as sorting algorithms, $O(\cdot)$ -notation, balanced binary search trees, etc.;
- knowledge of basic computer-graphics techniques;
- have a good level of English understanding, speaking and writing.

Bachelor programmes that in all probability satisfy those knowledge and skill requirements are

- BSc programmes with a major in computer science
- BSc with a major in science and a minor (or comparable) in computer science
- A HBO BSc programme in HIO or technical computer science

Learning outcomes

Kennis en inzicht
1. Is in staat om met de kennis van de informatica en haar toepassingen in de game- en mediatechnologie een wezenlijke bijdrage te leveren aan het ontwikkelen en/of toepassen van wetenschappelijke concepten en methodes, veelal in onderzoeksverband.
2. Is in staat de belangrijke recente ontwikkelingen binnen informatica en haar toepassingen in de game- en mediatechnologie te overzien en de implicaties van die ontwikkelingen voor vakgebied en samenleving aan te geven.
3. Is in staat om gespecialiseerde vakliteratuur over de informatica en haar toepassingen in de game- en mediatechnologie adequaat te hanteren en te interpreteren.
Toepassen kennis en inzicht
4. Is in staat een probleem uit het domein van de informatica en haar toepassingen in de game- en mediatechnologie te vertalen in een voor wetenschapsonwikkeling, productontwikkeling of educatie relevante en geschikte onderzoeksvraag.
5. Is in staat bij deze onderzoeksvraag een passend onderzoeksontwerp te formuleren conform de daarbij vereiste methodologische en wetenschappelijke standaard.
6. Is in staat dit onderzoek op eigen kracht en met de vereiste zorgvuldigheid en ethische verantwoordelijkheid uit te voeren en de daarbij empirisch verkregen data of andere uitkomsten op juiste wijze te verwerken, te analyseren, te interpreteren en te evalueren.
Oordeelsvorming
7. Is in staat de uitkomsten van empirisch of theoretisch onderzoek te bediscussiëren en te verbinden met de huidige wetenschappelijke stand van zaken en literatuur.
8. Is in staat de relevantie aan te geven van dit onderzoek voor de oplossing van vragen en problemen in de informatica en haar toepassingen in de game- en mediatechnologie, waar mogelijk ook vanuit een maatschappelijk standpunt.
9. Is in staat kritisch te reflecteren op de eigen inspanningen als onderzoeker in de informatica en haar toepassingen in de game- en mediatechnologie vanuit een maatschappelijk perspectief.
Communicatie
10. Is in staat de resultaten van onderzoek zowel schriftelijk als mondeling duidelijk over te brengen op een publiek van specialisten en niet-vakdeskundigen in een internationale context.
11. Is in staat effectief te functioneren in een mogelijk multidisciplinair samengesteld onderzoeksteam.
Leervaardigheden
12. Bezit de vaardigheid om het eigen leer- en ontwikkelproces tijdens de studie te evalueren en zichzelf zonodig te motiveren en 'bij te sturen'.
13. Heeft zich een effectieve en resultaatgerichte werkwijze eigen gemaakt die hem of haar in staat stelt om zelfstandig te functioneren op een competitieve arbeidsmarkt.
14. Heeft de kwalificatie om een promotieopleiding te verkrijgen, dan wel een functie op de arbeidsmarkt.

Contents

Mandatory courses	0 ECTS
Primary electives	45 ECTS
Secondary electives	15 ECTS
Research part	60 ECTS
Total	120 ECTS

Primary electives

Select six out of the following list of courses (7.5 ECTS each): [Zou volgens de OAC informatica niet kloppen. Graag nakijken.](#)

INFOMCANIM computer animation,
INFOMCV computer vision,
INFOMGP game physics,
INFOGA geometric algorithms,
INFOMOMA motion and manipulation,
INFOMR multimedia retrieval,
INFOMMMI multimodal interaction,
INFOMPR pattern recognition,
INFOMADVG advanced graphics,
INFOMAGGA agents and games,
INFOMPAPL path planning

Secondary electives

Any master's course offered by the UU (including the unchosen primary electives), pending approval by the programme director.

At most one capita selecta, on an approved subject: [<add number of ECTS>-](#)

Courses that remove deficiencies, as recommended by the programme [coordinator](#)/[director](#).

Research part

A small project of 15 ECTS. [Osiris code?](#)

A thesis project of 45 ECTS. [Osiris code?](#)

History and Philosophy of Science

Admissions Criteria

Admission to the degree in History and Philosophy of Science

At the start of their master studies, students should possess:

- either: solid basic knowledge in one of the sciences or humanities with demonstrable interest in history and/or philosophy;
- or: solid basic knowledge in one of the other academic disciplines with proven interest in history and/or philosophy of their discipline;
- the ability to work independently;
- the skills to write English on an academic level

Applicants are expected to hold one of the following bachelor degrees

- a Bachelor's degree in one of the sciences;
- a Bachelor's degree in one of the Humanities;
- any other academic Bachelor's degree;

In the case of BSc degree graduates, students with a minor in History and/or Philosophy are especially encouraged to enroll.

In the case of BA degree graduates, students with a major in History or Philosophy, or a minor in one of the sciences are especially encouraged to enroll.

In the other cases the candidate should be able to demonstrate an interest in history and/or philosophy.

There is no automatic admission to this degree.

Admission to the programme

There is no automatic admission to this programme.

Learning outcomes

Knowledge and understanding	
	1a. Has detailed knowledge of one of the areas of history and/or philosophy of the sciences and the humanities. 1b. Is able to contribute to scientific research in one of these areas using an appropriate methodology.
	2a. Is aware of important recent developments in one of these areas. 2b. Understands the relevance of these developments for his/her scientific discipline. 2c. Understands the possible social relevance of these developments.
	3a. Has the skills to understand the specialized literature on at least one of these areas. 3b. Has the skills to use and interpret this literature adequately.
Applying knowledge and understanding	
	4. Is able to formulate an original research question in one of these areas relevant for scientific development, education, or public understanding.
	5a. Is able to formulate a fitting research plan in accordance with scientific and methodological standards. 5b. Can overlook the possibilities and pitfalls in applying his/her knowledge on social questions.
	6. Is able to carry out a research plan according to the rules of good practices and ethics.
Making judgements	
	7. Is able to participate critically and constructively in scientific debates.
	8. Is able to assess the scientific and possible social relevance of his/her research.
	9. Is able to reflect critically upon his/her own historiographical or philosophical position within the

	chosen area, if appropriate also from a societal perspective.
Communication	
	10. Has the skills to conceive papers for international peer-reviewed journals. Is able to present his/her work orally on an academic level.
	11. Is able to cooperate effectively with fellow researchers.
Learning skills	
	12. Has the skills to work self-reliantly, to evaluate his/her own learning and development process and to adjust this process if necessary.
	13a. Is able to write, with the help of a senior researcher, a grant proposal. 13b. Is able to successfully compete for a position for which an academic training in one of the areas is required or useful.
	14a. Has the qualifications to enrol in a PhD programme in the field of history and philosophy of science. 14b. Is qualified to acquire a position as a professional in the field of history and philosophy of science, or e.g. science publishing, science communication, public policy, science management, or science museums.

Contents

Mandatory courses	22,5 ECTS
Primary electives	30 ECTS
Secondary elective	7,5 ECTS
Research part	60 ECTS
Total	120 ECTS

Mandatory courses and primary electives reflect the body of knowledge in which a student must be sufficiently prepared to successfully engage in research. At least 30 ECTS of the primary electives need to be taken. The secondary elective can be used for further specialization.

Mandatory courses

- History, Role and Impact of the Natural Sciences, NS-HP401M
- Philosophy of Science, NS-HP402M
- History, Role, and Impact of the Humanities, OGMV05006

Optional courses

Four Primary electives (30 ects)

- Foundations of Quantum Mechanics, NS-HP428M
- Philosophy of Space and Time, NS-HP430M
- Science and the Public, NS-HP436M
- Science and the Dilemmas of Modernity I, NS-HP438M
- Science and the Dilemmas of Modernity II, NS-HP438M
- History of Modern Life Sciences, NS-HP433M
- Einstein, NS-HP440M
- History, Role, and Impact of the Social Sciences, OGMV05007
- History, Role, and Impact of the Biomedical Sciences, OGMV07003
- Geschiedenis van de Moderne Natuurkunde, NS-361B
- History of Classroom Mathematics, WISL901
- Seminar History of Mathematics, WISM481
- Science in Islamic Civilization, WISM483
- Realism in MetaEthics, WBMV12001
- Science and Epistemology III, WBMV09002

- CS Philosophy of Mind, WBMV05004
- Philosophy of AI, WBMV05003
- CS German Idealism, WBMV12003
- Tutorial Foundations of Science, WBRM0005
- Tutorial Foundations of Science, WBRM0006
- Law as an Academic Discipline, Science and Humanities, RGMawe100

One Secondary elective (7,5 ects)

- Any master course, after approval by the Board of Examiners

Research part

Research Part:	60 ECTS
Research Seminar	7.5 ECTS
Research	52.5 ECTS

The research part consists of a mandatory research seminar History and Philosophy Canon, NS-HP501M (7,5 ECTS), and either (preferably) an internship abroad (15 ECTS) and a thesis of 37,5 ECTS, or a thesis of 52,5 ECTS.

Special provisions for students enrolled in the year 2010-2011 and earlier

For students who enrolled in the History and Philosophy of Science or the Historical and Comparative Studies of the Sciences and Humanities programmes before September 2012, the earlier applicable EER's remain valid.

Mathematical Sciences

Admission Criteria

Admission to the degree in Mathematical Sciences

At the start of their master studies, students should possess:

- Solid basic knowledge of mathematics;
- The ability to analyze mathematical problems;
- The ability to communicate findings verbally and in writing, in an appropriate mathematical manner.

Applicants are therefore expected to hold one of the following degrees:

- A BSc with a major in Mathematics
- A BSc with a major in Physics with a strong component in mathematics
- A BSc with a major in Computer Science with a strong component in mathematics
- A BSc with a major in Science with a strong component in mathematics

Applicants holding a BSc in Mathematics of Utrecht University have a legal right under Dutch Law (doorstroomrecht) to be admitted to the degree in Mathematical Sciences.

Learning outcomes

Knowledge and understanding

- have theoretical and practical knowledge of advanced general concepts, principles and techniques of fundamental and applied mathematics;
- have an overview of the area of scientific research and development concerned;
- have in-depth knowledge of at least one area in the field of fundamental or applied mathematics in such that the international research literature can be understood.

Applying knowledge and understanding

- have the skills to:
- assimilate complex mathematical ideas and arguments;
- identify, formulate, analyse and suggest independently possible solutions to problems in the field of mathematical sciences;
- conduct research in the field of mathematical sciences and report on it in a manner that meets the customary standards of the discipline (including correct referencing, appropriate layout and style)

Making Judgements

- have theoretical and practical knowledge of advanced general concepts, principles and techniques of fundamental and applied mathematics, which enables them to evaluate, in a broad perspective their own research and research of others.

Communication skills

- have the skills to communicate conclusions both written and orally, as well as the underlying knowledge, grounds and considerations, to an audience composed of specialists or non-specialists in English;
- have the skills to work together in a (possibly interdisciplinary) team of experts with different backgrounds.

Learning skills

- have the skills to reflect on their own research and on research of others;
- should be able to enroll in a PhD programme in mathematics, or begin a career as a professional mathematician

Comment [Johan van1]: We willen dit niet expliciet maken met het noemen van vakken, dit zou juist niet SMART zijn.

We willen studenten kunnen afwijzen op hun gebrek aan wiskunde kennis. Een alternatieve formulering, zou kunnen zijn: students should possess a bachelor which includes a mathematics part comparable with the major part of the bachelor "Wiskunde" or Wiskunde en Toepassingen" of Utrecht University.

Contents

Mandatory courses	0 ects
Primary electives	58 ects

Secondary electives	15 ects
Research part	47 ects
total	120 ects

Primary Electives

Primary elective courses are chosen from the course list given below or, if approved by the programmedirector, from other mathematics courses given at a university in the Netherlands. Students must choose their courses in consultation with their tutor so as to create a coherent course load in one of the eight specializations. This has to be in agreement with the standards as set by the coordinator of that specialization. The eight specializations are:

- Algebraic Geometry and Number Theory
- Applied Analysis
- Differential Geometry and Topology
- History of Mathematics
- Logic
- Probability and Statistics
- Pure Analysis
- Scientific Computing

Secondary Electives

The secondary elective courses can be any course from the course list below or other courses on the master level, if approved by the programmedirector. Courses to remedy deficiencies are also counted in this category.

Research part

Thesis research work for 47 ECTS.

Course list

The course list is made up of local courses, courses that are part of the national Mastermath Programme, selected courses that are part of the Master Industrial and Applied Mathematics (IAM) of the Eindhoven University of Technology and courses that are part of Stochastics and Financial Mathematics (SFM) Programme, which is offered by the University of Amsterdam (UvA), the Free University (VU), the University of Leiden (RUL) and the University of Utrecht (UU). The courses that are part of the national Mastermath programme, as listed on <http://www.mastermath.nl>, form the core part of the master's programme Mathematical Sciences. Examination takes place according to general rules of Mathermath, to be found at <http://www.mastermath.nl>. These rules apply fully to the rules of the University of Utrecht.

Mastermath courses 2012-2013

Introduction to Stochastic Processes (WISL102, 4 ECTS)
 Continuous Optimization (WISL103, 6 ECTS)
 Systems and Control (WISL201, 6 ECTS)
 Discrete Optimization (WISL101, 6 ECTS)
 Heuristic Methods in Operations Research (WISL110, 6 ECTS)
 Functional Analysis (WISL401, 8 ECTS)
 Fourier analysis (WISL410, 8 ECTS)
 Dynamical Systems (WISL404, 8 ECTS)
 Measure-theoretical Probability (WISL701, 8 ECTS)
 Asymptotic Statistics (WISL702, 8 ECTS)
 Parallel Algorithms (WISL603, 8 ECTS)
 Numerical Linear Algebra (WISL601, 8 ECTS)
 Stochastic Differential Equations (WISL108, 6 ECTS)
 Advanced Modelling in Science (WISL203, 6 ECTS)
 Applied Statistics (WISL106, 6 ECTS)
 Applied Finite Elements (WISL204, 6 ECTS)
 Advanced Linear Programming (WISL105, 6 ECTS)
 Scheduling (WISL107, 6 ECTS)
 Queuing Theory (WISL108, 6 ECTS)
 Algebraic Geometry (WISL509, 8 ECTS)

Partial Differential Equations (WISL402, 8 ECTS)
 Stochastic Processes (WISL703, 8 ECTS)
 Numerical Methods for time-dependent PDEs (WISL602, 8 ECTS)
 Time Series (WISL704, 8 ECTS)
 Historical Aspects of Classroom Mathematics (WISL909, 6 ECTS)
 Algebraic Number Theory (WISL305, 8 ECTS)
 Cryptology (WISL304, 8 ECTS)
 Hamiltonian Mechanics (WISL423, 5 ECTS)
 Algebraic Topology (WISL508, 8 ECTS)
 Symplectic Geometry (WISL516, 8 ECTS)
 Nonlinear Evolution Equations (WISL424, 8 ECTS)
 Advanced Algebraic Geometry (WISL521, 8 ECTS)
 Analysis on Manifolds (WISL511, 8 ECTS)
 Nonparametric Bayesian Statistics (WISL707, 8 ECTS)
 Geometry (WISL507, 6 ECTS)
 Computability Theory (WISL321, 8 ECTS)
 Bifurcation Analysis of ODE's with delays (WISL425, 8 ECTS)
 Infinite Dimensional Systems (WISL205, 6 ECTS)
 Mathematical Structures for Logic (WISL320, 8 ECTS)
 Asymptotic Methods for Differential Equations (WISL427, 8 ECTS)
 Set Theory (WISL316, 8 ECTS)
 P-adic Numbers and Applications (WISL312, 8 ECTS)
 Semisimple Lie Algebras (WISL520, 8 ECTS)

SFM courses 2012-2013

see also <http://www.math.vu.nl/sto/onderwijs/sfm/index.html>.

Stochastic Optimization (WISS101-09, 6 ECTS)
 Stochastic Processes for Finance (WISS102, 6 ECTS)
 Ergodic Theory (WISS122, 7.5 ECTS)
 Semiparametric Statistics (WISS112, 6 ECTS)
 Stochastic Integration (WISS105, 8 ECTS)
 Information Theoretic Learning (WISS119, 8 ECTS)
 Simulation Methods in Statistics (WISS11-09, 8 ECTS)
 Portfolio Theory (WISS104, 6 ECTS)
 Stochastic Models for Genetic Evolutionary (WISS111, 6 ECTS)
 Forensic Statistics and Graphical Models (WISS109, 6 ECTS)
 Probability (WISS128, 6 ECTS)
 Probabilistic Combinatorics (WISS129, 7.5 ECTS)
 Computational Finance (WISS130, 6 ECTS)
 Introduction to Spatial Probability Models (WISS131, 6 ECTS)
 Levy Processes and Stochastic Volatility (WISS132, 6 ECTS)
 Mixing Times for Markov Chains (WISS133, 7.5 ECTS)
 Percolation Theory (WISS134, 6 ECTS)
 Interest Rate Models (WISS135, 6 ECTS)
 Levy Fluctuation Theory with Applications in Finance and OR (WIS136, 6 ECTS)
 Statistical Learning (WISS137, 4 ECTS)
 Topics in Stochastic Networks (WISS138, 6 ECTS)

IAM courses 2012-1013

Random Graphs (WISM562, 3 ECTS)
 Evolution equations (WISM533, 6 ECTS)
 Modeling and perturbation methods (WISM534, 3 ECTS)
 Coding and Crypto 1 (WISM541, 6 ECTS)
 Cryptographic Protocols (WISM542, 6 ECTS)
 Graphs and Algorithms (WISM543, 6 ECTS)

Local courses 2012-2013

Laboratory Class Scientific Computing (WISM454, 7.5 ECTS)

Advanced course on probabilistic and extremal combinatorics (WISM561, 7.5 ECTS)
Model Theory (WISM422, 7.5 ECTS)
Introduction to differential topology (WISM441, 7.5 ECTS)
Galois theory and fundamental groups (WISM429, 7.5 ECTS)
Perturbation Theory (WISM532, 7.5 ECTS)
Mathematical models for the spread of infectious diseases (WISM436, 7.5 ECTS)
Seminar History of Mathematics (WISM481, 7.5 ECTS)
Wavelets and Fourier transforms (WISM453, 7.5 ECTS)

Honours programme

Students who are registered (1) for both the master's programme in Theoretical physics and the Master's programme in Mathematical Sciences, and (2) are registered for the Honours programme in Theoretical Physics and Mathematics and (3) fulfill all of the other requirements to successfully complete the honours programme, can do a thesis project of 60 ECTS, co-supervised by staff members of the ITP and the Mathematics Institute. Such a thesis has to contain sufficient mathematics and theoretical physics, such that it has to meet the standard of both programmes. The extra 13 credits of the thesis project exceeding the research part of the programme may be counted towards the secondary electives credit load.

Meteorology, Physical Oceanography and Climate (MPOC)

Admission Criteria

Admission to the degree Physics and Climate Science

At the start of their master studies, students should possess:

- Solid basic knowledge in classical physics, quantum mechanics, electrodynamics and thermal physics, as well as in the mathematics required for the study of such topics at an advanced level.
- The ability to work independently as well as in groups on solving physical problems, present the results of solving problems and to read (English) physics literature at the level of graduate textbooks.
- Intermediate problem-solving skills in the main fields of physics and/or their applications.

Applicants are therefore expected to hold one of the following academic degrees

- A BSc degree with a major in physics,
- A major in science with a strong component in physics

Applicants holding a BSc in Physics and Astronomy of Utrecht University have a legal right under Dutch Law (doorstroomrecht) to be admitted to the degree in Physics and Climate Science

Admission to the programme MPOC

Students admitted to the Physics & Climate Science degree qualify for admission to this programme if they possess the following skills and knowledge:

- solid basic knowledge in classical physics, especially fluid dynamics, as well as in the mathematics required for the study of such topics at an advanced level
- The ability to work independently as well as in groups on solving physical problems, present the results of solving problems and to read (English) physics literature at the level of graduate textbooks.
- Intermediate problem-solving skills in the main fields of physics and/or their applications.

Applicants with a BSc and a minor "meteorologie, fysische oceanografie and climate" are automatically admitted to the programme.

Applicants with a BSc and background in related fields like chemistry, earth sciences, geophysics, mathematics can be admitted if their background level in physics and mathematics and in fluid dynamics is sufficient.

Learning outcomes

Kennis en inzicht

- 1a. Heeft kennis van de fysica van het klimaatsysteem in de breedste zin van het woord.
- 1b. Heeft een goed begrip van de dynamica van atmosfeer, oceaan en klimaat.

- 2a. Heeft kennis van de belangrijkste ontwikkeling op gebied van mondiale klimaatmodellen alsmede proces georiënteerde modellen.

3. Heeft kennis van de vakliteratuur op gebied van de fysica van het klimaatsysteem.

Toepassen kennis en inzicht

- 4a. Kan een probleem definiëren, een vraagstelling formuleren en een basis strategie ontwikkelen om het probleem op te lossen.
5. Is in staat een numeriek model te ontwikkelen alsmede te kunnen werken met en het verbeteren van een complex model van het klimaatsysteem of een deel daarvan.
6. Is in staat om (gemeten) datasets te analyseren, bewerken en te interpreteren.

Oordeelsvorming

7. Is in staat te discussiëren over klimaatproblematiek
8. Is in staat de relevantie van het vakgebied te verwoorden
9. is in staat kritisch te reflecteren op eigen inspanningen alsmede ten aanzien van gepubliceerde literatuur in het vakgebied.
Communicatie
10. Is in staat de resultaten van onderzoek zowel schriftelijk als mondeling duidelijk over te brengen aan een publiek van specialisten en andere geïnteresseerden.
11. Is in staat effectief te functioneren in een mogelijk multidisciplinair samengesteld onderzoeksteam.
Leervaardigheden
12. Bezit de vaardigheid om het eigen leer- en ontwikkelproces tijdens de studie te evalueren en zichzelf zonnodig te motiveren en 'bij te sturen'.
13. Heeft zich een effectieve en resultaatgerichte werkwijze eigen gemaakt die hem of haar in staat stelt om zelfstandig te functioneren op een competitieve arbeidsmarkt.
14. Heeft voldoende kennis en vaardigheden verworven om zelfstandig onderzoek te kunnen verrichten, of ander vakinhoudelijk werk te kunnen verrichten.

Contents

Mandatory courses	37,5ECTS
Primary Electives	22,5-37,5 ECTS
Secondary Electives	0-15 ECTS
Research part	45 ECTS
Total	120 ECTS

Mandatory courses

- Dynamical Oceanography (NS-MO401M, 7.5 ECTS)
- Dynamical Meteorology (NS-MO402M, 7.5 ECTS)
- Atmospheric Composition and Chemical Processes (NS-MO405M, 7.5 ECTS)
- Simulation of Ocean, Atmosphere and Climate (NS-MO501M, 7.5 ECTS)
- Making, analyzing and Interpreting Observations (NS-MO502M, 7.5 ECTS)

Primary Electives

At least 22,5 ECTS has to be chosen from the following list of courses

- Turbulence, mixing (NS-MO406M, 3.75 ECTS)
- Boundary Layer Meteorology (NS-MO407M, 3.75 ECTS)
- Ocean Waves (NS-MO428M, 7.5 ECTS)
- Physics of Coastal Systems (NS-MO426M, 7.5 ECTS)
- Ice and Climate (NS-MO427M, 7.5 ECTS)
- Current Themes in Climate Change (NS-MO434M, 7.5 ECTS)
- Climate and the Hydrological Cycle (NS-MO408M, 7.5 ects)
- Oceans and Climate (NS-MO441M, 3.75 ects)
- Remote sensing (NS-MO442M, 3.75 ects)
- Marine masters course(NS-MO446M, 3.75ects)

Secondary electives

- At most 15 ECTS may be chosen from all MSc course offered by the Graduate School of Natural Sciences
- For other courses approval by the programme director is required

Research part

The research part of the Master's programme will consist of 9 months of research under the supervision of a staff member of the Institute for Marine and Atmospheric Research or adjoint faculty. This research is concluded with a written Master's thesis.

Research can be done in the following directions:

- Ice and Climate
- Ocean Circulation and Climate
- Atmospheric Physics and Chemistry
- Atmospheric Dynamics and the Hydrological Cycle
- Coastal and Shelf Sea Dynamic

Nanomaterials: Chemistry & Physics

Admission Criteria

This programme can be completed within the framework of two degrees:

- 1) Chemical Sciences
- 2) Physics & Climate Science

Admission to the degree in Chemical Sciences

At the start of their master studies, students should possess a sound basic knowledge of physical, inorganic and organic chemistry.

Applicants are therefore expected to hold one of the following academic degrees:

- A BSc degree with a major in chemistry or materials science
- A major in science with a strong component in chemistry.

Admission to the degree in Physics and Climate Science

At the start of their master studies, students should possess:

- Solid basic knowledge in classical physics, quantum mechanics, electrodynamics and thermal physics, as well as in the mathematics required for the study of such topics at an advanced level.
- The ability to work independently as well as in groups on solving physical problems, present the results of solving problems and to read (English) physics literature at the level of graduate textbooks.
- Intermediate problem-solving skills in the main fields of physics and/or their applications.

Applicants are therefore expected to hold one of the following academic degrees

- A BSc degree with a major in physics,
- A major in science with a strong component in physics

Applicants holding a BSc degree in Physics and Astronomy from Utrecht University or a BSc degree in Chemical Sciences from Utrecht University are legally entitled under Dutch Law (doorstroomrecht) to be admitted to the degree in Physics and Climate Science or the degree in Chemical Sciences respectively.

Admission to the programme

Students admitted to the Chemical Sciences degree qualify for admission to this programme if they possess the following skills and knowledge:

-The student must have successfully completed at least three subjects out of the following four: 1) Physical Chemistry (classic and principles of statistical thermodynamics), 2) Inorganic and Solid State Chemistry, 3) Knowledge on several spectroscopic and analytical techniques (MS, IR/VIS, NMR, ESR, RDX, SAXS/SANS, CSLM) and 4) Advanced organic chemistry.

-Prospective students must have acquired practical skills in the field of physical, inorganic and organic chemistry. Experience in writing a research report, such as a bachelor thesis, is a prerequisite.

-Degrees mentioned in the paragraph *Admission to the degree of chemical sciences* normally satisfy these conditions.

b) Students admitted to the Physics & Climate Science degree qualify for admission to this programme if they possess the following skills and knowledge:

-The student must have successfully completed at least two subjects out of the following five at a level corresponding to second to third year Utrecht physics bachelor courses: 1) quantum mechanics (Hilbert space, angular momentum, spin, charged particles in a e-m field, perturbation theory, variation techniques, WKB method, many-body systems, scattering theory), 2) statistical physics (ensemble, Boltzmann distribution, quantum statistics, bosons, fermions, Bose-Einstein condensation, phase transitions, etc.), 3) condensed matter physics (crystal structure, phonons, electrons, plasmons, dielectrics, magnetism, superconductivity, Bose-Einstein condensation, quantum dots, photonic crystals), 4) electrodynamics (electrostatics, magnetism, electrodynamics, Maxwell equations, electromagnetic waves, radiation), and 5) mechanics (Newton's laws, Hamilton Lagrange formalism, oscillations, Coriolis force, Kepler's laws, rotation and translation).

-Prospective students must have acquired practical skills in the field of experimental physics, electronics and computer techniques. Experience in writing a research report such as a bachelor thesis and in presenting scientific results is a prerequisite.

-Degrees mentioned in the paragraph *Admission to the degree of Physics and Climate Science* normally satisfy these conditions.

Learning outcomes

Knowledge and understanding
1a. Has knowledge of and insight into nanomaterials with an emphasis on colloids, catalysts, and condensed matter.
1b. Is able with this knowledge to contribute to scientific research in these areas using appropriate methods and instrumentation.
2a. Is aware of recent developments in the research of colloids, catalysis, and condensed matter.
2b. Understands the relevance of these developments for his/her scientific discipline.
3. Has the skills to understand the professional literature in the area of colloids, catalysis, and condensed matter and to relate this to his/her own research.
Applying knowledge and understanding
4. Is able to formulate together with the supervisor an original research question for the synthesis of nanomaterials, or for obtaining new knowledge of the chemical or physical properties of such materials.
5. Is able to design, under supervision of a member of the scientific staff, a research plan that addresses a research question and that conforms to the methodological and scientific standards of the discipline.
6a. Is able to carry out this research plan under the supervision of a member of the scientific staff according to the rules of good experimental practice and ethics.
6b. Is able to analyze and interpret the acquired materials and/or data according to scientific standards.
Making judgements
7. Is able to participate critically and constructively in the scientific debate in the research group.
8. Is able to indicate the relevance of his/her research for the advancement of the chemistry and physics of nanomaterials.
9. Is able to reflect critically upon his/her own contribution to nanomaterials research, and that of others.
Communication
10. Has the skills to discuss, both in spoken and written English and in Dutch, on the results of research, including the underlying knowledge and background.
11. Is able to function effectively in a possibly multidisciplinary team of experts working in the area of chemistry and physics of nanomaterials.
Learning skills
12. Has the skills to evaluate his/her own learning and development process and to adjust this process if necessary.

13. Displays a professional and academic work attitude that enables him/her to work in an area related to the research on nanomaterials.

14a. Has the qualifications to enroll in a PhD programme in one of the research groups of the Debye Institute or of related institutes working in the area of colloids, catalysis, or condensed matter.

14b. Is qualified to acquire a research position in a (semi) public or commercial organization.

Contents

Mandatory courses	7,5 ects
Primary electives	22,5 ects
Secondary electives	30 ects
Research part	60 ects
Total	120 ects

Mandatory course

Nanomaterials: Catalysis, Colloids, Nanophotonics (SK-MNCCN).

Primary electives

Chemical Sciences students must take 3 courses irrespective their signature, while **Physics and Climate Science students** must take 3 courses with a Physical Sciences (P) or a combined C/P signature. All courses have a study load of 7,5 ECTS.

Chemical science courses	Physical science courses
Kinetics & Diffusion (SK-MKIDI) (C/P)	Plasma Physics (NS-NM434M)(P)
Advanced Organic Synthesis (SK-MOSS)	Soft Condensed Matter Theory (NS-TP453M)(P)*
Advanced Spectroscopy of Nanomaterials (SK-MASPN)	Photon Physics (NS-NM427M)(P)
Solids & Surfaces (SK-MSOLS)	Soft Condensed Matter (NS-NM429M) (C/P)
Synthesis of Complex Nanostructures (SK-MSYNA)	Computational Materials Science (NS-CP432M) (C/P)
Advanced Physical Chemistry (SK-MPC3) (C/P)	
Adsorption, Kinetics and Catalysis (SK-MAKC)	
Organometallic Chemistry and Homogeneous Catalysis (SK-MOCHC)	
Advanced Quantum Modelling (SK-MAQM) (C/P)	

*only taught every two year (2012-2013, 2014-2015)

Secondary electives

For the remaining 30 ECTS, several options are possible such as any MSc course offered by the Graduate Schools of Natural and Life Sciences or other courses, such as 3rd year bachelor courses, with permission from the programme directors or a 15 to 30 ECTS internship outside Utrecht University. Internships can only start as soon as the mandatory and primary elective courses and the research project of 60 ECTS have been finished.

Secondary electives can also be those courses required to fulfill the admission requirements in the case of deficiencies. The programme director decides which courses need to be followed during the master's programme. Deficiencies will be stated in the Letter of Admission.

Research part

The student may start with his/her research project before the completion of the mandatory course with the permission of his/her supervisor.

Particle Physics

Admission Criteria

Admission to the degree Physics and Climate Science

At the start of their master studies, students should possess:

- Solid basic knowledge in classical physics, quantum mechanics, electrodynamics and thermal physics, as well as in the mathematics required for the study of such topics at an advanced level.
- The ability to work independently as well as in groups on solving physical problems, present the results of solving problems and to read (English) physics literature at the level of graduate textbooks.
- Intermediate problem-solving skills in the main fields of physics and/or their applications.

Applicants are therefore expected to hold one of the following degrees

- a completed Bachelor's of Science with a major in physics,
- a major in Science with strong component in physics

Applicants holding a BSc in Physics and Astronomy of Utrecht University have a legal right under Dutch Law (doorstroomrecht) to be admitted to the degree in Physics and Climate Science.

Admission to the programme

Students admitted to the Physics and Climate degree qualify for admission to this programme, if they possess skills and knowledge in Quantum Mechanics, Thermal Physics at an advanced bachelor level and have general knowledge in Subatomic Physics and in Classical Field Theory.

Learning outcomes

Graduates have knowledge of, and insights into:

- modern particle physics with an emphasis on the Standard Model, and
- profound knowledge of the physics of strong interactions and/or another special subtopic of relevance in current particle physics research such that the international research literature can be understood.
- They further have knowledge on experimental techniques of particle detection and data analysis in high-energy physics.

Graduates have the skills to:

- identify, formulate, analyse and suggest possible solutions to problems independently in the field of particle physics;
- conduct research in the field of particle physics under supervision of a scientific staff member and report on it in a manner that meets the customary standards of the discipline;
- apply knowledge and insight in original research projects in the area of particle physics, at the level of international scientific journals.
- communicate both orally and written conclusions, as well as the underlying knowledge, grounds and considerations, to an audience composed of specialists or non-specialists in English

Graduates display attitudes that enable them to

- work together constructively critical in an international team of experts and use modern means of scientific communication
- work independently and take initiatives where necessary
- apply knowledge and insight in a way that demonstrates a professional approach to his or her work or profession
- enrol in a PhD programme in the field of particle physics

Contents

Mandatory courses	18	ECTS
Primary electives	24	ECTS
Secondary electives	13-23	ECTS
Research part	65-55	ECTS
Total	120	ECTS

Mandatory courses

1. NS-PP 401M Particle Physics (12 ECTS)
2. NS-PP 402M Strong Interactions (6 ECTS)

Primary electives

A choice of 24 ECTS from:

- the following courses from the NIKHEF Particle & Astroparticle Physics programme
 - NS-PP430M Beyond the Standard Model (3 ECTS)
 - NS-PP431M CP Violation (3 ECTS)
 - NS-PP432M Gravitational Waves (3 ECTS)
 - NS-PPxxxM Programming C++ (3 ECTS)
 - NS-PP428M Particle Detection (6 ECTS)
 - NS-PP427M Astroparticle Physics (6 ECTS)
 - NS-PP429M NIKHEF Project (6 ECTS)
 - NS-PP434M Statistical Data Analysis (6 ECTS)
- CERN Summer Student programme (6 ECTS)
- NS-TP401M Quantum Field Theory (10 ECTS)
- NS-EP438M Modeling & Simulation (7.5 ECTS)
- NS-TP529M Field Theory in Particle Physics (7.5 ECTS)
- pending approval from the programme director the following courses may also be included :
 - a Quantum Field Theory course from a partner university in the NIKHEF Particle & Astroparticle Physics programme (e.g. UvA)

Secondary electives

For the remaining ECTS a choice of:

- master's courses offered by the Graduate School of Natural Sciences
- other master's courses offered by the UU or by UvA or VU pending approval from the programme coordinator

Any courses mentioned as primary electives and not used in that category can be used as secondary electives. The surplus of credits from primary electives beyond the requested 24 ECTS can also be counted towards the required credits in the secondary electives. One of the following courses used to compensate deficiencies as mentioned above can be included in the secondary electives:

- Quantum mechanics 2 (NS-356B)
- Particle Physics (NS-262B)
- Subatomic Physics (NS-369B)

Research part

The research part NS-PP510M consists of a thesis project of 55-65 ECTS. Research is usually done at the corresponding Institute at the UU in the field of high-energy nuclear collisions as studied in the ALICE experiment at CERN. Projects are also possible in other subfields of Sub Atomic Physics according to agreements with the programme director.

Science and Business Management

Admission Criteria

Admission to the degree in Science and Business

Applicants are eligible for admission when holding one of the following degrees:

- Bachelor degree in one of the natural sciences
- Bachelor degree in one of the life sciences

Admission to the programme Science and Business Management

Students admitted to the Science and Business degree qualify for admission to this programme when they possess the following skills and knowledge:

- Solid knowledge of one of the natural or life sciences;
- An interest in the application of science must be demonstrated;
- Academic skills at the level of a Dutch university Bachelor of science degree.

Bachelor degree's that satisfy these requirements on knowledge and skills are:

- Bachelor degree in Biology;
- Bachelor degree in Biomedical Sciences;
- Bachelor degree in Chemistry;
- Bachelor degree in Informatics;
- Bachelor degree in Mathematics;
- Bachelor degree in Pharmacy;
- Bachelor degree in Physics;
- Or a similar degree.

Learning outcomes

Kennis en inzicht

1a Heeft door het doen van een onderzoeksstage bij één van de aangesloten vakgroepen binnen de Natural (of Life) Sciences zich verdiept in de theoretische achtergronden van het betreffende deelgebied. Tijdens deze periode heeft de afgestudeerde wetenschappelijk methodes en concepten leren toepassen in een wetenschappelijke onderzoekssetting;

1b Heeft zich de wetenschappelijke methode eigen gemaakt;

1c Heeft basiskennis over een aantal aspecten van economie en management zoals marketing, organisatiekunde, financieel management, human resource management, kwantitatieve besluitkunde, management accounting, ICT for business.

2. Kan reflecteren op het eigen onderzoek en de context waarin dat onderzoek zich bevindt. Tijdens de cursus "Introduction, return meetings and essay" (AS-SP401M) wordt er een essay geschreven, een expert geïnterviewd en een presentatie gegeven over de toepassingen van het onderzoek dat gedaan is tijdens de onderzoeksstage.

3. Heeft actuele kennis over het onderzoeksgebied van de onderzoeksstage en is in staat deze kennis adequaat te gebruiken op het gebied van toegepast onderzoek.

Toepassen kennis en inzicht

4. Kan door onderzoekservaring tijdens de wetenschappelijke stage een probleem uit het deelgebied analyseren en door systematisch onderzoek verder in kaart brengen. Kan de relevantie van probleemstellingen inschatten. Kan een onderzoeksvraagstelling definiëren en onderbouwen vanuit theorie en recente literatuur. (onderzoeksstage).

5. Heeft ervaring met zowel het formuleren van een (natuur)wetenschappelijke onderzoeksvraag, alsmede met een meer bedrijfs- of maatschappelijkgerichte onderzoeksvraag. (onderzoeksstage en bedrijfsstage).

6. Is in staat de regels van de experimentele praktijk en andere ethische aspecten in acht te nemen en is voldoende zelfstandig, volhardend en geordend om het onderzoeksplan uit te voeren. Bezit over de benodigde experimentele vaardigheden om zelfstandig onderzoek te doen en is op de hoogte van de verschillende methodes die worden toegepast bij de onderzoeksgroep waar de onderzoeksstage gedaan wordt.

Is tevens in staat een onderzoek uit te voeren tijdens de bedrijfsstage op het gebied van business management door gebruik te maken van methodes die zijn aangeboden tijdens de FBE cursus.

Oordeelsvorming

7. Heeft de resultaten uit de onderzoeksstage verwerkt in een wetenschappelijk verantwoord onderzoeksverslag inclusief achtergrondinformatie over de huidige stand van zaken.

8. Heeft tijdens de cursus "Introduction, return meetings and essay" (AS-SP401M) een essay geschreven, een expert geïnterviewd en een presentatie gegeven over de toepassingen van hun onderzoek.

9. Heeft tijdens de cursus "Introduction, return meetings and essay" (AS-SP401M) gereflecteerd over de eigen inspanningen. Heeft tevens tijdens de cursus Idea & Start kennisgemaakt met Maatsschappelijk Verantwoord Ondernemen.

Communicatie

10. Heeft tijdens de cursus "Introduction, return meetings and essay" (AS-SP401M), presentaties gegeven en een essay geschreven waarin aan niet-vakdeskundigen uitgelegd wordt wat de relevantie en resultaten van het uitgevoerde onderzoek zijn.

11. Heeft onder andere tijdens de FBE cursus in steeds variërende groepen studenten gewerkt aan casussen.

Leervaardigheden

12. Kan studeren op een grotendeels zelfgestuurde en zelfstandige manier.

13. Heeft tijdens de FBE cursus kennisgemaakt met het een systeem zonder hertentamens, net als op de arbeidsmarkt. Dit spoort aan tot effectief en resultaatgericht leergedrag. B. 13b. Kan zelfstandig onderzoek uitvoeren op het gebied van de Uitgevoerde onderzoeksstage

14. Het programma leidt met name op voor functies op de arbeidsmarkt ipv een promotieopleiding, hoewel dat niet uitgesloten is. De bedrijfsstage is wat dat betreft een uitstekende voorbereiding op de arbeidsmarkt.

Contents

Mandatory courses/internship	64 ECTS
Primary electives	5 ECTS
Secondary electives	0-18 ECTS
Research	33-51 ECTS
Total	120 ECTS

Mandatory courses

Courses	ECTS
• Introduction, return meetings and essay (AS-SP401M)	4
• Course Fundamentals of Business and Economics (AS-SP501M7)	15
• Finance and management accounting (AS-SP511M)	7.5
• Idea and start (AS-SP403M)	7.5
Internship	30

Primary Electives

- Theoretical science course(s)* 5
- *This course may be chosen from the Utrecht University Master's degree science programmes (Graduate School of Life Sciences or Graduate School of Natural Sciences) pending approval by the programme director or programme coördinator.*

Secondary Electives

- In some cases students can select one or more science courses with a total academic load for a maximum of 18 ects. The level of the optional courses must be at least 3rd year Bachelor (for a maximum of 15 ECTS) and they can be chosen from university Bachelor's or Master's degree science programmes;

Research/internship

- Research project 33-51* ects

** The research project usually consists of 51 ECTS, although in some cases up to 18 ECTS can be used to follow optional courses*

Science Education and Communication

The degree Science Education and Communication provides the opportunity to qualify for a teacher degree in biology, chemistry, physics, mathematics, computer science or astronomy as part of the programme.

Admissions Criteria

Applicants who are eligible for admission to the programme Science Education and Communication have:

- Solid knowledge of one of the natural or life sciences at the level of a Dutch university Bachelor of science degree;
- Academic skills at the level of a Dutch university Bachelor of science degree.

Bachelor degrees that satisfy these requirements are:

- Bachelor of Science (BSc) degree in one of the natural sciences;
- Bachelor of Science (BSc) degree in one of the life sciences.

In order to qualify for the teacher education components of the programme, there are additional requirements upon the student's prior education. Bachelor degrees that satisfy these requirements are:

- BSc degree in Biology (teacher certificate biology);
- BSc degree in Chemistry (teacher certificate chemistry);
- BSc degree in Physics (teacher certificate physics);
- BSc degree in Mathematics (teacher certificate mathematics);
- BSc degree in Astronomy (teacher certificate astronomy);
- BSc degree in Computer Science or Information Science (teacher certificate computer science).

Students who get admitted on different, but related, degrees may have to take prescribed courses within and beyond the programme in order to qualify for a teacher degree. These prescribed courses will be determined by the Board of Admissions upon recommendation by the programme coordinator such that the specifications determined by the Interdisciplinary Committee on Teacher Education of the VSNU (see brochure *Universitaire lerarenopleidingen Vakinhoudelijk masterniveau*) will be met at the end of the master's programme. Prescribed courses that are specific to the aim of obtaining a teacher degree will only be regarded as 'deficiencies' according to EER 3.6.3, as long as the student pursues a teacher degree within the programme. If a student, who initially did not pursue a teaching degree, switches to pursue a teacher degree within the programme, the Letter of Acceptance will be revised if necessary.

The regular version of the teacher education components is in Dutch. Students may take the English language version of the teacher education (U-Teach) instead, but U-Teach will have its own, competitive, application procedure, and admission to the programme Science Education and Communication does not imply admission to the U-Teach programme.

Learning outcomes

Knowledge and understanding

Graduates of this programme have knowledge of:

- a broad range of science subjects, with an in-depth knowledge of at least one area in the natural sciences or in the life sciences, at such a level that they can understand the international research literature;
- the learning, teaching and communication processes that play a role in formal and informal science education and communication, and the factors that influence those processes, at such a level that this knowledge can inform their teaching and design activities;
- the current state of scientific research and development in Science Education and Communication, at such a level that they can understand the international research literature.

Applying knowledge and understanding

Graduates have the skills to:

- identify, formulate, analyse and solve problems independently in the field of Science

<p>Education and Communication;</p> <ul style="list-style-type: none"> conduct research in the field of Science Education and Communication under supervision of a scientific staff member, at a level that enables them to enter a PhD-programme.
<p>Making judgements</p> <p>Graduates are able to:</p> <ul style="list-style-type: none"> form well-founded judgement, also if only limited information is available, and to act in accordance with these judgements, taking into account the ethical and societal responsibilities associated with Science Education and Communication practices and professions.
<p>Communication</p> <p>Graduates have the skills to:</p> <ul style="list-style-type: none"> communicate conclusions both orally and written, as well as the underlying knowledge, grounds and considerations, to various audiences, both specialist and non-specialist in English (and for Dutch natives also in Dutch); be able to work together in a (possibly interdisciplinary) team of experts with different nationalities and backgrounds.
<p>Learning skills</p> <p>Graduates are able to:</p> <ul style="list-style-type: none"> acquire and integrate new knowledge and competencies in science education and communication and in their disciplinary field; <p>Graduates display attitudes that enable them to:</p> <ul style="list-style-type: none"> provide constructive feedback towards own and other one's plans, visions and research results; work independently and take initiatives where necessary; apply knowledge and insight in a way that demonstrates a professional approach to his or her work or profession.

In order to qualify for a teacher degree within this programme, students will acquire additional qualifications, according to the specifications determined by the Interdisciplinary Committee on Teacher Education of the VSNU (see the brochure "Competentieprofiel van leraren die aan een ULO zijn opgeleid" at www.universitairelerarenopleiding.nl).

Contents

Curriculum requirements vary dependent on whether the student takes the full teacher education component, so as to obtain a teacher certificate in one of the school subjects, and whether the student's research project is in Science or in Science Education and Communication. Within the programme, the following three combinations will occur:

- A. Teacher degree + Science research
- B. Teacher degree + Science Education and Communication research
- C. No Teacher degree + Science Education and Communication research

The following table presents the curriculum requirements for each of these combinations:

Mandatory courses	7,5 ECTS
AS-SEC410- Introduction to Science Education and Communication	3,75 ECTS
AS-SEC412- Designing Science Education and Communication	3,75 ECTS
Primary electives	37,5 – 63,75 ECTS
<i>Select one of the clusters below:</i>	
<u>Cluster A</u>	
Teacher Training (regular or U-Teach) ¹	60 ECTS
<u>Cluster B</u>	
AS-SEC414 - Research Methods Science Education and Communication	3,75 ECTS
Teacher Training (regular 52,5 ECTS ² or U-Teach 60 ECTS)	52,5 - 60 ECTS
<u>Cluster C</u>	
AS-SEC411 - Public Science Communication with Multi Media	3,75 ECTS
AS-SEC413 - Innovation and Dissemination	3,75 ECTS
AS-SEC414 - Research Methods Science Education and Communication	3,75 ECTS
AS-SEC415 - Advanced Topics in Science Education and Communication	3,75 ECTS
AS-SEC420 - Professional Practice Internship	22,5 ECTS
Secondary electives	18,75 - 30 ECTS
A coherent set of master's courses offered by the UU faculty of science, pending prior approval by the programme director.	
i. Up to 15 ECTS ³ can be taken at Bachelor level 3.	
ii. If specific level 1 or 2 courses have been prescribed upon the student's admission in accordance with EER art. 3.6.3, these courses can also be taken here, but the total of i and ii will not exceed 15 ECTS.	
As a global criterion, the set of secondary electives will be regarded coherent if at least half of the course credits will be obtained from a single coherent master's programme. Acceptable choices include	
<ul style="list-style-type: none"> • Courses in the field of Science Education and Communication, including non-selected primary elective courses • Courses directly relevant to the student's research project • Courses relevant to a teacher's professional practice, including courses required to meet the requirements for a teacher degree (see brochure <i>Universitaire lerarenopleidingen Vakinhoudelijk masterniveau</i>) • An extension of the research project up to a maximum project size of 45 ECTS. 	
Electives from outside the UU faculty of science that contribute towards the above criteria will be accepted if the faculty of science does not offer a comparable course.	
Research part	30 - 45 ECTS
<i>Select one of the following options:</i>	
Research Project Science (in combination with cluster A)	30 - 45
Research Project Science Education and Communication	
<ul style="list-style-type: none"> • (in combination with cluster B) • (in combination with cluster C) 	30 - 45 45
Total	120 ECTS

¹Detailed programme for Teacher Training/UTeach is published by COLUU.

²As part of cluster B the regular teacher training does not include PGO ('Praktijkgericht Onderzoek').

³The maximum of 15 ECTS (conditions i and ii) does not apply for students who started their master programme before September 2011, provided that they graduate no later than October 1, 2014.

Technical Artificial Intelligence

Admission Criteria

Admission to the degree Computer Science

Applicants should possess:

- solid basic knowledge of computer science and logic;
- the ability to analyze and model computer science problems;
- the ability to communicate facts and findings verbally and in writing, also using information and communication technology and audio-visual means.

Degrees in all probability meeting these requirements are:

- A BSc with a major in Computer Science or Artificial Intelligence;
- A BSc with a science major and (a) a minor in Computer Science or (b) a minor in Technical Artificial Intelligence or (c) a comparable use of the non-major part ('profileringsruimte') of the bachelor programme;
- A HBO-diploma 'Hogere Informatica Opleiding' (HIO) or (Technical) Computer Science.

Applicants holding a BSc in Computer Science or Artificial Intelligence of Utrecht University have a legal right under Dutch Law (doorstroomrecht) to be admitted to the computer science degree.

Admission to the programme

No further knowledge and skills are required in addition to those required for admission to the degree Computer Science.

In addition to the degrees mentioned above, the following degrees also in all probability meet the requirements for admission to this master's programme:

- A UU-BSc in Information Science with a Minor in Technical Artificial Intelligence (TKI).

Learning outcomes

1. Knowledge and understanding:
 - a. Mastery of technical artificial intelligence at an advanced academic level. This means mastery of a number of advanced general subjects in the areas of agent technology, AI techniques and agent-oriented software engineering, in depth-knowledge and ability in at least one advanced subject (such as agent design, agent programming, multi-agent communication, (multi-) agent logics, argumentation, adaptive agents and games and agents). Mastery of the necessary logical and computational tools.
 - b. Thorough experience with research in (pure or applied) technical artificial intelligence and complete awareness of the applicability of research in technological developments and organisational contexts.
 - c. Being able to read research articles in technical artificial intelligence.
2. Application of knowledge and understanding:
 - a. Capable of understanding a wide variety of different research problems in technical artificial intelligence and being able to formulate these at an abstract level. To see, from the abstract level, the relation between diverse problems and to contribute creatively to their solution focused on practical applications.
 - b. Able to point at solutions for identified problems using the most advanced techniques from artificial intelligence.
 - c. Capable of creating innovative software and information system designs, taking account of feasibility issues.

- d. Mastery of the necessary skills in theoretical analysis, modelling and experimentation.
- 3. Judgement:
 - a. Capable of assessing and discussing research results and of taking part in discussions within the research group.
 - b. Able to evaluate research results in the context of similar research on technical artificial intelligence. Capable of assessing the practical feasibility and usefulness of artificially intelligent designs.
 - c. Capable of reflecting on his/her own activities as a researcher and being aware of social and ethical responsibilities concerning application of research.
- 4. Communication:
 - a. Capable of making English language presentations orally or in writing of one's own research activities to diverse audiences. Being able to adapt to the background and interest of the audience.
 - b. Capable of working in a (possibly interdisciplinary) team of experts performing the aforementioned activities and communicating easily in both written and oral English.
- 5. Study skills
 - a. Capable of working independently and of taking initiatives where necessary. Identifying areas where expertise is lacking and remedying the situation.
 - b. Capable of writing a research proposal and independently carrying out research in an area of technical artificial intelligence.
 - c. Capable of acquiring a PhD position in the area of specialization or a key position in the software industry, in IT consultancy or at IT departments of organizations.

Contents

Mandatory courses	0 ECTS
Primary electives	15-37,5 ECTS
Secondary electives	37,5-60 ECTS
Research part	45 ECTS
Total	120 ECTS

Format

Students follow study lines. Students can design their own study line subject to approval of the TAI programme director or select one of three currently approved studylines:

- Agent Technology
- AI Techniques
- Agent-Oriented Software Engineering.

Mandatory courses

None.

Primary electives – mandatory per studyline

Up to three courses per studyline:

- Agent Technology:
 - Intelligent Agents (INFOIAG), Multi-Agent Systems (INFOMAS), Multi-Agent Programming (INFOMAP).
- AI Techniques:
 - None.
- Agent-Oriented Software Engineering:
 - Intelligent Agents (INFOIAG), Multi-Agent Systems (INFOMAS), Multi-Agent Programming (INFOMAP)

Primary electives - optional per study line

Up to five courses per study line, with some bounded-choice options:

- Agent Technology:
 - Choice of two courses from: Multi-agent Learning (INFOMAA), Commonsense Reasoning (INFOCR), Games and Agents (INFOMGMAG), Philosophy of AI (WBMV05003).
- AI Techniques:
 - Choice of one course from: Intelligent Agents (INFOIAG), Multi-Agent Systems (INFOMAS).
 - Choice of two courses from: Adaptive Agents (INFOMAA), Commonsense Reasoning (INFOCR), Philosophy of AI (WBFAI).
 - Choice of two courses from: Advanced Datamining (INFOADM), Evolutionary Computing (INFOEA), Probabilistic Reasoning (INFOPROB).
- Agent-Oriented Software Engineering:
 - Choice of one course from: Programme Verification, Automatic Programme Analysis (INFOAPA).

Secondary **electives**

Comment [AVK2]: 7,5 ECTS profiel?

- Free choice from the Computer Science curriculum designated at <http://www.cs.uu.nl/education/> unless marked with a cross under "TAI".

Students who do not fully possess the prerequisite knowledge for TAI can select at most two deficiency courses from the [UU Bsc programme in Computer Science](#) (max 15 ects). The student's choice of deficiency course(s) is subject to approval of the TAI programme leader. If the student has chosen a currently approved study line, then the chosen deficiency courses are part of the study line's secondary electives.

As part of an own-designed programme or the secondary electives of a study line students can do one or two [experimentation projects](#) (INFOEPAT (7,5 ects, INFOEPAT1, 15 ects), to a maximum of 15 ects, either alone or with another student.

Subject to approval of the TAI programme leader, students can also select courses from outside the UU Computer Science master programmes, including courses from other universities in the Netherlands or other countries. If made in the context of one of the currently approved study lines, they are part of the secondary electives. Courses from other universities in the Netherlands or other countries must also be approved by the Examination Committee.

Research part

In the research part the student carries out a research project (INFOMATEC) under the supervision of one of the staff members of the research groups within the Department of Information and Computing Sciences offering the programme. The project is normally performed within the Department but can also be done in a research-and-development department of a company or institution. Students who have not yet passed all primary electives or who have more than 15 ECTS still open can only start with the research part after approval by the TAI programme leader.

Theoretical Physics

Admission Criteria

Admission to the degree Physics and Climate Science

At the start of their master studies, students should possess:

1. Solid basic knowledge in classical physics, quantum mechanics, electrodynamics and statistical physics, as well as in the mathematics required for the study of such topics at an advanced level;
2. The ability to work independently as well as in groups on solving physical problems, present the results of solving problems and to read (English) physics literature at the level of graduate textbooks;
3. Intermediate problem-solving skills in the main fields of physics and/or their applications.

Applicants are therefore expected to hold one of the following degrees

- A BSc degree with a major in physics;
- A major in Science with strong component in physics

Applicants holding a BSc degree in Physics and Astronomy from Utrecht University are legally entitled under Dutch Law (doorstroomrecht) to be admitted to the degree in Physics and Climate Science.

Admission to the programme

Students admitted to the Physics and Climate Science degree qualify for admission to this Master's programme if they have successfully completed courses in quantum mechanics, statistical physics, and electrodynamics at an advanced level (typically the second courses on these topics in a physics curriculum).

Students who did not pass these courses with high grades (above average) are advised not to choose this Master's programme. Note that there is no automatic admission to this programme.

Learning outcomes

Students should acquire the amount of knowledge, insight and technical skills in the field of theoretical physics and related disciplines required to work independently at a professional academic level, or to continue their education in a PhD programme.

Kennis en inzicht

Bezit de velden-theoretische en mathematische basiskennis van de theoretische fysica, en heeft inzicht in het gebruik hiervan in de hoge-energie fysica en/of de gecondenseerde materie en/of de statistische fysica.

Is in staat met deze kennis een bijdrage te leveren aan het lopende onderzoek in een van deze gebieden.

Is op de hoogte van recente ontwikkelingen in de theoretische fysica, en kan deze plaatsen in een groter kader van de natuurkunde in zijn geheel.

Is in staat om de internationale vakliteratuur in minstens één tak van de theoretische fysica te begrijpen en te relateren aan het eigen onderzoek.

Toepassen kennis en inzicht

Is in staat om, eventueel met behulp van een stafid, een probleem uit de theoretische natuurkunde in een onderzoeksvraag te vertalen.

Is in staat om onder begeleiding van een stafid een onderzoeksplan te formuleren dat voldoet aan de wetenschappelijke standaard.

Is in staat om dit onderzoek onder begeleiding van een stafid zorgvuldig uit te voeren, en de daarbij verkregen resultaten en inzichten op juiste wijze te analyseren en te interpreteren.

Oordeelsvorming

Is in staat om de resultaten van het theoretisch onderzoek te bediscussiëren met begeleider en medestudenten, en eventueel met andere onderzoekers uit de betreffende onderzoeksgroep.

Is in staat om aan te geven wat de betekenis is van dit onderzoek voor de betreffende tak van de theoretische natuurkunde.

Is in staat om kritisch te reflecteren op het eigen onderzoek in de theoretische fysica.

Communicatie

Is in staat de resultaten van onderzoek zowel schriftelijk als mondeling in het Engels duidelijk over te brengen op een publiek van specialisten en mede-studenten.

Is in staat om onder begeleiding van een stalin een onderzoek uit te voeren in de theoretische fysica, mogelijk als onderdeel van een groter al dan niet multidisciplinair onderzoeksteam

Leervaardigheden

Heeft zich studievaardigheden eigen gemaakt om doelgericht en zelfstandig te kunnen studeren.

Heeft een academische werkwijze op het gebied van de theoretische natuurkunde die hem/haar in staat stelt hierin of daarbuiten verder te groeien.

Is gekwalificeerd om te worden toegelaten tot een promotie onderzoek op gebied van de theoretische fysica, de fysica in bredere zin, en/of de wiskunde.

Contents

Mandatory courses	30 ects
Primary electives	30 ects
Secondary electives	15 ects
Research part	45 ects
Total	120 ects

Mandatory courses (Each 10 ECTS)

- Quantum Field Theory NS-TP401M
- Statistical Field Theory NS-TP402M
- Student seminar in Theoretical Physics

Participation in 18 sessions of the Theoretical physics colloquium is required.

Electives

Primary Electives: 22,5 ECTS to choose out of the following list	Secondary Electives: 15 ECTS to choose out of the following list
<ul style="list-style-type: none"> - A Master level course in Mathematics* -General Relativity -Cosmology -String Theory -Modelling and Simulation -Field Theory in Condensed Matter -Kramers course -Soft Condensed Matter theory -Field Theory in Particle Physics -Theory for Technology 	<ul style="list-style-type: none"> -Any MSc course offered by the Graduate School of Natural Sciences. -With the consent of the programme director also other master level courses may be selected.

*Some mathematics courses offered in the third year of the bachelor programme in mathematics can replace the mandatory master level course in Mathematics. These courses are:

- Differentieerbare variëteiten
- Complexe functies
- Topologie en Meetkunde
- Maat en Integratie

- Stochastische processen
- Distributies
- Functionaalanalyse.

Note that at most one of these courses can be selected as part of the Master's programme, that the official language of education in these courses is Dutch, and that courses which are listed on the Bachelor's degree cannot be used for the Master's degree.

Research part

Research Part:	45 ECTS
Thesis	45 ECTS

Research can be done in any area of theoretical physics, provided that a staff member of the ITP is willing to act as the primary responsible supervisor.

Honours Programme

Students who are registered (1) for both the master's programme in Theoretical physics and the Master's programme in Mathematical Sciences, and (2) are registered for the Honours programme in Theoretical Physics and Mathematics and (3) fulfill all of the other requirements to successfully complete the honours programme, can do a thesis project of 60 ECTS, co-supervised by staff members of the ITP and the Mathematics Institute. Such a thesis has to contain sufficient mathematics and theoretical physics, such that it has to meet the standard of both programmes. The extra 15 credits of the thesis project exceeding the research part of the programme may be counted towards a secondary electives credit load.

Honours programme Mathematical Sciences and Theoretical Physics

Admission Criteria

The applicant should satisfy the admissions criteria for the master programmes Theoretical Physics and Mathematical Sciences, which are stated in the corresponding programme descriptions. Moreover, the application will be reviewed by a selection-committee, consisting of representatives of the two master programmes. The selection committee will base its decision on previous study results, motivation and the CV of the applicant. Typically, an applicant will have completed a bachelor degree in Physics and one in Mathematics, both with high grades.

Contents

Mandatory Physics courses	30 ects
Optional Physics courses	22,5 ects
Optional Mathematics courses	52,5 ects
Thesis	60 ects
Total	165 ects

Mandatory Physics courses

Quantum Field Theory	10 ects
Statistical Field Theory	10 ects
Student seminar in Theoretical Physics	10 ects

Optional Physics courses (7,5 ects each)

General Relativity Cosmology, String Theory, Modelling and Simulation, Field Theory in Condensed Matter, Field Theory in Particle Physics, Soft Condensed Matter theory.

Optional Mathematics courses

See the programme appendix of Mathematical Sciences.

Thesis

The thesis must be co-supervised by a staff member of the ITP and one from the Mathematical Institute. It must meet the requirements of both master's programmes.